PROJECT MANUAL

FOR

WATER SUPPLY AND TREATMENT SYSTEM
CONTRACT 4 – REVERSE OSMOSIS WATER TREATMENT PLANT

Brunswick Regional Water and Sewer H2GO
Leland, North Carolina

3081-AB

JUNE 2020



7-JUNE-20

Charles W. Davis, P.E.

THE WOOTEN COMPANY
120 North Boylan Avenue Raleigh NC 27603-1423
919.828.0531 fax 919.834.3589
License Number: F-0115

CERTIFICATION PAGE

A. Civil Engineering Design

I, Charles W. Davis, P.E., hereby certify that the Bidding Requirements, Contracting Requirements, Division 1, Division 2, Section 03300, Section 09900, Section 11064, Section 11068, Section 11094, Section 11100, Section 11240, Section 11242, Section 12900, Section 13206, Section 13420, Section 13445, and Division 14 of the Brunswick Regional Water and Sewer H2GO Reverse Osmosis (RO) Water Treatment Plant Project Manual were prepared by me or under my direct supervision.

SEAL



7-JUNE-20

B. Civil Engineering Design

I, Carl W. Scharfe, P.E., hereby certify that Section 02511, Section 13203, Section 13229, Section 13602, Division 11 and Appendix A of the Brunswick Regional Water and Sewer H2GO Reverse Osmosis (RO) Water Treatment Plant Project Manual were prepared by me or under my direct supervision.

SEAL



7-June-20

C. Architectural Design

I, Russell D. Pearlman, A.I.A., hereby certify that the Divisions 3, 4, 5, 6, 7, 8, 9, 10, 12 and Section 13121, Pre-Engineered Metal Buildings, of the Brunswick Regional Water and Sewer H2GO Reverse Osmosis (RO) Water Treatment Plant Project Manual were prepared by me or under my direct supervision.

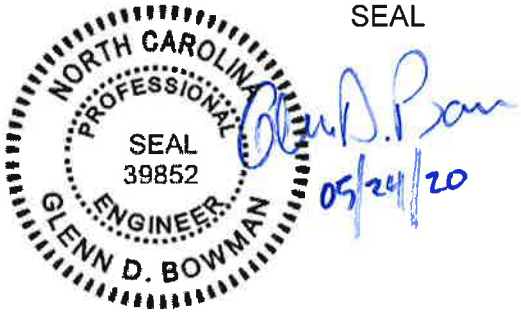
SEAL



D. Mechanical Engineering Design

I, Glenn D. Bowman, P.E., hereby certify that the Division 15 of the Brunswick Regional Water and Sewer H2GO Reverse Osmosis (RO) Water Treatment Plant Project Manual was prepared by me or under my direct supervision.

SEAL



E. Electrical Engineering Design

I, Robert E. Egan, P.E., hereby certify that the Division 16 of the Brunswick Regional Water and Sewer H2GO Reverse Osmosis (RO) Water Treatment Plant Project Manual was prepared by me or under my direct supervision.

SEAL



END OF DOCUMENT

TABLE OF CONTENTS

Document	Title	Pages
00005	Certification Page	1-2
00010	Table of Contents	1-5
	Bidding Requirements	
00100	Advertisement for Bids	1-2
00200	Instruction to Bidders	1-11
00320	Geotechnical Data	61
00410	Bid Form	1-8
00410a	Bidder's Checklist	1-1
00415	Equipment Manufacturer List	1-2
00430	Bid Bond	1-2
00432	Page for Attaching Power of Attorney (Bid Bond)	1-1
	Identification of Minority Business Participation	1-1
	Affidavit A, Listing of Good Faith Efforts	1-1
	Affidavit B, Intent to Perform Contract with Own Workforce.	1-1
	Affidavit C, Portion of the Work to be Performed by Minority Firms	1-1
	Affidavit D, Good Faith Efforts	1-1
	E-Verify Affidavit	1-1
	Iran Divestment Act	1-1
00490	Addenda	
	Contract Requirements	
00510	Notice of Award	1-1
00520	Agreement	1-7
00550	Notice to Proceed	1-1
00610	Performance Bond	1-3
00615	Payment Bond	1-3
00616	Page for Attaching Power of Attorney (P & P Bonds)	1-1
00618	Page for Attaching Certificate of Insurance	1-1
00620	Contractor's Application for Payment	1-4
	MBE Documentation for Contract Payment	1-1
	NC County Sales and Use Tax Report	1-1
00625	Certificate of Substantial Completion	1-1
00634	Certificate of Owner's Attorney & Pre-Audit Statement (Exhibit GC-A)	1-1
00700	General Conditions (EJCDC, 2007)	1-68
00800	Supplementary Conditions	1-10
	a. Permits	
	• NCDENR Erosion Control Permit	1-3
	• NC DEQ NPDES Permit	1-13
	• PWS Water System Extension Permit	1-7
	• State Stormwater Permit	1-24
	• Well Construction Permit	1-2
	b. Rules Implementing Settlement Conferences	1-9
00940	Work Change Directive	1-1
00941	Change Order(s)	1-2

Technical Specifications

Division 1 - General Requirements

Section	Title	Pages
01100	Summary of Work	1-6
	Attachment 1 – Harn R/O Systems Scope of Supply (4/17/17)	1-10
	Attachment 2 – Harn R/O Systems Scope of Supply (5/4/20)	1-4
	Attachment 3 – Contract 1 – Well Construction – Section 02526	1-13
	Attachment 4 – ECS Southeast Soil Testing Reports	1-128
01210	Allowances	1-2
	Attachment 1 – Clearwater Proposal	1-4
	Attachment 2 – Tonka Water Quotation	1-12
01312	Project Coordination	1-1
01314	Project Meetings	1-1
01330	Submittal Procedures	1-5
01450	Quality Control	1-3
01500	Temporary Facilities and Controls	1-3
01600	Product Requirements	1-3
01700	Execution Requirements	1-4
	Division 2 - Site Construction	
02082	Specialty Valves	1-6
02230	Clearing and Grubbing	1-2
02300	Earthwork	1-10
02315	Trenching for Utilities	1-10
02370	Erosion Control	1-3
02510	Water Distribution System	1-20
02511	Stainless Steel	1-7
02512	Disinfection of Potable Water System	1-6
02513	Water Pipe Liner	1-3
02530	Sanitary Sewer System	1-14
02532	Sanitary Sewer Pipe Liner System	1-3
02606	Precast Concrete Water Structures	1-5
02630	Storm Drainage System	1-5
02700	Pavement and Appurtenances	1-4
02820	Fencing (Chain Link)	1-5
02831	Cantilever Slide Gates	1-4
02920	Lawns and Grasses	1-5
	Division 3 - Concrete	
03100	Cast-in-place Concrete	1-15
03335	Concrete Finishing	1-4
03354	Polished Concrete Finish	1-5
	Division 4 - Masonry	
04010	Masonry Mortaring	1-3
04100	Masonry Grouting	1-3
04200	Unit Masonry	1-21
	Division 5 - Metals	
05050	Miscellaneous Metal	1-7
05120	Steel Framing	1-4

Division 6 - Wood and Plastics

06100 Rough Carpentry 1-2

Division 7 - Thermal and Moisture Protection

07141 Cold Fluid-Applied Waterproofing 1-3
07190 Water Repellents 1-3
07213 Pre-Engineered Building Insulation 1-5
07214 Board Insulation 1-3
07215 Batt Insulation 1-2
07260 Vapor Retarders 1-2
07412 Standing Seam Metal Roofing 1-16
07620 Sheet Metal Flashing and Trim 1-9
07640 Mineral-Fiber Cement Siding 1-3
07840 Firestopping 1-3
07920 Joint Sealers 1-5

Division 8 - Doors and Windows

08113 Stainless Steel Doors and Frames 1-3
08220 FRP Doors and Frames 1-5
08330 Overhead Coiling Doors 1-4
08360 Sectional Overhead Doors 1-5
08410 Aluminum Frame Entrances and Storefronts 1-4
08451 Fiberglass Sandwich Panel Assemblies 1-5
08710 Door Hardware 1-7
08800 Glazing 1-6

Division 9 - Finishes

09220 Metal Support Assemblies 1-4
09250 Gypsum Board 1-4
09510 Acoustical Ceilings 1-4
09651 Resilient Base 1-2
09900 Painting 1-7

Division 10 - Specialties

10110 Visual Display Boards 1-3
10300 Plaques 1-2
10400 Interior Panel Signs 1-2
10430 Dimensional Letter Signage 1-3
10508 Metal Lockers 1-2
10523 Fire Extinguishers and Cabinets 1-2
10800 Toilet Accessories 1-3
10850 Solid Surfacing Shower Stall 1-2

Division 11 - Equipment

11064 Vertical Turbine Pumps 1-8
11065 Sump Pump 1-7
11068 Submersible Well Pump 1-10
11094 Submersible Mixer 1-7
11100 Quarterturn Electric Motor Actuator 1-8
11223 Wafer Style Injection Mixers 1-3

11240	Caustic Feed System	1-11
11242	Corrosion Inhibitor Feed System	1-8
11243	Hydrofluorosilicic Acid Feed System	1-12
11265	On-site Sodium Hypochlorite Generation System	1-20
11307	Submersible Non-Clog Pump Station	1-7
11975	Carbon Dioxide Storage and Carbonic Acid Feed Equipment	1-10

Division 12 - Furnishings

12350	Wood Lab Casework	1-10
12495	Horizontal Louver Blinds	1-2
12900	Laboratory Equipment	1-2

Division 13 - Special Construction

13121	Pre-Engineered Buildings	1-11
13203	Horizontal Calcite Contactor System	1-30
13206	Prestressed Concrete Water Tank	1-9
13229	Horizontal Cartridge Filters	1-4
13420	Instrumentation	1-18
13445	Supervisory Control & Data Acquisition (SCADA) System	1-68
13602	Fiberglass Reinforced Plastic Building	1-4

Division 14 - Conveying System

14301	Hoists	1-3

Division 15 - Mechanical

15005	General Provisions Related to Plumbing Work	1-7
15072	Vibration Isolation	1-6
15085	Piping Insulation	1-9
15100	Electrical Requirements for Plumbing Equipment	1-4
15135	Gauges and Meters	1-2
15140	Plumbing Supports and Anchors	1-6
15185	Refrigerant Piping and Specialties	1-8
15190	Plumbing Identification	1-3
15260	Piping Insulation	1-5
15410	Plumbing Piping	1-8
15430	Plumbing Specialties	1-6
15440	Plumbing Fixtures	1-8
15450	Plumbing Equipment	1-4
15460	Tests and Cleaning	1-4
15500	Basic HVAC Requirements	1-10
15501	Electrical Requirements for HVAC Equipment	1-4
15503	Supports and Anchors	1-6
15509	Ductwork Insulation	1-4
15760	Terminal Heating Units	1-3
15830	Variable Refrigerant Volume HVAC System	1-13
15838	HVAC Fans	1-4
15840	Unitary Air Conditioning Units	1-8
15890	Ductwork	1-8
15910	Ductwork Accessories	1-6
15940	Air Distribution	1-4
15990	Testing, Adjusting, and Balancing	1-9
15995	HVAC Systems Commissioning	1-9

Division 16 - Electrical

16050	General Provisions Related to Electrical Work	1-7
16060	Grounding and Bonding	1-4
16070	Supporting Devices	1-4
16075	Electrical Identification	1-6
16120	Building Wire and Cable	1-6
16130	Conduit	1-10
16135	Underground Electrical	1-6
16136	Boxes	1-6
16140	Wiring Devices	1-4
16210	Utility Service Entrance	1-4
16230	Engine Generator System	1-10
16280	Surge Protective Devices	1-6
16410	Enclosed Switches	1-4
16411	Enclosed Circuit Breakers	1-4
16420	Enclosed Motor Controllers	1-16
16422	Controls and Relays	1-6
16440	Distribution Switchboard	1-10
16441	Panelboards	1-6
16442	Motor Control Center	1-10
16460	Dry Type Transformers	1-10
16475	Protective Device Study	1-4
16483	Variable Frequency Drives	1-10
16510	Interior Luminaires	1-8
16670	Lighting Protection System	1-6
16750	Intrusion Detection System	1-2
16727	Access Control	1-3
16741	Communication Network	1-10

APPENDIX A: Reverse Osmosis Equipment Procurement Project Manual

END OF DOCUMENT

ADVERTISEMENT FOR BIDS

Project: Water Supply and Treatment System
Contract 4 – Reverse Osmosis Water Treatment Plant

Owner: Brunswick Regional Water and Sewer H2GO
PO Box 2230 / 516 Village Road, NE
Leland, NC 28451

Engineer: The Wooten Company
120 N. Boylan Avenue
Raleigh, NC 27603
(919) 828-0531

Separate sealed Bids will be received until **2:00 pm, Thursday, July 16, 2020**, in the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C., at which time and place bids will be publicly opened and read aloud for the construction of the Water Supply and Treatment System Contract 4 – Reverse Osmosis Water Treatment Plant.

After Bids are opened, the Owner shall evaluate them in accordance with the methods and criteria set forth in the Instructions to Bidders. The Owner reserves the right to waive any informality or to reject any or all Bids. Unless all Bids are rejected, Award will be made to the lowest responsible Bidder, taking into consideration quality, performance and the time specified in the proposals for the performance of the Contract.

The Project consists of the following major items:

- Complete the construction of five (5) water supply well sites consisting of two (2) deep wells and associated appurtenances per site.
- Construction of a 4 MGD reverse osmosis water treatment plant including, but not limited to, treatment plant building, two (2) reverse osmosis treatment trains, chemical feed and storage systems, calcite contactor vessels, 1 MG ground storage tank, high service pumps, instrumentation, SCADA system, sitework, roadwork, yard piping, electrical and all associated appurtenances.

A pre-bid meeting will be held on Tuesday, June 23, 2020 at 10:00 am at the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C. Pre-bid meeting attendance is not mandatory, but is highly encouraged for prospective bidders.

Bidding Documents may be examined at Engineer's and Owner's office and at:
McGraw Hill Dodge Company (online)*
The Bluebook Building and Construction Network (online)*
Construct Connect (online)*
Construction Journal (online)*
*If documents are obtained online, its recommended that you notify the Engineer to ensure you receive updates and addenda.

Complete Bidding Documents may be obtained at the Issuing Office of the Engineer upon paying a fee in the amount of $200.00 for each set of documents, which includes all contracts.

With request for Bidding Documents supply the following information: Company name, contact person, street address, and phone and fax numbers for Bidding office; N. C. contractor's license with limitation and classification; indicate if the firm will be a Bidder, Supplier or Sub-Contractor.

Bidders will be required to show evidence that they are licensed to perform the work in the Bidding Documents as required by North Carolina General Statute, Chapter 87 and the Instructions to Bidders.

Bid Security in the amount of five percent of the Bid must accompany each Bid and shall be subject to the conditions provided in the Instructions to Bidders.

Owner is an Equal Opportunity Employer and does not discriminate. Small, minority and woman's businesses and labor surplus area firms are encouraged to submit bids.

END OF DOCUMENT

INSTRUCTIONS TO BIDDERS

Table of Articles

Article 1 - Defined Terms	1
Article 2 - Copies of Bidding Documents	1
Article 3 - Minority Participation Goals	2
Article 4 - Qualifications of Bidders	2
Article 5 – Examination of Bidding Documents, Other Related Data, and Site	3
Article 6 – Pre-Bid Conference	5
Article 7 - Site and Other Areas	6
Article 8 - Interpretations and Addenda	6
Article 9 - Bid Security	6
Article 10 - Contract Times	7
Article 11 - Liquidated Damages	7
Article 12 - Substitute and "Or-Equal" Items	7
Article 13 - Subcontractors, Suppliers, and Others	7
Article 14 - Preparation of Bid	8
Article 15 - Submittal of Bid	9
Article 16 - Modification and Withdrawal of Bid	9
Article 17 - Opening of Bids	9
Article 18 - Bids to Remain Subject to Acceptance	9
Article 19 - Basis of Bid; Comparison of Bids	10
Article 20 - Evaluation of Bids and Award of Contract	10
Article 21 - Contract Security and Insurance	11
Article 22 – Signing of Agreement	11
Article 23 – Sales and Use Taxes	11
Article 24 – Contract to be Assigned	11

ARTICLE 1 DEFINED TERMS

1.01 Terms used in these Instructions to Bidders will have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below which are applicable to both the singular and plural thereof.

A. Issuing Office: The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.

ARTICLE 2 COPIES OF BIDDING DOCUMENTS

2.01 Complete sets of the Bidding Documents in the number and for the amount stated in the Advertisement for Bids may be obtained from the Issuing Office as identified in the advertisement. The deposit/fee will be refunded in accordance with the conditions indicated in the Advertisement for Bids.

2.02 Complete set of Bidding Documents must be used in preparing bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete set of Bidding Documents.

2.03 Owner and Engineer in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids for the Work and do not confer a license or grant for any other use.

ARTICLE 3 MINORITY PARTICIPATION GOALS

3.01 Bidders must make positive efforts to utilize minority businesses. There is no required goal for participation of minority business for this project; however, Contractor shall show good faith efforts to solicit bids from MBE/WBE subcontractors and suppliers.

3.02 Bidder shall be required to submit identification of firms and Affidavits as required in the Bid Form.

ARTICLE 4 QUALIFICATIONS OF BIDDERS

4.01 Bidders are notified that Chapter 87, Article 1 of the General Statutes of North Carolina, will be observed in receiving and awarding contracts. Bidders for this Project must be licensed in the following classifications and limitations:

A. General: Must have a General Contractors license with one of the following classifications with a limitation appropriate to the bid amount.
   1. Classifications:
      a. Unclassified
      b. Public Utilities Contractor
      c. Public Utilities (Water Purification and Sewage Disposal)
   2. Limitations:
      a. "Limited": Up to $500,000
      b. "Intermediate": Up to $1,000,000
      c. "Unlimited": No limit on contract value

4.02 To demonstrate Bidder's qualifications to perform the Work prior to award, within five (5) days of Owner's request, Bidder shall submit written evidence which shall include, but not be limited to, the following:

A. Official name of Bidder and length of time the organization has been in business under present name.

B. Address, phone and fax numbers of main place of business. Address and phone numbers of company office that will manage the Project if different than above.

C. Officers of the company. Name and resume of designated project manager and field superintendent. Number of regular employees of the organization.

D. Latest financial statement showing assets and liabilities of the company.

E. Name and home office address of the Surety proposed and the name and address of the responsible local claim agent.

F. Listing of completed projects of similar size and type. Provide name and phone number of project owner representative.

G. Existing work commitments.

H. List of work to be subcontracted. Name and addresses of subcontractors.

I. Names and addresses of major material Suppliers.

J. Statement that bidder is capable of completing the project within the stated time.

4.03 Any additional submittals required with the General Conditions, Supplementary Conditions, or the State and Federal Special Conditions shall be submitted within the stated timeframes and on the supplied forms, where available.

4.04 Failure or refusal to furnish information requested shall constitute a basis for disqualification of Bidder and the withholding of the Bid Bond.

ARTICLE 5 EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND SITE

5.01 Subsurface and Physical Conditions

A. The Supplementary Conditions identify:
   1. Those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used, if any, in preparing the Bidding Documents.
   2. Those drawings of physical conditions in or relating to existing surface and subsurface structures at or contiguous to the Site (except Underground Facilities) that Engineer has used in preparing the Bidding Documents.

B. Copies of reports and drawings referenced in Paragraph 5.01.A will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.02 of the General Conditions has been identified and established in Paragraph 4.02 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions or information contained in such reports or shown or indicated in such drawings.

5.02 Underground Facilities

A. Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site is based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.

5.03 Hazardous Environmental Condition

A. The Supplementary Conditions identify those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that Engineer has used in preparing the Bidding Documents.

B. Copies of reports and drawings referenced in Paragraph 5.03.A will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.06 of the General Conditions has been identified and established in Paragraph 4.06 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

5.04 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions and Underground Facilities, and possible changes in the Bidding

Documents due to differing or unanticipated conditions appear in paragraphs 4.02, 4.03, and 4.04 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work appear in paragraph 4.06 of the General Conditions.

5.05 On request, Owner will provide Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for submission of a Bid. Bidder shall fill holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all applicable Laws and Regulations relative to excavation and utility locates.

5.06 It is the responsibility of each Bidder before submitting a Bid to:

A. Examine and carefully study the Bidding Documents, the other related data identified in the Bidding Documents, and any Addenda;

B. Visit the Site and become familiar with and satisfy Bidder as to the general, local and Site conditions that may affect cost, progress, and performance of the Work;

C. Become familiar with and satisfy Bidder as to all federal, state and local Laws and Regulations that may affect cost, progress, and performance of the Work;

D. Carefully study all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in paragraph 4.02 of the General Conditions, and (2) reports and drawings of Hazardous Environmental Condition at the Site which have been identified in the Supplementary Conditions as provided in paragraph 4.06 of the General Conditions;

E. Obtain and carefully study (or assume responsibility for not doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto;

F. Agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents;

G. Become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;

H. Correlate the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents;

I. Promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder; and

J. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.

5.07 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid is premised upon performing and furnishing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in Bidding Documents and the written resolutions thereof by Engineer are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

5.08 After Bids have been submitted, Bidder shall not assert that there was a misunderstanding concerning the quantities of Work or of the nature of Work to be done.

5.09 Bidding Documents contain the provisions required for construction of the Project. Information obtained from an officer, agent, or employee of the Owner or any other person shall not affect the risks or obligations assumed by the Bidder or relieve him from fulfilling the conditions of the contract.

5.10 Failure or omission of Bidder to do the foregoing shall in no way relieve Bidder from the obligations in respect to his Bid.

ARTICLE 6 PRE-BID CONFERENCE

6.01 Pre-Bid Conference will be held at.

A. Location: Brunswick Regional Water and Sewer H2GO Office

B. Time: 10:00 a.m.

C. Date: Tuesday, June 23, 2020

6.02 Representatives of Owner and Engineer will be present to discuss the Project. Bidders are encouraged to attend and participate in the conference but it is not mandatory. Engineer will transmit to Bidding Document holders of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 7 SITE AND OTHER AREAS

7.01 The Site is identified in the Bidding Documents. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by Owner unless otherwise provided in the Bidding Documents. Additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment to be incorporated in the Work are to be obtained and paid for by Contractor.

ARTICLE 8 INTERPRETATIONS AND ADDENDA

8.01 Questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. Questions may be faxed or e-mailed. Questions will not be taken by phone. Engineer's fax number is 1-919-834-3589. E-mail address is cdavis@thewootencompany.com.

8.02 Submittal with questions shall include the project name, the person's name submitting the question, firm, telephone number, fax number and e-mail when available.

8.03 Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to parties recorded by Engineer as having received the Bidding Documents. Questions received less than five working days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other written interpretations or clarifications will be without legal effect.

8.04 Addenda may be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer.

ARTICLE 9 BID SECURITY

9.01 Bid must be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder's maximum Bid price and in the form of a certified or bank check or a Bid Bond (on the form attached) issued by a surety meeting the requirements of paragraphs 5.01 and 5.02 of the General Conditions.

9.02 The Bid security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required contract security and met the other conditions of the Notice of Award, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and provide the required contract security within 10 days after the Notice of Award, Owner may annul the Notice of Award and the Bid security of that Bidder will be forfeited. The Bid security of other Bidders whom Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of seven days after the Effective Date of the Agreement or the end of the Bid holding period as indicated in the Bid Form, whereupon Bid security furnished by such Bidders will be returned.

9.03 Bid security of other Bidders whom Owner believes do not have a reasonable chance of receiving the award will be returned within seven days after the Bid opening.

ARTICLE 10 CONTRACT TIMES

10.01 The number of days within which, or the dates by which, the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

ARTICLE 11 LIQUIDATED DAMAGES

11.01 Provisions for liquidated damages, if any, are set forth in the Agreement.

ARTICLE 12 SUBSTITUTE AND OR-EQUAL ITEMS

12.01 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, including Addenda. Bidders may propose "or equal" materials and equipment, which if approved by Engineer will be identified by Addendum. The materials and equipment described in the Bidding Documents establish a standard of required type, function, and quality to be met by any proposed "or-equal" item. No item of material or equipment will be considered by Engineer as an "or-equal" unless written request for approval has been submitted by Bidder and has been received by Engineer at least 15 days prior to the date for receipt of Bids. Each such request shall conform to the requirements of Paragraph 6.05 of the General Conditions. The burden of proof of the merit of the proposed item is upon Bidder. Engineer's decision of approval or disapproval of a proposed item will be final. Bidders shall not rely upon approvals unless set forth in an Addendum

ARTICLE 13 SUBCONTRACTORS, SUPPLIERS, AND OTHERS

13.01 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or others to be submitted to Owner in advance of a specified date prior to the Notice of Award, the apparent Successful Bidder, and any other Bidder so requested, shall within five days after Bid opening, submit to Owner a list of such Subcontractors, Suppliers, and others proposed for those portions of the Work for which such identification is required. An experience statement shall accompany such list with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, and others if requested by Owner. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, or others, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit a substitute, without an increase in the Bid.

13.02 If apparent Successful Bidder declines to make any such substitution, Owner may determine such Bidder to be non-responsive, reject the Bid, and award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers, individuals, or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Subcontractor, Supplier, or others so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to revocation of such acceptance after the Effective Date of the Agreement as provided in paragraph 6.06 of the General Conditions.

13.03 Contractor shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom Contractor has reasonable objection.

13.04 The Contractor shall not award work to Subcontractor(s) in excess of the limits stated in SC 6.06.

ARTICLE 14 PREPARATION OF BID

14.01 The Bid form is included with the Bidding Documents. Additional copies may be obtained from Engineer.

14.02 Bids must be made on required Bid Form. Blanks on the Bid Form shall be completed by printing in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid Price shall be indicated for each item listed therein, or the words "No Bid," "No Change," or "Not Applicable" entered. Unsigned modifications to Bid Form may cause Bid to be rejected.

14.03 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid form.

14.04 The postal and email addresses and telephone number for communication regarding the Bid shall be shown.

14.05 The Bid shall contain evidence of Bidder's authority and qualification to do business in the state or locality where the Project is located. Bidder's state contractor license number shall also be shown on the Bid form.

14.06 Bid Form shall be executed as follows:

A. Sole Owner: Evidenced by word "owner" appearing after the name of the person-executing document.

B. Partnership: Executed in the partnership name and signed by a partner, whose title shall appear under the signature, accompanied by evidence of authority to sign.

C. Corporation: Executed in the corporate name by the president or vice-president or other corporate officer accompanied by evidence of authority to sign. Corporate seal shall be affixed and attested by secretary or assistant secretary and the title of the office of such person shall appear after their signatures.

D. Joint Venture: Executed by each member of the Joint Venture in the above form for sole owner, partnership, or corporation, whichever form is applicable.

E. Limited Liability Company: Executed in the name of the firm by a member and accompanied by evidence of authority to sign.

F. Signatures shall be signed in ink and properly witnessed.

G. Names shall be typed or printed in ink below the signatures.

H. Official mailing address of owner, partnership, corporation, or joint venture shall be shown below the signature.

ARTICLE 15 SUBMITTAL OF BID

15.01 The Owner, at the location and time indicated in the Advertisement for Bids, will receive sealed Bids. Bids received after the indicated time and date shall not be considered.

15.02 Bids **shall be submitted** to the BRWS H2GO front office for time stamp of receipt.

15.03 Bid form is to be completed and submitted with all the attachments outlined in Article 7 of the Bid Form. The complete list of required bid documents can also be found in the attached Bidder's Checklist. The checklist shall be the first page of all bids submitted.

15.04 Submit Bid in an opaque sealed envelope plainly marked on the outside with the following:
Water Supply and Treatment System Contract 4 – Reverse Osmosis Water Treatment Plant
Bidder's name and address
N.C. Contractor's license number with classification and limitation

15.05 If forwarded by mail or other delivery system, enclose sealed envelope containing Bid and information listed above in another envelope with notation "BID ENCLOSED" and addressed to:
Bob Walker, Executive Director
Brunswick Regional Water and Sewer H2GO
PO Box 2230
516 Village Road, NE
Leland, NC 28451

When using the mail or other delivery system, the Bidder is totally responsible for the mail or other delivery system delivering the Bid at the place and prior to the time indicated in the Advertisement for Bid.

ARTICLE 16 MODIFICATION AND WITHDRAWAL OF BID

16.01 A Bid may be modified or withdrawn by an appropriate document duly executed in the manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Modifications shall indicate only the amount to be added to or deducted from the Bidder's Bid amount as submitted on the Bid Form.

16.02 No Bid may be withdrawn after the Bid opening for a period of time as indicated in the Bid Form except in accordance with the provisions of N. C. General Statues 143-129.1.

ARTICLE 17 OPENING OF BIDS

17.01 Bids will be opened at the time and place indicated in the Advertisement for Bids and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

ARTICLE 18 BIDS TO REMAIN SUBJECT TO ACCEPTANCE

18.01 Bids will remain subject to acceptance for the period of time stated in the Bid form, but Owner may, at its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 19 BASIS OF BID; COMPARISON OF BIDS

19.01 Lump Sum and Unit Price

A. Bidders shall submit a Bid on a lump sum and unit price basis as set forth in the Bid Form. Bid shall include the specified allowance.

ARTICLE 20 EVALUATION OF BIDS AND AWARD OF CONTRACT

20.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, non-responsive, unbalanced, or conditional Bids. Owner further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to be non-responsive. Owner also reserves the right to waive informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder.

20.02 More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of Bids in which that Bidder has an interest.

20.03 In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested in the Bid Form or prior to the Notice of Award.

20.04 In evaluating Bidders, Owner will consider the qualifications of Bidders and may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted as provided in the Supplementary Conditions.

20.05 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, individuals, or entities to perform the Work in accordance with the contract Documents.

20.06 In determining the lowest responsible Bidder, Owner shall take into consideration the past performance of Bidder on construction contracts with particular concern given to completion times, quality of work, cooperation with other contractors, and cooperation with owner.

20.07 Owner reserves the right to reject Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy Owner that such Bidder is properly qualified to carry out the obligations of the Agreement and to complete the Work described therein.

20.08 Should the Owner adjudge that the apparent low Bidder is not the lowest responsible Bidder by virtue of the above information, said apparent low Bidder will be so notified and his Bid security shall be returned.

20.09 If the Contract is to be awarded, Owner will award the Contract to the responsible Bidder whose Bid, conforming with all the material terms and conditions of the Instruction to Bidders, is lowest, price and other factors considered. If detailed in the bid form, factors such as discounts, transportation costs, and life cycle costs may be used to determine which bidder, if any, is to be offered the award.

ARTICLE 21 CONTRACT SECURITY AND INSURANCE

21.01 Article 5 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to Performance Bond, Payment Bond, and other Bonds and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it must be accompanied by such Bonds.

ARTICLE 22 SIGNING OF AGREEMENT

22.01 When Owner gives a Notice of Award to the Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents which are identified in the Agreement as attached thereto. Within 10 days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement, Bonds, Insurance, and other documents to Owner. Within 10 days thereafter, Owner shall deliver one fully signed counterpart to Successful Bidder with a complete set of the Drawings with appropriate identification.

22.02 In case of failure of Bidder to execute the Agreement, Owner may at his option consider Bidder in default, in which case Bid Bond accompanying Bid shall become the property of the Owner.

ARTICLE 23 SALES AND USE TAXES

23.01 The Owner is NOT exempt from sales tax. Said taxes must be included in the bid.

ARTICLE 24 CONTRACT TO BE ASSIGNED

24.01 Owner as "Buyer" has executed a contract with Harn R/O Systems, Inc. (Reverse Osmosis Equipment Manufacturer (ROEM)) as "Seller" for the procurement of goods and special services for Reverse Osmosis Equipment. The materials and equipment provided for in the procurement contract are to be furnished and delivered to the Point of Destination for installation by the Contractor. Owner will assign said procurement contract to Contractor as set forth in the agreement. Contractor will accept the assignment and assume responsibility for the "Seller" which will become a Subcontractor or Supplier to Contractor.

END OF DOCUMENT

GEOTECHNICAL DATA

PART 1 GENERAL

1.01 INVESTIGATION

A. Soil and subsurface investigations were conducted at the site, the results of which are to be found in the report issued by:
   1. Soil Consultant:
      S&ME
      3201 Spring Forest Road
      Raleigh, NC 27616
      919-872-2660
   2. Report Title:
      Geotechnical Engineering Report
      Brunswick Water Treatment Plant
      Belville, North Carolina
      S&ME Project No. 1305-16-116

B. A copy of the report is appended.

C. Bidders are urged to examine soil investigation data and to make their own investigation of the site before bidding.

1.02 INTERPRETATION

A. Soil investigation data are provided only for information and the convenience of bidders. The Owner and Engineer disclaim any responsibility for the accuracy, true location, and extent of the soils investigation that has been prepared by others. They further disclaim responsibility for interpretation of that data by bidders, as in projecting soil-bearing values, rock profiles, soil stability, and the presence, level, and extent of underground water.

B. Soil investigation data are not part of the Contract Documents.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF DOCUMENT

Geotechnical Engineering Report
Brunswick Water Treatment Plant
Belville, North Carolina
S&ME Project No. 1305-16-116

S&ME

Prepared for:
The Wooten Company
120 North Boylan Avenue
Raleigh, NC 27603

Prepared by:
S&ME, Inc.
3201 Spring Forest Road
Raleigh, NC 27616

December 22, 2016

December 22, 2016

The Wooten Company
120 North Boylan Avenue
Raleigh, North Carolina 27603

Attention: Mr. Charles Davis, P.E.

Reference: **Geotechnical Engineering Report**
Brunswick Water Treatment Plant
Belville, North Carolina
S&ME Project No. 1305-16-116
NC PE Firm License No. F-0176

Dear Mr. Davis:

S&ME, Inc. (S&ME) has completed our geotechnical exploration for the proposed Reverse Osmosis (RO) Water Treatment Plant (WTP) in Belville, North Carolina. The exploration was performed in general accordance with S&ME Proposal No. 13-1600338 dated July 13, 2016. These services were authorized on August 10, 2016 by The Wooten Company's Standard Form of Agreement Between Engineer and Geotechnical Engineer for Professional Services.

This report presents a brief discussion of our understanding of the project, results of the exploration, and our geotechnical conclusions and recommendations regarding the proposed structures.

S&ME appreciates the opportunity to provide our geotechnical engineering services for this project. If you have questions or need additional information regarding this report, please contact us.

Sincerely,

S&ME, Inc.

Kevin A. Nadeau, P.E.
Geotechnical Group Leader
NC Registration No. 34358

NORTH CAROLINA PROFESSIONAL SEAL 34358 ENGINEER KEVIN A. NADEAU 12-22-16

Finley Lloyd, P.E.
Project Manager

Senior reviewed by John R. Browning, P.E.

Table of Contents

1.0 Project Information and Site Description 1

2.0 Field Exploration 2

3.0 Laboratory Testing 3

4.0 Regional Geology 3

5.0 Subsurface Conditions 4

5.1 Surface Materials 4

5.2 Coastal Plain Soils 4

5.3 Water Levels 4

6.0 Conclusions and Recommendations 4

6.1 General Discussion 5

6.2 Earthwork 5

6.2.1 Site Preparation and Undercut 5

6.2.2 Excavations 6

6.2.3 Construction Groundwater Control 6

6.2.4 Use of On-Site Materials as Structural Fill 6

6.2.5 Fill Placement and Compaction 7

6.3 Pavements 7

6.3.1 Asphalt Pavement 7

6.3.2 Concrete Pavement 8

6.4 Foundation Recommendations 9

6.4.1 General 9

6.4.2 1 MG Storage Tank 9

6.4.3 Backwash Holding Tank 10

6.4.4 RO Treatment and Chemical Feed Facility 10

6.4.5 Calcite Facility 11

6.4.6 Miscellaneous Structures 11

6.4.7 Footing Evaluations 12

6.5 Floor Slabs 12

6.6 Seismic Design Parameters 12
6.7 Liquefaction Potential 12
6.8 Hydrostatic Uplift Forces 12
6.8.1 Rigid Mat Foundation Projection Beyond Structure Exterior Face 13
6.8.2 Increasing Foundation Thickness 13

7.0 Limitations of Geotechnical Report 13

Appendices

Appendix I – Figures
Appendix II – S&ME Exploration Logs
Appendix III –Laboratory Test Results

1.0 Project Information and Site Description

Our understanding of project information is based on the following:

- Your proposal request via an email to Mr. Kevin Nadeau, P.E. with S&ME on July 11, 2016.
- *Preliminary Water Treatment Plant Site Layout* prepared by The Wooten Company dated July 11, 2016.
- *Well and Pilot Plant Location Map* Figure 1.1 prepared by The Wooten Company (undated).
- Google Earth aerial imagery.
- The following structural information provided to S&ME at a project meeting on October 10, 2016 by The Wooten Company:

Proposed Structure	Approximate Footprint Dimensions	Existing Grade Elevation (ft)	Top of Wall Elevation (ft)	Top of Slab Elevation (ft)	Subgrade Elevation (ft)	Final Grade Elevation (ft)	Weight (lbs)
RO Building (Main Plant)	70' x 120'	26	54[a]	30 FFE	28	29.88	--
RO Building (Chem Area)	60' x 60'	26	42[b]	30 FFE	28	29.88	--
RO Building (Admin Area)	20'-8"x70'-8" (east side) 15'-6"x65'-4" (south side)	26	42[c]	30 FFE	28	29.88	--
CO2 Storage	41'-6" x 31'-6"	26	42.0[d]	29.25	27.25	29	43,500/ tank
Calcite Contactors	50' x 70'	26	70[e]	30	28	29.75	140,000/ vessel[f]
Calcite Contactors (future)	50' x 35'	26	70[e]	30	28	29.75	140,000/ vessel[f]
Ground Storage Tank	80'-0" inside dia.	26	52.67	26	24.67	28.5 - 28.75	8,365,222[g]
Stand-by Generator	62' x 14'	26	--	29.25	27.25	29	--
Backwash Holding Tank	30' diameter	26	27.5	15.5 @ side wall, 14.25 @ center	13.5 @ side wall, 12.25 @ center1	26.5	460,000[g]

a. Represents 24 ft eave height.
b. Represents 12 ft eave height.
c. Represents 12 ft eave height.
d. Represents 14 ft eave height at high end. (single slope roof)
e. Represents 40 ft ridge height.
f. Six (6) vessels total. Includes tank weight.
g. Weight of water stored. Does not include structure weight.

We understand that The Wooten Company is in the process of designing a Reverse Osmosis (RO) Water Treatment Plant (WTP) in Belville, North Carolina for Brunswick Regional Water & Sewer H2GO. Based on the preliminary information provided, we understand the proposed plant will include a primary water treatment building, calcite treatment units, 1 million gallon (MG) ground storage tank, a high service pump station, a 30-foot diameter Backwash Holding Tank, and several equipment pads as detailed above, along with paved access drives.

At the time of our reconnaissance, the site was generally cleared, grass-covered land. The photo below was taken from the southeast side of the site facing northwest.



Site grading will include fill depths of up to 4 feet and local excavation depths of up to 14 feet below existing grades for the Backwash Holding Tank.

The Wooten Company requested that S&ME perform geotechnical engineering services to aid in the design and construction of the water treatment plant.

2.0 Field Exploration

An S&ME geotechnical professional marked planned boring locations in the field using a hand-held GPS unit with northing and easting coordinates obtained from a CAD file provided by The Wooten Company on October 19, 2016. S&ME performed 17 soil test borings within the planned Water Treatment Plant and 1 soil test boring at the proposed Wastewater Treatment Plant Sewer Outfall location on the west bank of the Brunswick River. The outfall boring was performed for subsurface information only; geotechnical analysis of this structure is not included in this report.

Soil borings were advanced to depths ranging from 10 to 75 feet below the existing ground surface using 3 ¼ -inch hollow stem continuous flight augers and mud rotary drilling techniques with an ATV-mounted Diedrich D-50 drill rig. Within the soil test borings, samples of subsurface soils were obtained at approximately 2½-foot intervals to a depth of 10 feet and at 5-foot intervals below 10 feet using a split-spoon sampler. Standard penetration tests were conducted in conjunction with split-spoon sampling in general accordance with ASTM D 1586 -11.

The boreholes were observed for groundwater at completion of drilling. Selected boreholes were left open for 24 hours after drilling and observed for 24-hour stabilized groundwater levels. Following groundwater observations, each borehole was backfilled with soil cuttings and a commercial hole closure device was placed in each borehole prior to departure from the site.

One bulk sample of auger cuttings was obtained at boring B-5 from 1 to 5 feet. A Shelby tube sample was attempted at boring B-13 from 28 to 30 feet, but no recovery was obtained.

3.0 Laboratory Testing

Split spoon samples from the test borings were returned to S&ME's Raleigh laboratory for visual classification by a geotechnical professional. The soil samples were visually examined to estimate the distribution of grain sizes, plasticity, organic content, moisture condition, color, presence of lenses and seams and apparent geological origin. The soils were classified in general accordance with the Unified Soil Classification System. Similar soils were grouped into strata on the logs. The strata contact lines represent approximate boundaries between the soil types; the actual transition between the soil types in the field may be gradual in both the horizontal and vertical directions. The results of the classifications, as well as the field test results, are presented on the individual boring logs included in the Appendix.

In addition to the visual classifications, select samples were submitted for further laboratory testing. The laboratory testing program for this project included determinations of moisture content, plasticity indices, grain size, moisture-density relationship testing (Standard Proctor), and California Bearing Ratio (CBR) testing. Laboratory testing was performed in accordance with applicable ASTM standards.

Natural moistures of the selected split spoon samples ranged from 17.0 to 46.8 percent. Natural moisture of the bulk sample was 17.4 percent (B-5, 1 to 5 feet). Atterberg limits testing of selected samples indicated liquid limits ranging from 27 to 42 and corresponding plasticity indices ranging from 2 to 23. Grain size testing of selected samples indicated fines content (silt and clay) ranging from 6.6 to 16.8 percent and sand contents ranging from 83.2 to 93.4 percent.

Standard Proctor testing of the bulk sample revealed a maximum dry density of 121.4 pounds per cubic foot (pcf) with a corresponding optimum moisture content (OMC) of 12.3 percent. Natural moisture of the bulk sample indicates the soils are about 5.1 percent wet of OMC. CBR testing revealed a corrected CBR value of 11.3 (SW-SC material). After a soaking period of about 96 hours, the CBR sample exhibited no apparent swell.

4.0 Regional Geology

The site is located within the Coastal Plain geologic province of North Carolina. Coastal Plain deposits generally consist of poorly consolidated sediments which include gravel, sands, silts, clays, limestones and other sedimentary rocks. The deposits of the Coastal Plain form a wedge shape block that increases in thickness from an edge along its northwestern border, the Fall Line, to a thickness on the order of one-half mile along the coast.

The Coastal Plain province can be physiographically divided into the Upper Coastal Plain subprovince and the Lower Coastal Plain subprovince. The Upper Coastal Plain is located between the Lower Coastal Plain and Piedmont formations and is topographically similar to the Piedmont. Unconsolidated wind-blown dune deposits are frequently located in the Upper Coastal Plain in close proximity to the Piedmont. The Lower Coastal Plain is located between the Upper Coastal Plain and the Atlantic Ocean. The Lower Coastal Plain consists of younger, less consolidated formations and typically has very gently sloping topography and a groundwater depth of less than 10 feet.

The proposed facility is located within the Lower Coastal Plain subprovince.

5.0 Subsurface Conditions

A general description of subsurface conditions is provided below. For more detailed information the Boring Logs in the Appendix should be reviewed.

5.1 Surface Materials

A surficial layer of topsoil, approximately 2 to 3 inches in thickness, was encountered at all borings. Topsoil is typically a dark-colored soil material containing roots, fibrous matter, and/or other organic components, and is unsuitable for engineering purposes. The topsoil depths provided in this report are based on measurements made at the time of drilling and should be considered approximate. We note that the transition from topsoil to underlying natural soils may be gradual. Actual topsoil depths should be expected to vary across the site.

5.2 Coastal Plain Soils

Coastal Plain deposits were encountered underlying the topsoil layer at all borings and extended to the target boring termination depths of 10 to 75 feet. The soils were generally described as loose to very loose clayey sands and silty sands (SC and SM) and very soft to soft low plasticity sandy clays and sandy silts (CL and ML) within 3 to 6 feet of the existing ground surface. Below a depth of 6 feet, soils were typically described as loose to medium dense clayey sands, silty sands, and sands (SC, SM, SP, and SP-SM) with occasional layers exhibiting very loose consistency below a depth of about 12 feet. One isolated layer of high plasticity clay (CH) was encountered by the borings (B-16 at 14 to 15 feet). SPT N-values typically ranged from 1 to 4 blows per foot (bpf) within 3 to 4 feet of the existing ground surface with exception at B-9, where these very loose soils extended to about 5 ½ feet. Below a depth of 3 to 5½ feet, SPT N-values typically ranged from 5 to 25 bpf with occasional higher and lower values.

5.3 Water Levels

Water level measurements were taken within the boreholes at the time of drilling (noted as "ATD" on the Boring Logs) and approximately 24 hours after completing drilling. Water was recorded in all borings at typical depths of approximately 2 to 4 feet below the existing ground surface, approximately 24 hours after completing drilling. A 24-hour level was not measured in boring B-18. The ATD level at B-18 was 7.5 feet below the existing ground surface. Groundwater elevations can be expected to fluctuate due to seasonal variations in rainfall, evaporation, and other factors.

6.0 Conclusions and Recommendations

The following conclusions and recommendations are based on our field exploration, laboratory testing, our understanding of the proposed construction, our engineering analyses, experience with similar projects and subsurface conditions, and our correspondence with you. If the WTP development plans are different from those indicated, we should be provided the opportunity to review and comment upon the recommendations of this report so that they may be confirmed, extended, or modified as necessary. If subsurface conditions adverse to those indicated by this report are encountered during construction, those differences should be reported to us for review and comment.

6.1 General Discussion

Based on our review of the provided project information and geotechnical analyses of field and laboratory testing data, it is our opinion that this site is adaptable for the planned WTP facility provided that recommendations presented herein are implemented during construction. Primary geotechnical considerations for this site include the following:

- **Very Loose Near-surface Soils.** These soils typically extend to depths of 3 to 4 feet below the ground surface. Removal and replacement is recommended.
- **Total Settlement of the 1MG Storage Tank.** Total settlement estimates of the 80-foot diameter ground-supported concrete tank range from approximately 3 to 4 inches, assuming a relatively rigid reinforced concrete foundation. If this magnitude of settlement is unsatisfactory, we recommend preloading the subsoils by hydro testing the tank or the use of ground improvement to reduce total settlement magnitudes.
- **Overlapping Stresses from the 1MG Storage Tank.** Due to the close proximity of several facility structures to the tank, soil stresses from the tank could influence performance of these foundations. We recommend that the tank be constructed, filled, and settlement stabilized prior to construction of the adjacent foundations.
- **Fill-Induced Settlement.** Settlements due to the 2 to 4 feet of new site fill should be allowed to substantially complete prior to construction of settlement-sensitive structures. We recommend that all site grading be completed prior to any structure construction.
- **Shallow Groundwater.** Construction dewatering will be required for all site excavations.

The following sections present our conclusions and recommendations regarding site development.

6.2 Earthwork

6.2.1 Site Preparation and Undercut

Initial site preparation should include stripping of organics and topsoil, and any other deleterious materials. Borings performed for this exploration indicate that topsoil thickness is about 3 inches. Logging operations often disturb the upper soils, mixing topsoil with undisturbed soils below, thus increasing stripping depths. This is especially true if logging occurs during wet conditions.

After initial site preparation is complete, the exposed subgrade of areas to receive fill and areas near final grades should be evaluated by the geotechnical engineer or their representative. Based on the very loose near-surface soils and shallow groundwater encountered by the borings at this site, the ground surface is not expected to support rubber-tired construction equipment. We recommend that the near surface soils (estimated to be 3 to 4 feet in depth) be removed from the footprints of all structures and pavements at this site, plus 5 feet outside. The undercuts will need to be performed with tracked excavators, top loading dump trucks. The undercut excavations will also require dewatering as recommended in Section 6.2.3 of this report. The undercut bottoms should be observed by the geotechnical engineer to determine if sufficient undercut has occurred prior to fill placement. The undercut excavations should be backfilled with structural fill placed and compacted in accordance with the recommendations in this report.

Site grading will be difficult during periods of extended rainfall that generally occur during the winter months. To reduce potential earthwork problems, site preparation and grading should be scheduled

during the typically drier months of May through November, if possible. After areas are undercut and fill placed heavy rubber-tired construction equipment should not be allowed to operate on exposed subgrades during wet conditions. Even during drier periods of the year, we recommend that exposed subgrades be sloped and sealed at the end of each day to promote runoff and reduce infiltration from rainfall.

6.2.2 Excavations

Undercut excavations should be performed with tracked excavators, top loading dump trucks. This will help reduce disturbance of soils at the undercut bottoms. Haul roads will have to be constructed to provide access for dump trucks. Soils to be excavated for undercutting, footings, utilities, pavements, and Backwash Holding Tank should be able to be performed with tracked equipment.

All excavations should be performed in accordance with applicable OSHA regulations. The Contractor is solely responsible for site safety. Excavation shoring and sloping for excavations deeper than 20 feet must be designed by a licensed Professional Engineer employed by the Contractor.

6.2.3 Construction Groundwater Control

Groundwater control will be required for all site excavations and for the recommended structure undercuts. The means and methods of groundwater control are typically left to the discretion of the Contractor. Groundwater control means and methods used should be sufficient to lower the groundwater level prior to excavation to a level of 2 feet or more below the required bottom of construction excavation.

Continuous pumping (24 hours per day, 7 days per week) from deep, cased sumps or well points will likely be needed to provide the necessary construction groundwater control. Sump and/or well point spacing should be sufficient to lower the groundwater level to a depth of 2 feet or more below the undercut or construction excavation grade (including slope faces). Continuous pumping may be required to lower the groundwater level.

Groundwater control must be established prior to excavation of planned bottom of excavation. Excavation to final subgrade prior to effectively dewatering, or loss of groundwater control during construction, may result in disturbance of the bearing surface. Repair of disturbed soils would require deepening the excavation to remove and replace disturbed soils, which may require increasing the depth to which groundwater control is required and laying back of construction excavation slopes.

We anticipate horizontal seepage at the contact between clayey soil layers and overlying sandy soils. This may result in seeps in construction excavation slopes at these contacts, even when the groundwater level is controlled 2 feet below the construction excavation grade. If significant seepage occurs at these contacts that potentially destabilizes the construction excavation slope, it may be necessary to intercept and control the seepage with slope drains.

6.2.4 Use of On-Site Materials as Structural Fill

The soil types encountered within the anticipated excavation depths at this site include Unified Soil Classification designations of ML, CL, SM, and SC. We recommend that the sandy soils (SC and SM), which

are the predominate soil types to be excavated, be used for structural fill. These soils are expected to be well above compactable levels (especially those soils below the water table) and drying of these soils will be required prior to placement and compaction. Use of lime may be needed if natural drying is not effective.

Offsite borrow should consist of sandy soils having Unified soil classifications of SW, SM, SC, and SP. SW and SP soils are preferable as the initial fill lift in undercut bottoms. These soils should have standard Proctor maximum dry unit weights of at least 110 pcf, a maximum plasticity index of 15 percent, and maximum particle size of 2 inches.

6.2.5 Fill Placement and Compaction

Settlements due to the 2 to 4 feet of new site fill should be allowed to substantially complete prior to construction of settlement-sensitive structures. We recommend that all site grading be completed prior to any structure construction.

All structural fill should be placed in 8 to 10-inch loose lifts (6 to 8 inches for utility trench backfill) and compacted to at least 95 percent of the standard Proctor maximum dry density (MDD) (ASTM D 698). The moisture content of structural fill should be maintained within +/- 3 % of optimum moisture during compaction. The top 12 inches beneath pavements and structures should be compacted to at least 98 percent of the material's MDD. Drying of soils to achieve compaction should be anticipated, especially for soils excavated below the water table. Use of lime may be needed if natural drying is not effective.

Fill placement and compaction should be observed by a qualified soil technician working under the supervision of the geotechnical engineer. An appropriate number of soil density tests should be conducted to confirm that adequate fill compaction is achieved.

6.3 Pavements

Pavement design procedures are based on AASHTO "Guide for Design of Pavement Structures" (1993) and associated literature. Traffic loading was not provided to S&ME at the time of this report. Given the planned site use, we anticipate the design traffic will consist of tractor trailer delivery trucks. For the purposes of this report, we have assumed an 18-Kips ESAL value of 30,000 for heavy duty pavements (entrances and main drive lanes) and car-traffic only in parking areas where truck traffic is excluded. The pavement analysis was based on an initial serviceability index of 4.2, a terminal serviceability index of 2.0 and a 20-year design life. Once traffic loading information is available, we request the opportunity to review our recommendations and revise if needed.

6.3.1 Asphalt Pavement

Based on the soil types present on site and the results of the laboratory testing data, a design CBR value of 10 percent was used for pavement design. Since pavement areas will need to be undercut, we have assumed fill soils at design subgrade will have soil classifications of SW, SM, SC, or SP and a design CBR of at least 10 percent. If off-site soils are placed at design subgrade, laboratory CBR testing should be performed on these soils to confirm they have a CBR value of at least 10 percent. Recommendations for the car-parking and heavy duty pavements are provided in the table below.

Table 6-1 – Asphalt Pavement Recommendations

Material Type	Car Parking Areas Only	Heavy Duty
Asphalt Surface Course	2 Inches S 9.5B	3 Inches* S 9.5B
Aggregate Base Course (ABC) Stone	6 Inches	8 Inches

**Requires two lifts.*

All materials and construction methods should conform to the 2012 edition of the NCDOT "Standard Specifications for Roads and Structures." The aggregate base course (ABC) stone should consist of stone meeting the requirements under Section 520. ABC stone should be compacted to at least 100 percent of the maximum dry density as determined by the modified Proctor compaction test, AASHTO T-180 as modified by NCDOT. To confirm that the base course stone has been uniformly compacted, in place density tests should be performed by a qualified soils technician and the area should be thoroughly proofrolled under his observation.

Asphaltic concrete should conform to Section 610 in the 2012 edition of the NCDOT "Standard Specifications for Roads and Structures." Sufficient testing and observation should be performed during pavement construction to confirm that the required thickness, density, and quality requirements of the specifications are provided.

Although our analysis was based on traffic loading for a 20-year design life, our experience indicates that pavement maintenance is necessary due to normal weathering of the asphaltic concrete. Normal weathering (i.e., oxidation) causes asphalt to become more brittle, resulting in loss of flexural strength. This loss in strength can cause minor cracking which provides access for water infiltration into the subgrade. As the degree of saturation of the subgrade increases, the strength of the subgrade decreases leading to pavement failure. Routine maintenance in the form of sealing, patching, and maintaining proper drainage is required to increase pavement life. It is not uncommon for overlays to be required after 10 to 12 years.

6.3.2 Concrete Pavement

The concrete pavement design was performed using the same design traffic as in the heavy duty asphalt pavement areas (30,000 ESALs). The 28-day compressive strength of the concrete was assumed to be 4,000 psi. A modulus of subgrade reaction of 100 pci was used for design assuming 6 inches of compacted ABC stone. We have assumed that load transfer across contraction (saw) joints will be handled by aggregate interlock. ABC stone should meet the material and compaction requirements stated in the "Asphalt Pavement" section above.

Concrete pavement is recommended for heavily loaded traffic areas, such as loading docks and dumpster areas. The table below presents our recommended concrete pavement section thickness.

Table 6-2 – Concrete Pavement Recommendations

Material Type	Concrete Pavement Design Thickness
Air Entrained Concrete (4,000 psi)	6.0 inches
Aggregate Base Course (ABC) Stone	6.0 inches
Maximum Joint Spacing	12 feet in all directions. Saw joints should be cut to a depth of at least ¼ the thickness of the concrete.

6.4 Foundation Recommendations

6.4.1 General

Due to the close proximity of the individual plant structures to the 1MG tank foundation, soil stresses from the tank would influence performance of these foundations if the tank is constructed after the other equipment foundations are constructed. **To reduce the influence of overlapping stresses from the tank, we recommend that the tank be constructed, filled, and settlement stabilized prior to construction of adjacent foundations.**

Settlements due to the 2 to 4 feet of new site fill should be allowed to substantially complete prior to construction of settlement-sensitive structures. Although we anticipate this settlement to occur relatively rapidly (less than a week after filling), we recommend that all site grading be completed prior to any structure construction

Undercutting and replacement of existing near-surface site soils is recommended. That is addressed in Section 6.2.1 of this report.

6.4.2 1 MG Storage Tank

The tank will have a diameter of 80 feet and is anticipated to be supported by a 2-foot thick reinforced concrete mat bearing at an elevation of 24.67 feet. The tank's maximum contact pressure is anticipated to be about 2,000 pounds per square foot (psf), including the weight of the concrete mat. Based on our soil test borings and following removal and replacement of the upper very loose soils (anticipated undercut of 3 feet), the subsurface conditions at the storage tank are suitable for support of an allowable bearing pressure of up to 2,000 psf with an adequate safety factor.

A settlement analysis of the tank foundation was performed using Settle3D software by RocScience, Inc. and a net contact pressure of 1,700 psf. Based on a semi-rigid reinforced concrete tank support slab, we anticipate total settlements on the order of 3 to 4 inches at the tank center. Settlements around the tank perimeter of about 50 to 60% of these values are anticipated.

If these settlements are not acceptable before final piping connections are made, the foundation soils could be preloaded by hydro testing the tank. Top of foundation elevation measurements around the perimeter of the tank (4 locations minimum) should be recorded by a licensed surveyor immediately prior to filling the tank and then recorded every two days until the rate of settlement has stabilized. Based on the soil types encountered, we estimate that at least 50% of the total settlement could be realized in two to three weeks after the full hydro test load (tank filled to maximum operating level) is applied. Alternatively, the use of ground improvement (ie. aggregate piers) may be considered to reduce total settlement magnitudes.

We anticipate the mat foundation will be designed for a differential settlement angular distortion of 1/300 or less (center to edge). Based on this assumption, we recommend modulus of subgrade reaction (k) values ranging from 5 to 15 psi per inch (pci).

We recommend after the tank mat excavation has been made a geotechnical engineer observe the excavation bottom before reinforcement steel is placed.

6.4.3 Backwash Holding Tank

This tank will have a diameter of 30 feet and is anticipated to be supported by a 2-foot thick reinforced concrete mat bearing at elevations ranging from 12.25 feet at the center to 13.5 feet at the perimeter (about 12 feet below existing grade). The tank's maximum contact pressure (filled) is anticipated to be 1,000 psf. The subsurface conditions encountered by boring B-16 at these elevations include loose sands below the water table. Construction dewatering will be required. In order to obtain a stable bottom, the water table will have to be maintained several feet below the excavation bottom prior to and during structure installation, continuing until the excavation has been completely backfilled as discussed in Section 6.2.3 of this report.

An isolated layer of soft clay was encountered in boring B-16 below the tank subgrade elevation. If this layer is found to be present at a depth beneath the design subgrade elevation that prevents slab construction without subgrade damage, the subgrade soils should be undercut and replaced with washed stone (NCDOT #57). A non-woven geotextile filter fabric should be placed below the washed stone. Even where suitable bearing soils are encountered at the structure bearing surface, placement of a minimum 1-foot thick layer of washed stone underlain by a non-woven geotextile filter fabric is recommended to provide a medium for construction dewatering, a stable working surface, and a uniform bearing material.

The weight of the structure and water loading should result in a neglible net stress increase in the foundation soils. Provided the recommendations presented above are followed and based on the soil conditions found at B-16, the foundation soils are suitable to support the proposed tank and settlement magnitudes are expected to be negligible.

The groundwater levels recorded during this exploration will produce a net uplift force on the empty tank. Uplift resistance methods are recommended in Section 6.8 below.

6.4.4 RO Treatment and Chemical Feed Facility

The Reverse Osmosis (RO) Treatment and Chemical Feed Facility will include a 70-foot by 120-foot main plant, a 60-foot by 60-foot chemical area, and 21-foot by 71-foot and 16-foot by 65-foot administration

areas. These structures will be supported either on a 2-foot thick reinforced concrete slab or shallow spread footings and will include mat equipment foundations and non-structural slabs-on-grade. We anticipate foundations and equipment pads will have maximum column, wall, and floor loads of 100 kips, 4 kips per foot and 200 psf, respectively.

Based on our test borings and assuming the site is prepared as recommended above, these structures can be supported on shallow spread footings designed for an allowable bearing pressure of 2,000 pounds per square foot (psf). This bearing pressure assumes that footings will bear in compacted structural fill, or natural soils.

Footings should bear at least 18 inches below exterior grade to avoid frost penetration and develop the design bearing capacity. Continuous wall footings should be at least 18 inches wide, and isolated column footing should be at least 24 inches wide. This recommendation is made to prevent a localized or "punching" shear failure conditions which can occur with very narrow footings.

Based on encountered subsurface conditions, anticipated structural loads and recommendations made herein, we estimate that total settlements of the RO Treatment and Chemical Feed Facility will be 1 inch or less.

6.4.5 Calcite Facility

The Calcite Facility will consist of a 50-foot by 70-foot pad supporting six 140,000 lb storage vessels on a 2-foot thick reinforced concrete mat bearing at an elevation of 28 feet. The pad's maximum contact pressure is anticipated to be 700 psf. After removal and replacement of the very loose near-surface soils, and placement of about 2 feet of structural fill, the subsurface conditions should be suitable for support of an allowable bearing pressure of up to 1,000 psf with an adequate safety factor.

A settlement analysis of the calcite facility was performed using Settle3D software by RocScience, Inc. Based on a rigid reinforced concrete support slab, we anticipate total settlements on the order of 1 inch. Due to the relatively uniform local subsurface profile suggested by this exploration, negligible foundation tilt is anticipated. We recommend modulus of subgrade reaction (k) values ranging from 5 to 10 pci.

6.4.6 Miscellaneous Structures

The Water Treatment Plant site will include several individual smaller structures including the High Service Pump Station, a backup generator, a carbon dioxide storage pad, a transformer pad, and several small below-grade vaults. The above grade structures are anticipated to be supported on 2-foot thick reinforced concrete mats. Above-grade structures are anticipated to have foundation bearing elevations of 27.25 feet. Maximum mat contact pressures of 500 psf are anticipated.

Based on our test borings and assuming the site is prepared as recommended above, the structures can be supported on mat foundations designed for an allowable bearing pressure of 500 psf. This bearing pressure assumes that footings will bear in compacted structural fill, or natural soils.

Based on encountered subsurface conditions, anticipated structural loads and recommendations made herein, we estimate that total settlements of the miscellaneous structures will be 1 inch or less.

6.4.7 Footing Evaluations

The bottom of footing excavations should be evaluated by the project geotechnical engineer or a soils technician working under the direction of the geotechnical engineer using a hand auger and dynamic cone penetrometer (DCP) to gauge the consistency of subgrade soils. Footing subgrades that are unstable or exhibit DCP blow counts less than required to achieve the design bearing pressure should be over-excavated and replaced with NCDOT #57 stone or lean concrete. A layer of non-woven filter fabric may also be required.

6.5 Floor Slabs

Immediately prior to constructing the floor slabs, we recommend that the floor slab areas be proofrolled with a fully loaded dump truck to detect any softened, loosened or disturbed areas that may have been exposed to wet weather or construction traffic. Areas that are found to be disturbed or indicate pumping action during the proofrolling should be undercut and replaced with adequately compacted structural fill. Proofrolling should be observed by the geotechnical engineer or a senior soil technician working under his/her direction.

A slab-on-grade floor system for the RO Treatment Facility can be adequately supported on newly placed and compacted structural fill provided the site preparation and fill placement procedures outlined in this report are implemented. A design modulus of subgrade reaction (k) of 100 pci can be used provided the floor slab is directly supported on a 6-inch thick layer of crushed stone (NCDOT ABC). The crushed stone should be compacted to at least 95 percent of its modified Proctor maximum dry density. This layer of ABC stone will also help to provide a construction working surface.

6.6 Seismic Design Parameters

Based on our shear wave velocity correlations with the SPT N-values obtained to a depth of 75 feet and extrapolation to a depth of 100 feet, along with our experience with the area geology, we recommend Seismic Site Class D for use in seismic design for the proposed structures in accordance with the American Water Works Association Standard D100-05 or 2012 North Carolina State Building Code (2009 International Building Code with North Carolina Amendments).

6.7 Liquefaction Potential

We performed a seismic liquefaction analysis based on a design earthquake with magnitude 7.3. The design earthquake has a 2 percent probability of exceedance in a 50 year period. This is equivalent to an earthquake that has the likelihood of occurring once every 2,475 years. Using ASCE 7-10, the design seismic event has a peak ground acceleration (pga) of 0.098g at this site.

Based on the results of our analyses, we conclude that the site has a low liquefaction potential for the design earthquake, and no further consideration of liquefaction is necessary for the design of the project.

6.8 Hydrostatic Uplift Forces

The proposed Backwash Holding Tank will extend below the groundwater elevation. Proposed pipes and vaults are likely to extend below the groundwater elevation. These structures must be designed to resist buoyant uplift forces.

A net buoyant uplift force will be imposed on the 30-foot diameter Backwash Holding Tank. This net uplift force may be resisted by extending the edge of the mat foundation beyond the exterior wall face to engage the weight of backfill material or by increasing the thickness of the slab (dead weight). Helical anchors may be a practical earth anchor alternative, but were beyond the scope of this exploration.

6.8.1 Rigid Mat Foundation Projection Beyond Structure Exterior Face

The weight of a vertical-sided column of soil above a rigid mat foundation projection beyond the exterior face of the structure may be used to resist hydrostatic uplift forces. The following unit weights are recommended for design:

Table 6-3 Recommended Unit Weights

Material	Submerged Unit Weight
Structural Fill	52 pcf
Concrete	87 pcf
Washed Stone	28 pcf (bulk)

We recommend that shearing resistance along the perimeter of the soil block above the mat foundation extension be ignored. Similarly, we recommend that a "cone" of soil projecting beyond the edge of the foundation projection be ignored.

6.8.2 Increasing Foundation Thickness

The concrete foundation thickness may be increased to increase the foundation weight to resist hydrostatic uplift forces. In this application, the submerged weight of normal weight concrete should be used (87 pcf).

7.0 Limitations of Geotechnical Report

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other representation or warranty either express or implied, is made.

We relied on project information given to us to develop our conclusions and recommendations. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional information if necessary.

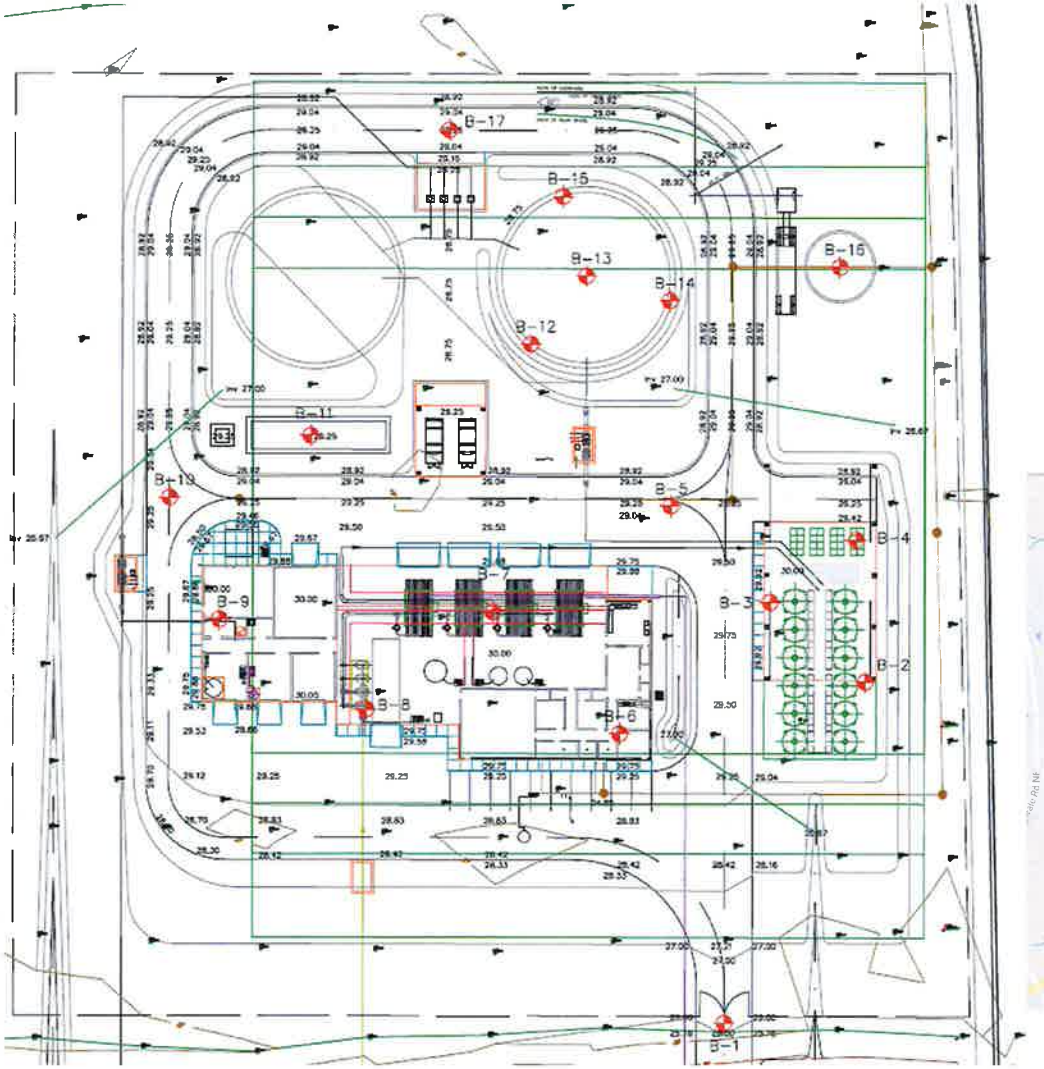
Our conclusions and recommendations are based on limited data from a field exploration program. Subsurface conditions can vary widely outside the explored area. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants. If there is a concern about these items, other studies should be performed. S&ME can provide a proposal and perform these services if requested.

S&ME should be provided the opportunity to review the final plans and specifications to confirm that our recommendations are properly interpreted and implemented. The recommendations in this report are contingent on S&ME's review of final plans and specifications followed by observation and monitoring during construction activities.

Appendices

Appendix I – Figures



LEGEND

SPT Boring



*Site plan prepared by The Wooten Company; Test locations shown are approximate.

Scale:	Not to scale
Date:	Nov. 2016
Drawn By:	KAN
Project No.:	1305-16-116

S&ME

Brunswick Water Treatment Plant
Gregory Road Northeast
Belville, North Carolina

Figure No.
1A



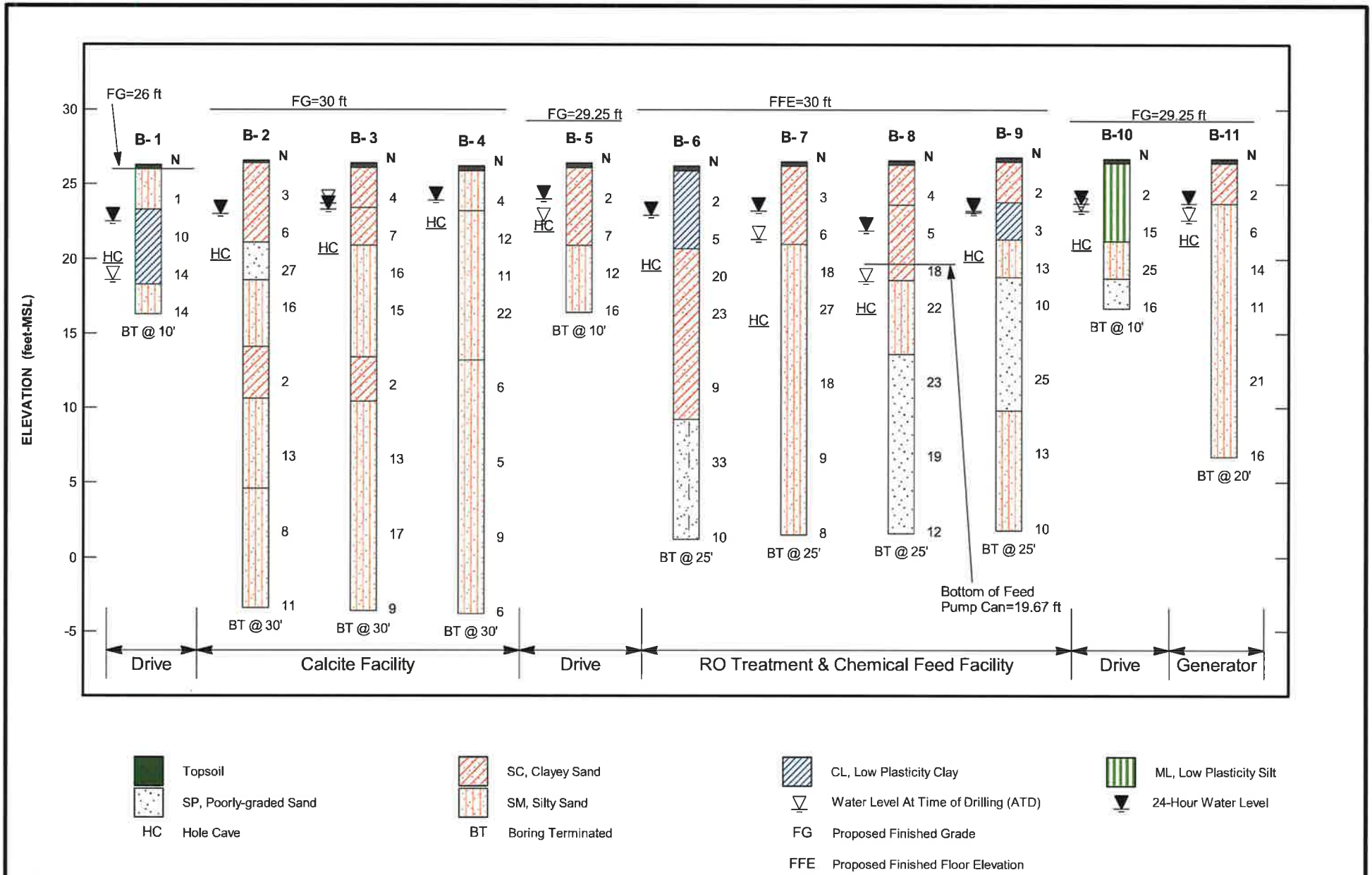
*Site plan provided by The Wooten Company; Test locations shown are approximate.

Scale:	Not to scale
Date:	Nov. 2016
Drawn By:	KAN
Project No.:	1305-16-116

S&ME

Proposed Sewer Outfall
River Road Southeast
Belville, North Carolina

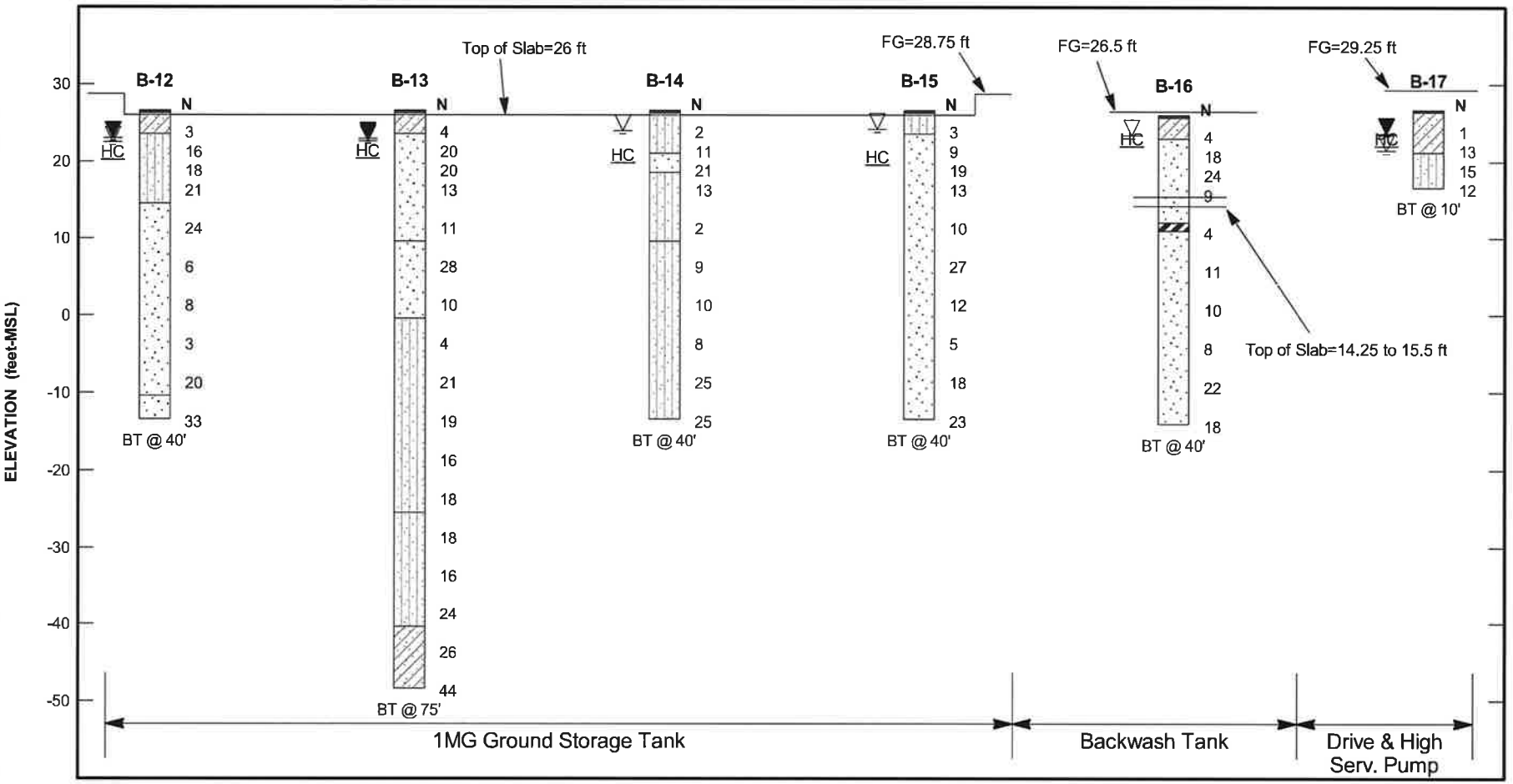
Figure No.
1B



Topsoil
SP, Poorly-graded Sand
HC Hole Cave
SC, Clayey Sand
SM, Silty Sand
BT Boring Terminated
CL, Low Plasticity Clay
Water Level At Time of Drilling (ATD)
FG Proposed Finished Grade
FFE Proposed Finished Floor Elevation
ML, Low Plasticity Silt
24-Hour Water Level

N = Standard Penetration Test resistance value (blows per foot). The depicted stratigraphy is shown for illustrative purposes only. The actual subsurface conditions will vary between boring locations.

JOB NO: 1305-16-116	S&ME	Diagram: Generalized Subsurface Profile	Figure 2A
DATE: DEC 2016		Project: Brunswick WTP	
		Location: Belville, NC	



N = Standard Penetration Test resistance value (blows per foot). The depicted stratigraphy is shown for illustrative purposes only. The actual subsurface conditions will vary between boring locations.

JOB NO: 1305-16-116	S&ME	Diagram: Generalized Subsurface Profile	Figure 2B
DATE: DEC 2016		Project: Brunswick WTP	
		Location: Belville, NC	

Appendix II – S&ME Exploration Logs

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)


Fill


Asphalt


Concrete


Topsoil


Gravel


Sand


Silt


Clay


Organic


Silty Sand


Clayey Sand


Sandy Silt


Clayey Silt


Sandy Clay


Silty Clay


Partially Weathered Rock


Cored Rock

WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring
▼ = Water Level Taken After 24 Hours
◄ = Loss of Drilling Water
HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES

(Shown in Samples Column)

Shelby Tube


Split Spoon


Rock Core


No Recovery

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B- 1**
DATE DRILLED: **10/24/16**	ELEVATION: **26.3 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.** **Elevations are approximate.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **10.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **7.7' ATD, 3.8' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **3¼" H.S.A.**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS (10 20 30 60 80)	N VALUE
	TOPSOIL (3 inches)									
	COASTAL PLAIN: SILTY SAND (SM) very loose, dark gray, with rootlets, fine	▼		1		1	WOH	1		1
5	**FINE SANDY CLAY (CL)** stiff, brown	HC	21.3	2		2	5	5		10
		▽		3		7	7	7		14
10	**SILTY SAND (SM)** medium dense, brown gray, fine		16.3	4		5	7	7		14
	Boring terminated at 10 ft									

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B- 2**
DATE DRILLED: **10/25/16**	ELEVATION: **26.6 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **30.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **3.6' 24 hr**	**Elevations are approximate.**	
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
	TOPSOIL (2 inches)								
	COASTAL PLAIN: CLAYEY SAND (SC) very loose to loose, gray, fine	▼		1		2	1	2	3
5				2		3	2	4	6
	SAND (SP) medium dense, gray, trace silt, fine	HC	21.6	3		9	13	14	27
10	**SILTY SAND (SM)** medium dense, gray, fine		16.6	4		6	7	9	16
	CLAYEY SAND (SC) very loose, brown, trace rootlets			5		1	1	1	2
15			11.6						
	SILTY SAND (SM) medium dense, brown			6		3	6	7	13
20			6.6						
	SILTY SAND (SM) loose to medium dense, gray green, fine			7		3	4	4	8
25			1.6						
				8		3	4	7	11
30	Boring terminated at 30 ft		-3.4						

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS — 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. ***THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.***
2. ***BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.***
3. ***STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.***
4. ***WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.***

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B- 3
DATE DRILLED: **10/25/16**	ELEVATION: **26.4 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **30.0 ft**	**Elevations are approximate.**	
DRILLER: **T. Williams**	WATER LEVEL: **2.7' ATD, 3.1' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
	TOPSOIL (3 inches)									
	COASTAL PLAIN: CLAYEY SAND (SC) very loose, gray brown, fine	▽		1		2	2	2		4
5	**CLAYEY SAND (SC)** loose, brown, fine	HC	21.4	2		2	2	5		7
	SILTY SAND (SM) medium dense, brown gray, fine			3		7	8	8		16
10			16.4	4		7	7	8		15
15	**CLAYEY SAND (SC)** very loose, brown		11.4	5		1	1	1		2
	SILTY SAND (SM) medium dense to loose, brown gray, fine									
20			6.4	6		6	7	6		13
25			1.4	7		2	8	9		17
30	Boring terminated at 30 ft		-3.6	8		3	5	4		9

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS: 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B- 4**
DATE DRILLED: **10/25/16**	ELEVATION: **26.2 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.** **Elevations are approximate.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **30.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **2.3' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
0	**TOPSOIL** (3 inches)									
	COASTAL PLAIN: SILTY SAND (SM) very loose, brown gray, fine	▼		1		2	2	2		4
		HC		2		2	4	8		12
5	**SILTY SAND (SM)** medium dense, brown gray, fine		21.2	3		7	6	5		11
				4		8	10	12		22
10			16.2							
	SILTY SAND (SM) loose, brown gray, fine			5		4	5	1		6
15			11.2							
				6		5	3	2		5
20			6.2							
				7		4	4	5		9
25			1.2							
				8		3	3	3		6
30	Boring terminated at 30 ft		-3.8							

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS: 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B- 5**
DATE DRILLED: **10/24/16**	ELEVATION: **26.4 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **10.0 ft**	**Elevations are approximate.**	
DRILLER: **T. Williams**	WATER LEVEL: **3.9' ATD, 2.4' 24 hr**	**Bulk sample collected from 1 to 5 feet.**	
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **3¼" H.S.A.**			

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS (10 20 30 60 80)	N VALUE
		TOPSOIL (3 inches)									
		COASTAL PLAIN: CLAYEY SAND (SC) very loose to loose, black brown, fine	▼		1		1	1	1		2
5		- - - Bulk Sample Classification: SW-SC	HC		2		1	2	5		7
		SILTY SAND (SM) medium dense, tan, fine		21.4	3		4	5	7		12
10		Boring terminated at 10 ft		16.4	4		7	7	9		16

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B- 6**
DATE DRILLED: **10/25/16**	ELEVATION: **26.2 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.** **Elevations are approximate.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **25.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **3.3' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
	TOPSOIL (3 inches)									
	COASTAL PLAIN: FINE SANDY CLAY (CL) very soft to firm, brown gray	▼		1		1	1	1		2
5				2		1	2	3		5
			21.2							
	CLAYEY SAND (SC) medium dense to loose, brown gray, fine	HC		3		7	8	12		20
10				4		8	11	12		23
			16.2							
15				5		4	4	5		9
			11.2							
	SAND (SP-SM) dense to loose, gray brown green, trace silt, fine			6		12	15	18		33
20			6.2							
				7		6	5	5		10
25			1.2							
	Boring terminated at 25 ft									

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS: 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B- 7
DATE DRILLED: 10/25/16	ELEVATION: 26.5 ft	NOTES: Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface. Elevations are approximate.	
DRILL RIG: Diedrich D-50	BORING DEPTH: 25.0 ft		
DRILLER: T. Williams	WATER LEVEL: 5.2' ATD, 3.3' 24 hr		
HAMMER TYPE: Automatic	LOGGED BY: N. Bradley		
SAMPLING METHOD: Split spoon			
DRILLING METHOD: Wash Boring			

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
		TOPSOIL (3 inches)									
		COASTAL PLAIN: CLAYEY SAND (SC) very loose to loose, brown, trace rootlets	▼		1		1	2	1		3
5			▽	21.5	2		1	2	4		6
		SILTY SAND (SM) medium dense to loose, gray brown green, fine to medium			3		7	8	10		18
10			HC	16.5	4		10	12	15		27
15				11.5	5		7	8	10		18
20				6.5	6		5	4	5		9
25		Boring terminated at 25 ft		1.5	7		3	4	4		8

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS: 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B- 8**
DATE DRILLED: **10/24/16**	ELEVATION: **26.6 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.** **Elevations are approximate.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **25.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **8.1' ATD, 4.7' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
	TOPSOIL (3 inches)									
	COASTAL PLAIN: CLAYEY SAND (SC) very loose, black, trace rootlets									
5	**CLAYEY SAND (SC)** loose to medium dense, gray brown	▼	21.6	1		1	3	1		4
				2		3	3	2		5
		▽		3		7	9	9		18
10	**SILTY SAND (SM)** medium dense, gray, fine to medium	HC	16.6	4		8	12	10		22
15	**SAND (SP)** medium dense, gray white, trace silt, fine		11.6	5		9	11	12		23
20			6.6	6		6	11	8		19
25	Boring terminated at 25 ft		1.6	7		5	6	6		12

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS: 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. ***THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.***
2. ***BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.***
3. ***STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.***
4. ***WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.***

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B- 9**
DATE DRILLED: **10/25/16**	ELEVATION: **26.8 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **25.0 ft**	**Elevations are approximate.**	
DRILLER: **T. Williams**	WATER LEVEL: **3.7' ATD, 3.6' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
0	**TOPSOIL** (3 inches)									
	COASTAL PLAIN: CLAYEY SAND (SC) very loose, brown, fine	▼		1		1	1	1		2
5	**FINE SANDY CLAY (CL)** soft, brown		21.8	2		1	2	1		3
	SILTY SAND (SM) medium dense, brown, fine	HC		3		7	6	7		13
10	**SAND (SP)** loose to medium dense, gray, trace silt, fine to medium		16.8	4		3	5	5		10
15			11.8	5		8	11	14		25
	SILTY SAND (SM) medium dense to loose, gray tan green, fine to medium									
20			6.8	6		7	7	6		13
25	Boring terminated at 25 ft		1.8	7		4	5	5		10

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. ***THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.***
2. ***BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.***
3. ***STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.***
4. ***WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.***

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B-10**
DATE DRILLED: **10/25/16**	ELEVATION: **26.7 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.** **Elevations are approximate.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **10.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **3.5' ATD, 3' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
	TOPSOIL (3 inches)									
	COASTAL PLAIN: SANDY SILT (ML) very soft to stiff, dark gray			1		1	1	1		2
5		HC	21.7	2		3	5	10		15
	SILTY SAND (SM) medium dense, brown, fine			3		8	14	11		25
	SAND (SP) medium dense, gray, trace silt, fine to medium			4		6	7	9		16
10	Boring terminated at 10 ft		16.7							

10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B-11**
DATE DRILLED: **10/24/16**	ELEVATION: **26.7 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **20.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **4.1' ATD, 3' 24 hr**	**Elevations are approximate.**	
HAMMER TYPE: **Automatic**	LOGGED BY: **N. Bradley**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **3¼" H.S.A.**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
	TOPSOIL (3 inches)									
	COASTAL PLAIN: CLAYEY SAND (SC) very loose, brown	▽								
5	**SILTY SAND (SM)** loose to medium dense, brown tan, fine	HC	21.7	1		1	1	1		2
				2		2	2	4		6
				3		4	7	7		14
10			16.7	4		2	5	6		11
15			11.7	5		8	10	11		21
				6		4	8	8		16
20	Boring terminated at 20 ft		6.7							

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS: 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B-12

DATE DRILLED: **10/26/16**	ELEVATION: **26.6 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **40.0 ft**	**Elevations are approximate.**
DRILLER: **T. Williams**	WATER LEVEL: **4.1' ATD, 3.5' 24 hr**	
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**	
SAMPLING METHOD: **Split spoon**		
DRILLING METHOD: **Wash Boring**		

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
0	**TOPSOIL** (3 inches)		26.6	1	SS	1	2	1		3
	COASTAL PLAIN: CLAYEY SAND (SC) very loose, brown, fine	▼								
5	**SILTY SAND (SM)** medium dense, brown gray, fine	HC	21.6	2	SS	4	6	10		16
				3	SS	9	10	8		18
10			16.6	4	SS	8	11	10		21
15	**SAND (SP)** medium dense to very loose, brown gray, trace silt, fine		11.6	5	SS	8	11	13		24
			6.6	6	SS	7	4	2		6
20										
25			1.6	7	SS	4	3	5		8
30			-3.4	8	SS	3	1	2		3
35			-8.4	9	SS	10	9	11		20
40	**SAND (SP)** dense, gray, trace silt, fine		-13.4	10	SS	7	16	17		33
	Boring terminated at 40 ft									

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B-13
DATE DRILLED: **10/26/16**	ELEVATION: **26.6 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface. Elevations are approximate.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **75.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **3.9' ATD, 3.6' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**	**Shelby tube sample attempted at 28 to 30 feet with no recovery.**	
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
0	**TOPSOIL** (3 inches)								
	COASTAL PLAIN: CLAYEY SAND (SC) very loose, brown gray, fine			1	SS	2	1	3	4
5	**SAND (SP)** medium dense, gray tan, trace silt, fine	HC	21.6	2	SS	4	8	12	20
				3	SS	8	10	10	20
10			16.6	4	SS	5	7	6	13
			11.6	5	SS	5	5	6	11
15									
20	**SAND (SP)** medium dense to loose, gray brown, trace silt, fine		6.6	6	SS	11	13	15	28
			1.6	7	SS	4	5	5	10
25									
30	**SILTY SAND (SM)** very loose to medium dense, brown gray		-3.4	8	SS	2	2	2	4
35			-8.4	9	SS	4	10	11	21
40			-13.4	10	SS	6	9	10	19
				11	SS	7	9	7	16

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS — 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B-13
DATE DRILLED: **10/26/16**	ELEVATION: **26.6 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface. Elevations are approximate.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **75.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **3.9' ATD, 3.6' 24 hr**		
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**	**Shelby tube sample attempted at 28 to 30 feet with no recovery.**	
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
50		**SILTY SAND (SM)** very loose to medium dense, brown gray *(continued)*		-23.4	12		9	7	11		18
55		**SILTY SAND (SM)** medium dense, dark gray, fine		-28.4	13		9	10	8		18
60				-33.4	14		6	5	11		16
65				-38.4	15		8	12	12		24
70		**CLAYEY SAND (SC)** medium dense to dense, gray, fine		-43.4	16		6	10	16		26
75		Boring terminated at 75 ft		-48.4	17		8	10	34		44

10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B-14**
DATE DRILLED: **10/26/16**	ELEVATION: **26.6 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **40.0 ft**	**Elevations are approximate.**	
DRILLER: **T. Williams**	WATER LEVEL: **2.6' ATD**		
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / ROD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
0	**TOPSOIL** (3 inches)									
	COASTAL PLAIN: SILTY SAND (SM) very loose to medium dense, brown	▽		1		2	1	1		2
				2		4	5	6		11
5			21.6							
	SAND (SP) medium dense, gray, trace silt, fine	HC		3		8	11	10		21
	SILTY SAND (SM) medium dense to very loose, gray		16.6	4		5	5	8		13
10										
			11.6	5		4	1	1		2
15										
	SILTY SAND (SM) loose to medium dense, brown gray		6.6	6		6	2	7		9
20										
			1.6	7		6	5	5		10
25										
			-3.4	8		3	4	4		8
30										
			-8.4	9		5	10	15		25
35										
			-13.4	10		10	13	12		25
40	Boring terminated at 40 ft									

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. ***THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.***
2. ***BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.***
3. ***STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.***
4. ***WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.***

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B-15
DATE DRILLED: **10/27/16**	ELEVATION: **26.6 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **40.0 ft**	**Elevations are approximate.**	
DRILLER: **T. Williams**	WATER LEVEL: **2.4' ATD**		
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
	TOPSOIL (3 inches)									
	COASTAL PLAIN: SILTY SAND (SM) very loose, brown gray, fine	▽		1		2	1	2		3
5	**SAND (SP)** medium dense to loose, gray tan, fine		21.6	2		3	3	6		9
		HC		3		9	9	10		19
10			16.6	4		6	6	7		13
15			11.6	5		5	5	5		10
20			6.6	6		12	14	13		27
25			1.6	7		4	5	7		12
30			-3.4	8		3	2	3		5
35			-8.4	9		8	11	7		18
40	Boring terminated at 40 ft		-13.4	10		9	10	13		23

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS: 10 20 30 60 80

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	**Brunswick WTP** **Belville, North Carolina** **S&ME Project No. 1305-16-116**	**BORING LOG**	**B-16**
DATE DRILLED: **10/26/16**	ELEVATION: **26.0 ft**	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **40.0 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **2.6' ATD**	**Elevations are approximate.**	
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / ROD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
0	**TOPSOIL** (3 inches)									
	COASTAL PLAIN: CLAYEY SAND (SC) very loose, brown gray, fine	HC		1		2	1	3		4
5	**SAND (SP)** medium dense to loose, tan gray, trace silt, fat		21.0	2		5	7	11		18
				3		11	12	12		24
10			16.0	4		2	4	5		9
15	**SILTY CLAY (CH)** soft, gray, with wood		11.0	5		5	2	2		4
	SAND (SP) medium dense to loose, tan white, medium to fine		6.0	6		5	5	6		11
20			1.0	7		5	5	5		10
25			-4.0	8		3	4	4		8
30			-9.0	9		6	10	12		22
35			-14.0	10		6	9	9		18
40	Boring terminated at 40 ft									

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B-17
DATE DRILLED: 10/24/16	ELEVATION: 26.7 ft	NOTES: Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface. Elevations are approximate.	
DRILL RIG: Diedrich D-50	BORING DEPTH: 10.0 ft		
DRILLER: T. Williams	WATER LEVEL: 5.2' ATD, 3' 24 hr		
HAMMER TYPE: Automatic	LOGGED BY: N. Bradley		
SAMPLING METHOD: Split spoon			
DRILLING METHOD: 3¼" H.S.A.			

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS (10 20 30 60 80)	N VALUE
		TOPSOIL (3 inches)									
		COASTAL PLAIN: CLAYEY SAND (SC) very loose to medium dense, brown gray	HC		1		1	WOH	1		1
5				21.7	2		3	5	8		13
		SILTY SAND (SM) medium dense, gray, fine to coarse			3		5	6	9		15
10				16.7	4		3	5	7		12
		Boring terminated at 10 ft									

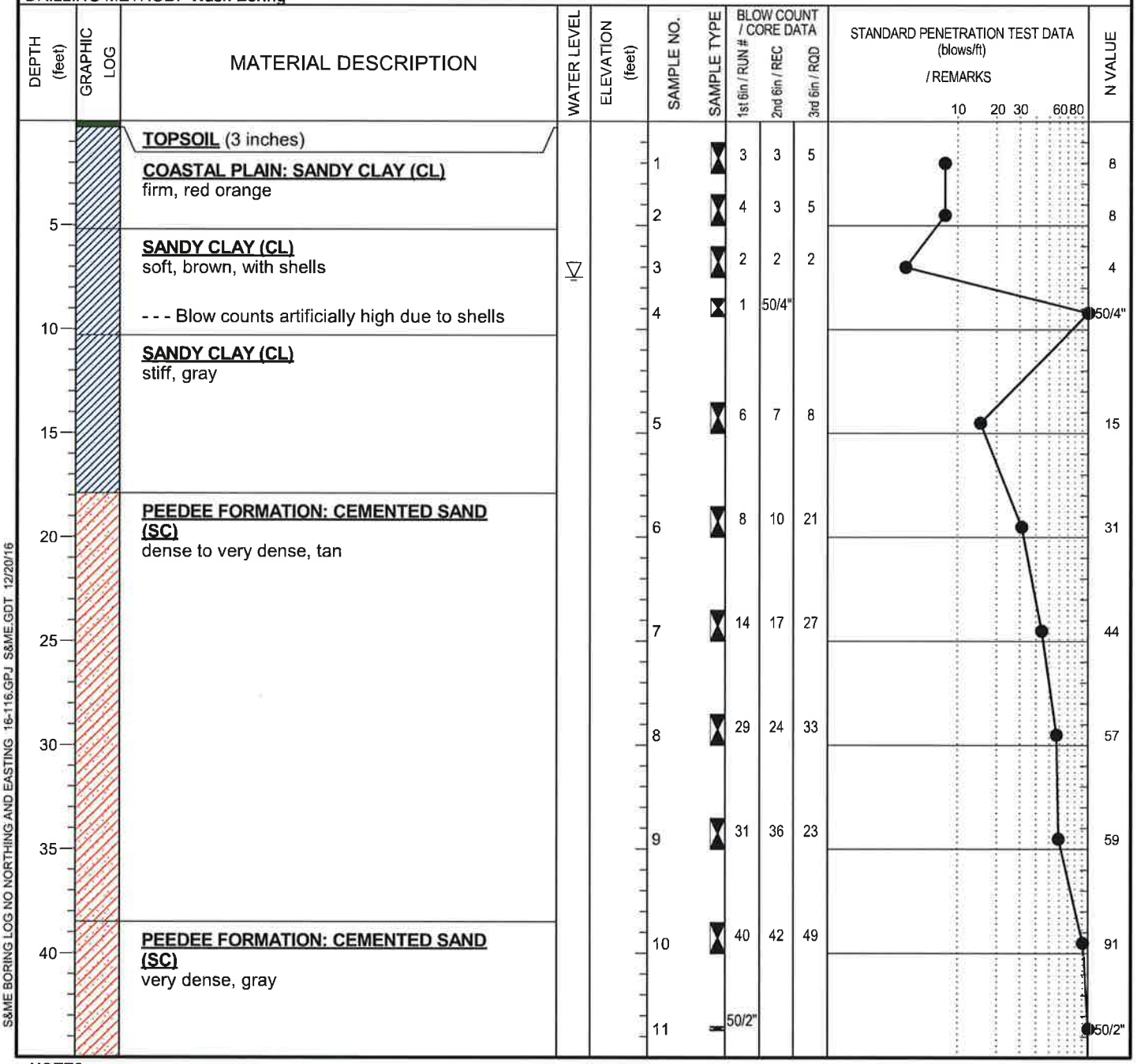
S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B-18
DATE DRILLED: **10/28/16**	ELEVATION:	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **48.7 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **7.5' ATD**		
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			



S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	Brunswick WTP Belville, North Carolina S&ME Project No. 1305-16-116	BORING LOG	B-18
DATE DRILLED: **10/28/16**	ELEVATION:	NOTES: **Borehole backfilled with auger cuttings and a commercial hole closure device placed near the surface.**	
DRILL RIG: **Diedrich D-50**	BORING DEPTH: **48.7 ft**		
DRILLER: **T. Williams**	WATER LEVEL: **7.5' ATD**		
HAMMER TYPE: **Automatic**	LOGGED BY: **D. Garrow**		
SAMPLING METHOD: **Split spoon**			
DRILLING METHOD: **Wash Boring**			

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS 10 20 30 60 80	N VALUE
		PEEDEE FORMATION: CEMENTED SAND (SC) very dense, gray *(continued)*	HC		12		50/2"				50/2"
		Boring terminated at 48.7 ft									

S&ME BORING LOG NO NORTHING AND EASTING 16-116.GPJ S&ME.GDT 12/20/16

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

Appendix III –Laboratory Test Results

S&ME

SUMMARY OF LABORATORY TEST DATA

Brunswick WTP
Belville, North Carolina
S&ME Project No. 1305-16-116

Boring	Sample Depth	Sample Type	USCS Classification	Standard Proctor		Natural Moisture Content (%)	Grain Size Analysis			Atterberg Limits			CBR	
				Maximum Dry Density (pcf)	Optimum Moisture (%)		Gravel (%)	Sand (%)	Silt and Clay (%)	LL	PL	PI	@ 0.1"	@0.2"
B-1	1' to 2.5'	SS	SM*	-	-	18.1	-	-	-	27	22	5	-	-
B-2	13.5' to 15'	SS	SC*	-	-	46.8	-	-	-	36	18	18	-	-
B-5	1' to 5'	Bulk	SW-SC**	121.4	12.3	17.4	0	88.4	11.6	-	-	-	11.3	13.9
B-6	6' to 7.5'	SS	SC*	-	-	32.3	-	-	-	42	19	23	-	-
	23.5' to 25'	SS	SP-SM**	-	-	27.0	0	93.4	6.6	-	-	-	-	-
B-10	1' to 2.5'	SS	ML*	-	-	17.0	-	-	-	27	25	2	-	-
B-13	58.5' to 60'	SS	SM**	-	-	27.5	0	83.2	16.8	-	-	-	-	-

SS - Split Spoon
Bulk - Bulk Sample

* Fines content visually/manually estimated
** Fines visually/manually classified

LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index

Form No: TR-D2216-T265-2
Revision No. 0
Revision Date: 02/22/08

Laboratory Determination of Water Content

S&ME

ASTM D 2216 ☑ *AASHTO T 265* ☐ ***Quality Assurance***

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	11/16/16
Project Name:	Brunswick WTP	Test Date(s):	11/15 - 11/16/16
Client Name:			
Client Address:			
Sample by:		Sample Date(s):	(varies)
Sampling Method:	Borehole - Split Spoon & Bulk	Drill Rig :	Diedrich D-50

Method: **A (1%)** ☐ **B (0.1%)** ☑ *Balance ID.* ***1024*** *Calibration Date:* ***11/6/16***

Boring No.	Sample No.	Sample Depth	Tare #	Tare Weight	Tare Wt.+ Wet Wt	Tare Wt. + Dry Wt	Water Weight	Percent Moisture
		ft.		grams	grams	grams	grams	%
B-1	SS-1	1 - 2.5		46.03	82.99	77.32	5.67	**18.1%**
B-2	SS-5	13.5 - 15		48.08	83.42	72.15	11.27	**46.8%**
B-6	SS-3	6 - 7.5		46.74	89.89	79.38	10.51	**32.2%**
B-6	SS-7	23.5 - 25		136.31	379.59	327.86	51.73	**27.0%**
B-10	SS-1	1 - 2.5		45.51	83.07	77.61	5.46	**17.0%**
B-13	SS-14	58.5 - 60		129.11	380.75	326.55	54.20	**27.5%**
B-5	Bulk	1 - 5		130.18	386.12	348.11	38.01	**17.4%**

Notes / Deviations / References

AASHTO T 265: Laboratory Determination of Moisture Content of Soils

ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No. TR-D4318-T89-90
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

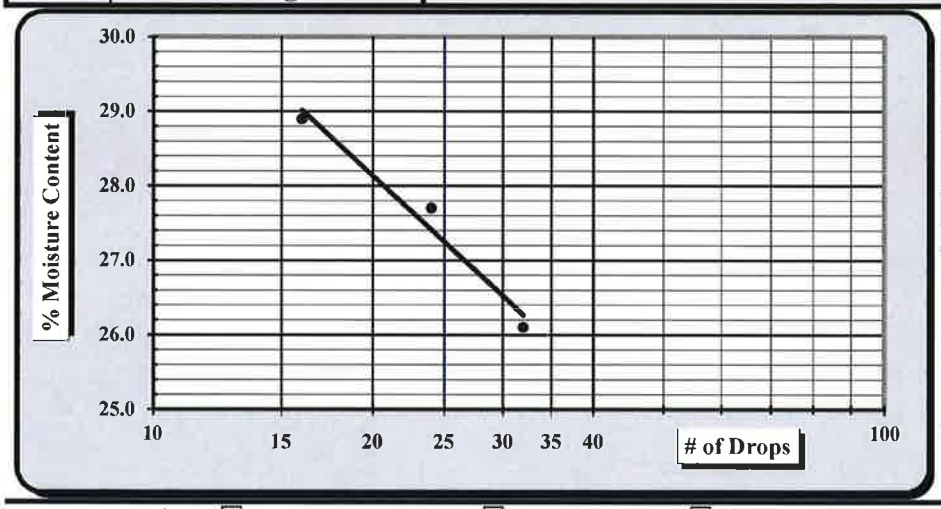
Test Methods: *ASTM D 4318* ☒ *AASHTO T 89* ☐ *AASHTO T 90* ☐ ***Quality Assurance***

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s)	11/15 - 11/22/16
Client Name:			
Client Address:			
Boring #:	B-1	Sample #: SS-1	Sample Date: 10/24/16
Location:	Site Borehole	Offset: N/A	Depth (ft): 1 - 2.5
Sample Description:	Dark Gray Silty SAND (fines content visually/manually estimated)		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	1024	11/6/2016	Grooving tool	S-1	5/18/2016
LL Apparatus	13288	8/10/2016			
Oven	1454	10/7/2016			

Pan #		Liquid Limit						Plastic Limit		
	Tare #:									
A	Tare Weight	13.13	13.04	13.02				16.75	15.29	
B	Wet Soil Weight + A	27.53	27.25	26.31				26.11	24.42	
C	Dry Soil Weight + A	24.55	24.17	23.33				24.43	22.81	
D	Water Weight (B-C)	2.98	3.08	2.98				1.68	1.61	
E	Dry Soil Weight (C-A)	11.42	11.13	10.31				7.68	7.52	
F	% Moisture (D/E)*100	26.1%	27.7%	28.9%				21.9%	21.4%	
N	# OF DROPS	32	24	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**21.7%**		



One Point Liquid Limit			
N	**Factor**	**N**	**Factor**
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	27
Plastic Limit	22
Plastic Index	5
Group Symbol	SM*
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☐ Dry Preparation ☐ Air Dried ☑ *Estimate the % Retained on the #40 Sieve:* 17%

Notes / Deviations / References:

* fines content visually/manually estimated

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No. TR-D4318-T89-90
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

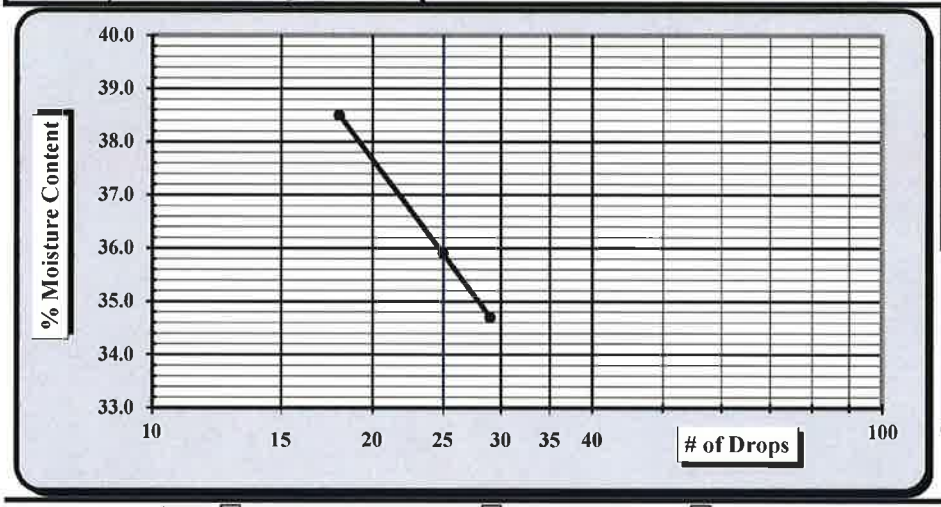
Test Methods: *ASTM D 4318* ☒ *AASHTO T 89* ☐ *AASHTO T 90* ☐ ***Quality Assurance***

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s)	11/15 - 11/22/16
Client Name:			
Client Address:			
Boring #:	B-2	Sample #: SS-5	Sample Date: 10/25/16
Location:	Site Borehole	Offset: N/A	Depth (ft): 13.5 - 15
Sample Description:	Brown Clayey SAND (fines content visually/manually estimated)		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	1024	11/6/2016	Grooving tool	S-1	5/18/2016
LL Apparatus	13288	8/10/2016			
Oven	1454	10/7/2016			

Pan #		Liquid Limit						Plastic Limit		
	Tare #:									
A	Tare Weight	21.00	21.21	20.89				10.98	15.32	
B	Wet Soil Weight + A	32.42	33.77	35.21				19.17	25.46	
C	Dry Soil Weight + A	29.48	30.45	31.23				17.93	23.93	
D	Water Weight (B-C)	2.94	3.32	3.98				1.24	1.53	
E	Dry Soil Weight (C-A)	8.48	9.24	10.34				6.95	8.61	
F	% Moisture (D/E)*100	34.7%	35.9%	38.5%				17.8%	17.8%	
N	# OF DROPS	29	25	18				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**17.8%**		



One Point Liquid Limit			
N	**Factor**	**N**	**Factor**
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**36**
Plastic Limit	**18**
Plastic Index	**18**
Group Symbol	**SC***
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☐ Dry Preparation ☐ Air Dried ☑ *Estimate the % Retained on the #40 Sieve:* 30%

Notes / Deviations / References:

* fines content visually/manually estimated

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Sieve Analysis of Soils

ASTM D 6913

S&ME

Quality Assurance

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	12/2/16
Project Name:	Brunswick WTP	Test Date(s):	11/28 - 12/2/16
Client Name:			
Client Address:			
Boring No.: B-5	Sample: Bulk	Sample Date:	10/24/16
Location: Site-Borehole	Offset: N/A	Depth (ft):	1 - 5 ft.

Sample Description: Dark Gray SAND with Clay

Description of Sand & Gravel Particles: Rounded ☒ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Particle Size Analysis / Without Hydrometer Analysis				*Material Excluded:*	
Tare No.	**1213**	Tare Wt.	**130.18**	Mass of Sample after Wash + Tare Wt.	**324.23**
Total Sample Wet Wt. + Tare Wt.			**386.12**	Mass of Sample after Wash	**194.05**
Total Sample Dry Wt. + Tare Wt.			**348.11**	Mass passing #200	**23.88**
Total Sample Dry Weight			**217.93**	% Passing #200 **(D1140)**	**11.0%**

Sieve Size		**Retained Weight**	**% Retained Between Sieves**	**% Retained**	**% Passing**	**SPECS**
				Cumulative		
Standard	*mm.*	*Cumulative*	*Individual*	*Total Sample*		
2.0"	50.00	0.00	0.0%	0.0%	**100.0%**	**NA**
1.5"	37.50	0.00	0.0%	0.0%	**100.0%**	**NA**
1.0"	25.00	0.00	0.0%	0.0%	**100.0%**	**NA**
3/4"	19.00	0.00	0.0%	0.0%	**100.0%**	**NA**
1/2"	12.50	0.00	0.0%	0.0%	**100.0%**	**NA**
3/8"	9.50	0.00	0.0%	0.0%	**100.0%**	**NA**
#4	4.75	0.00	0.0%	0.0%	**100.0%**	**NA**
#10	2.000	0.91	0.4%	0.4%	**99.6%**	**NA**
#20	0.850	21.72	9.5%	10.0%	**90.0%**	**NA**
#40	0.425	75.68	24.8%	34.7%	**65.3%**	**NA**
#60	0.250	116.09	18.5%	53.3%	**46.7%**	**NA**
#100	0.150	170.12	24.8%	78.1%	**21.9%**	**NA**
#200	0.075	192.56	10.3%	88.4%	**11.6%**	**NA**
Pan	<0.075	193.61		**% Passing #200 (D6913) =**		**11.6%**

D2487	Maximum Particle Size	**#4**	Medium Sand	< 2.00 mm and > 0.425 mm (#40)	34.3%
Gravel	< 75 mm and > 4.75 mm (#4)	**0.0%**	Fine Sand	< 0.425 mm and > 0.075 mm (#200)	53.7%
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	**0.4%**	% Silt & Clay	< 0.075 mm	11.6%

Notes / Deviations / References:

D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Mal Krajan, ET		Laboratory Manager	12/2/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Sieve Analysis of Soils

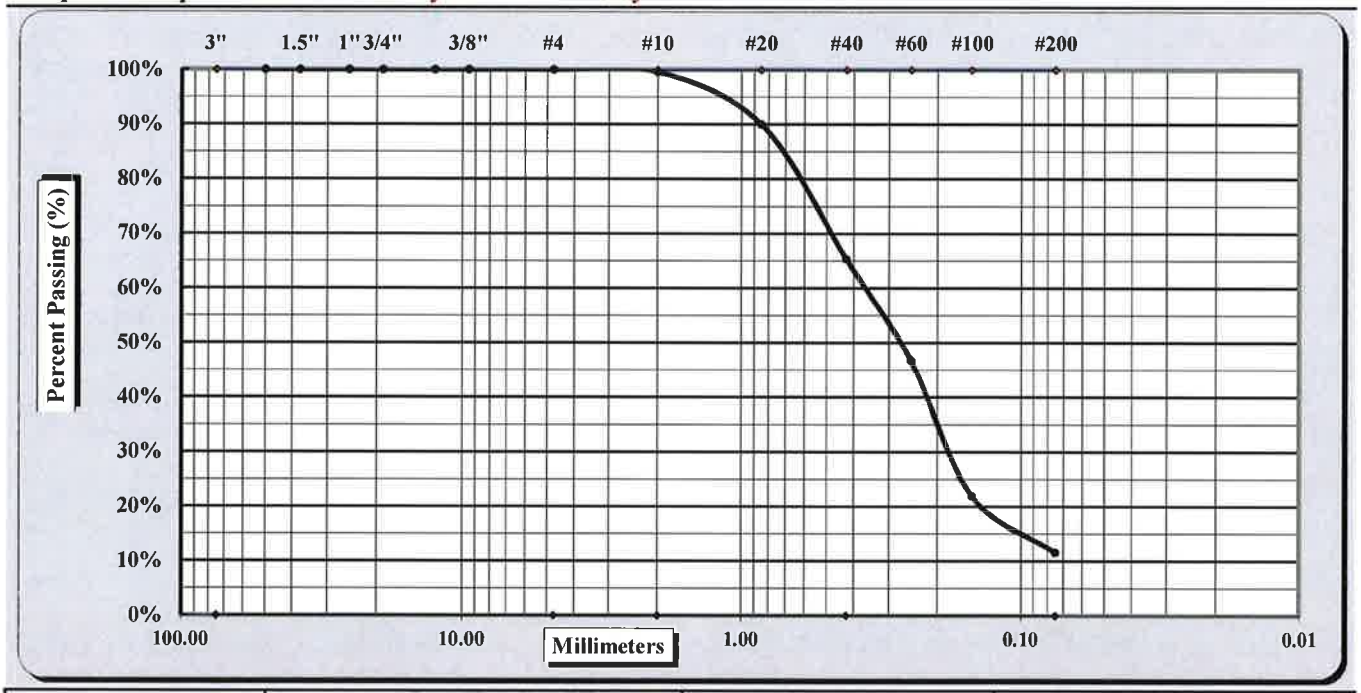
ASTM D 6913

Quality Assurance

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	**1305-16-116**	Report Date:	12/2/16
Project Name:	Brunswick WTP	Test Date(s):	11/28 - 12/2/16
Client Name:			
Client Address:			
Boring No.: B-5	Sample: Bulk	Sample Date:	10/24/16
Location: Site-Borehole	Offset: N/A	Depth (ft):	1 - 5 ft.

Sample Description: Dark Gray SAND with Clay



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	#4	Coarse Sand	0.4%	Fine Sand	53.7%
Gravel	0.0%	Medium Sand	34.3%	Silt & Clay	11.6%
Liquid Limit	ND	Plastic Limit	ND	Plastic Index	ND
Specific Gravity	ND			Moisture Content	17.4%
Coarse Sand	0.4%	Medium Sand	34.3%	Fine Sand	53.7%

Description of Sand & Gravel Particles: Rounded ☒ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Notes / Deviations / References: ND=Not Determined.

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Mal Krajan, ET		Laboratory Manager	12/2/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

S&ME
Quality Assurance

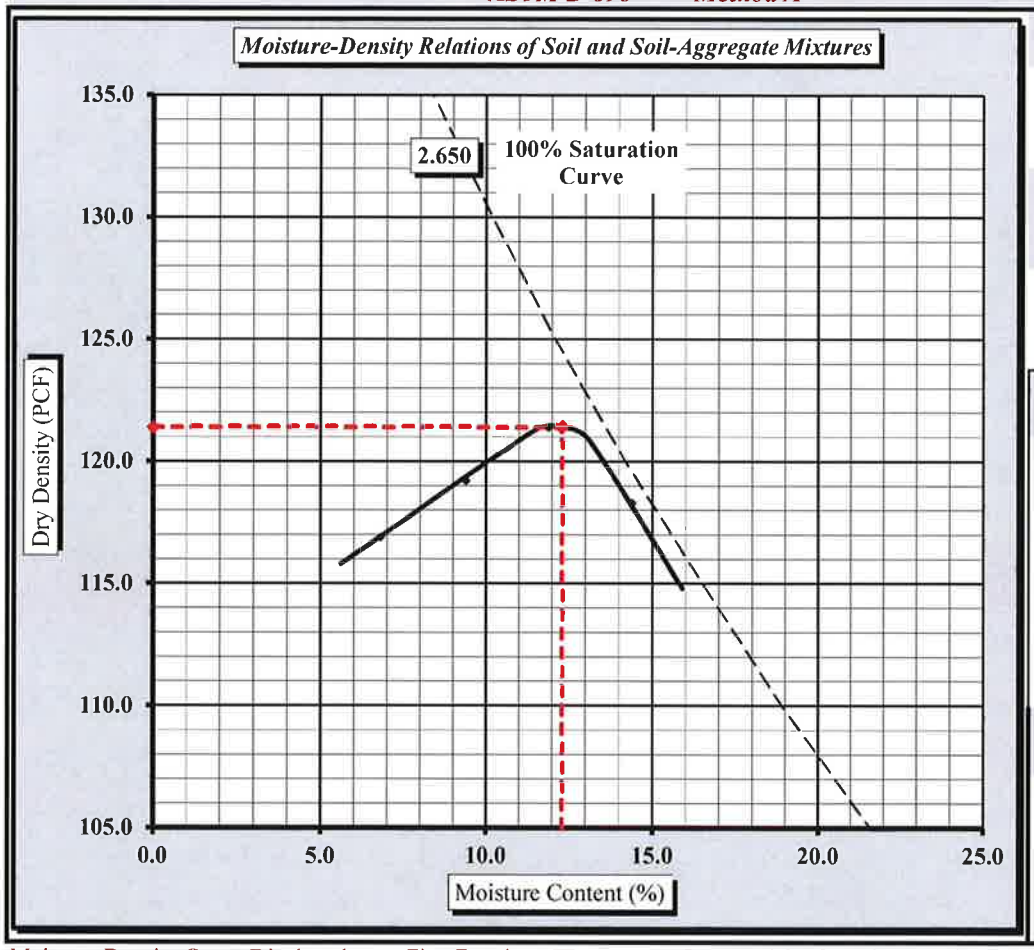
S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

S&ME Project #:	**1305-16-116**	Report Date:	11/29/16
Project Name:	Brunswick WTP	Test Date(s):	11/22 - 11/29/16
Client Name:			
Client Address:			

Boring #:	B-5	Sample #:	Bulk	Sample Date:	10/24/2016
Location:	Borehole	Offset:	N/A	Depth:	1 - 5 ft
Sample Description:	Dark Gray SAND with Clay				

Maximum Dry Density **121.4** **PCF.** **Optimum Moisture Content** **12.3%**

ASTM D 698 -- Method A



Soil Properties	
Natural Moisture Content	17.4%
Assumed Specific Gravity	2.650
Liquid Limit	ND
Plastic Limit	ND
Plastic Index	ND

% Passing	
3/4"	100.0%
3/8"	100.0%
#4	100.0%
#10	99.6%
#40	65.3%
#60	46.7%
#200	11.6%

Oversize Fraction	
Bulk Gravity	
% Moisture	
% Oversize	
MDD	
Opt. MC	

Moisture-Density Curve Displayed: Fine Fraction ☒ Corrected for Oversize Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations: ND=Not Determined.

ASTM D 422: Particle Size Analysis of Soils

ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort

Mal Krajan, ET		Laboratory Manager	11/29/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No. TR-D1883-T193-3
Revision No. 0
Revision Date: 2/6/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

ASTM D 1883

S&ME

Quality Assurance

S&ME, Inc.Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

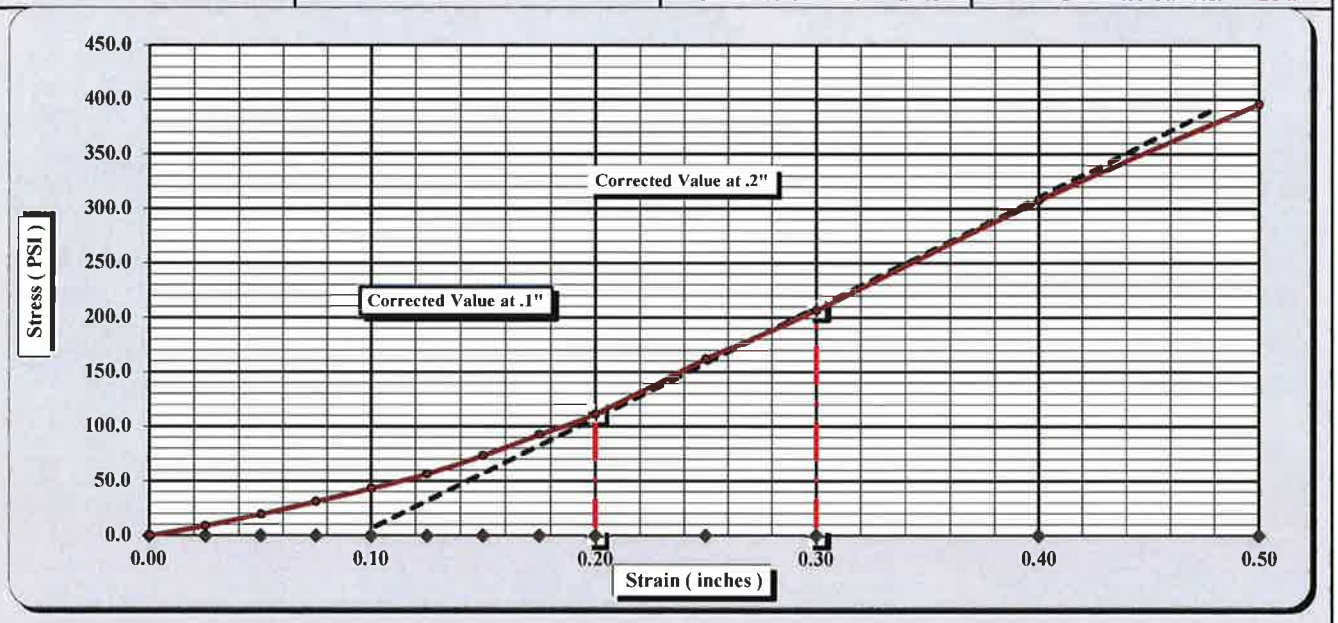
Project #:	**1305-16-116**	Report Date:	12/4/16
Project Name:	Brunswick WTP	Test Date(s)	11/28 - 12/4/16
Client Name:			
Client Address:			
Boring #:	B-5	Sample #: Bulk	Sample Date: 10/24/16
Location:	Borehole	Offset: N/A	Depth (ft): 1 - 5 ft

Sample Description: Dark Gray SAND with Clay

ASTM D 698 *Method A* Maximum Dry Density: **121.4 PCF** Optimum Moisture Content: **12.3%**

Compaction Test performed on grading complying with CBR spec. % Retained on the 3/4" sieve: **0.0%**

Uncorrected CBR Values		Corrected CBR Values	
CBR at 0.1 in. 4.3	**CBR at 0.2 in. 7.4**	**CBR at 0.1 in. 11.3**	**CBR at 0.2 in. 13.9**



CBR Sample Preparation:

The entire gradation was used and compacted in a 6" CBR mold in accordance with ASTM D1883, Section 7.1.1

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	40	Final Dry Density (PCF)	119.3
Initial Dry Density (PCF)	119.3	Average Final Moisture Content	12.3%
Moisture Content of the Compacted Specimen	12.2%	Moisture Content (top 1" after soaking)	12.4%
Percent Compaction	98.3%	Percent Swell	0.0%

Soak Time: 96-hr Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.9

Liquid Limit ND Plastic Index ND

Notes/Deviations/References: ND=Not Determined.

Test specimen was compacted to 98% at optimum moisture.

Mal Krajan, ET		Laboratory Manager	12/4/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full without the written approval of S&ME, Inc.

Form No. TR-D4318-T89-90
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

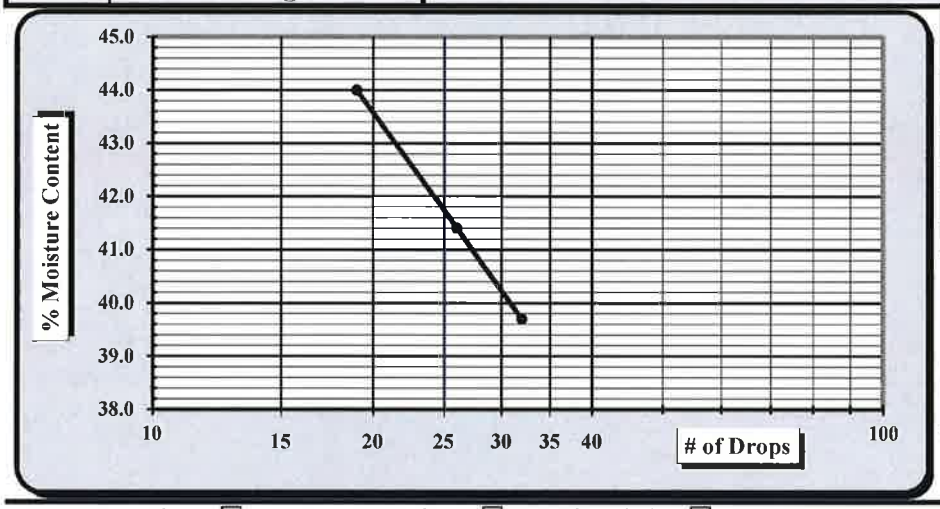
Test Methods: *ASTM D 4318* ☒ *AASHTO T 89* ☐ *AASHTO T 90* ☐ ***Quality Assurance***

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s)	11/15 - 11/22/16
Client Name:			
Client Address:			
Boring #:	B-6	Sample #: SS-3	Sample Date: 10/25/16
Location:	Site Borehole	Offset: N/A	Depth (ft): 6 - 7.5
Sample Description:	Brown Gray Clayey SAND (fines content visually/manually estimated)		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	1024	11/6/2016	Grooving tool	S-1	5/18/2016
LL Apparatus	13288	8/10/2016			
Oven	1454	10/7/2016			

		Liquid Limit						Plastic Limit		
Pan #	Tare #:									
A	Tare Weight	13.68	13.59	13.55				13.16	12.49	
B	Wet Soil Weight + A	26.48	27.42	27.63				23.07	21.44	
C	Dry Soil Weight + A	22.84	23.37	23.33				21.45	19.99	
D	Water Weight (B-C)	3.64	4.05	4.30				1.62	1.45	
E	Dry Soil Weight (C-A)	9.16	9.78	9.78				8.29	7.50	
F	% Moisture (D/E)*100	39.7%	41.4%	44.0%				19.5%	19.3%	
N	# OF DROPS	32	26	19				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**19.4%**		



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	42
Plastic Limit	19
Plastic Index	23
Group Symbol	SC*
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☐ Dry Preparation ☐ Air Dried ☑ *Estimate the % Retained on the #40 Sieve:* 8%

Notes / Deviations / References:

* fines content visually/manually estimated

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Sieve Analysis of Soils

ASTM D 6913

Quality Assurance

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s):	11/15 - 11/20/16
Client Name:			
Client Address:			
Boring No.: B-6	Sample: SS-7	Sample Date:	10/25/16
Location: Site-Borehole	Offset: N/A	Depth (ft):	23.5 - 25

Sample Description: Gray Brown Green SAND with Silt

Description of Sand & Gravel Particles: Rounded ☒ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Particle Size Analysis / Without Hydrometer Analysis

				Material Excluded:	
Tare No.	1212	Tare Wt.	136.31	Mass of Sample after Wash + Tare Wt.	317.20
Total Sample Wet Wt. + Tare Wt.			379.59	Mass of Sample after Wash	180.89
Total Sample Dry Wt. + Tare Wt.			327.86	Mass passing #200	10.66
Total Sample Dry Weight			191.55	% Passing #200 **(D1140)**	5.6%

Sieve Size		Retained Weight	% Retained Between Sieves	% Retained	% Passing	SPECS
				Cumulative		
Standard	*mm.*	*Cumulative*	*Individual*	*Total Sample*		
2.0"	50.00	0.00	0.0%	0.0%	100.0%	NA
1.5"	37.50	0.00	0.0%	0.0%	100.0%	NA
1.0"	25.00	0.00	0.0%	0.0%	100.0%	NA
3/4"	19.00	0.00	0.0%	0.0%	100.0%	NA
1/2"	12.50	0.00	0.0%	0.0%	100.0%	NA
3/8"	9.50	0.00	0.0%	0.0%	100.0%	NA
#4	4.75	0.00	0.0%	0.0%	100.0%	NA
#10	2.000	0.00	0.0%	0.0%	100.0%	NA
#20	0.850	0.28	0.1%	0.1%	99.9%	NA
#40	0.425	2.19	1.0%	1.1%	98.9%	NA
#60	0.250	19.35	9.0%	10.1%	89.9%	NA
#100	0.150	128.31	56.9%	67.0%	33.0%	NA
#200	0.075	178.92	26.4%	93.4%	6.6%	NA
Pan	<0.075	180.39		**% Passing #200 (D6913) =**		6.6%

D2487	Maximum Particle Size	#10	Medium Sand	< 2.00 mm and > 0.425 mm (#40)	1.1%
Gravel	< 75 mm and > 4.75 mm (#4)	0.0%	Fine Sand	< 0.425 mm and > 0.075 mm (#200)	92.3%
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	0.0%	% Silt & Clay	< 0.075 mm	6.6%

Notes / Deviations / References:

D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Sieve Analysis of Soils

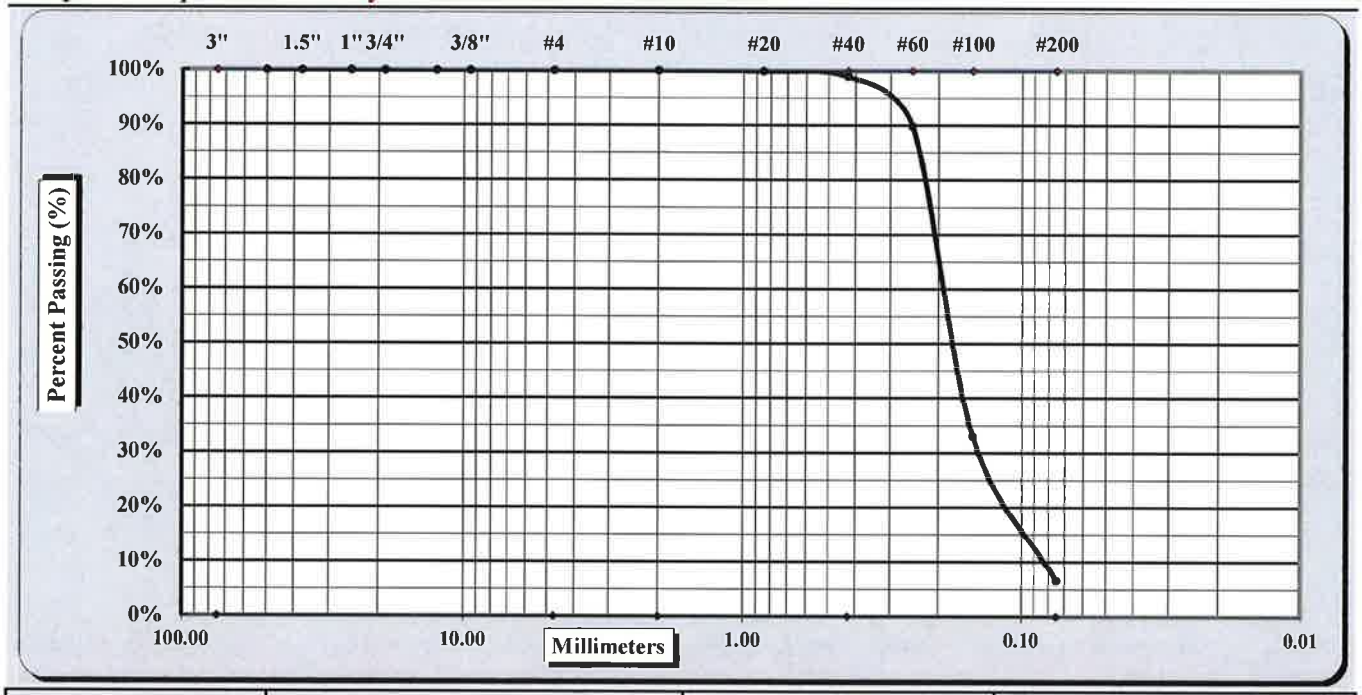
ASTM D 6913

Quality Assurance

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	**1305-16-116**	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s):	11/15 - 11/20/16
Client Name:			
Client Address:			
Boring No.: B-6	Sample: SS-7	Sample Date:	10/25/16
Location: Site-Borehole	Offset: N/A	Depth (ft):	23.5 - 25

Sample Description: Gray Brown Green SAND with Silt



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	#10	Coarse Sand	0.0%	Fine Sand	92.3%
Gravel	0.0%	Medium Sand	1.1%	Silt & Clay	6.6%
Liquid Limit	ND	Plastic Limit	ND	Plastic Index	ND
Specific Gravity	ND			Moisture Content	27.0%
Coarse Sand	0.0%	Medium Sand	1.1%	Fine Sand	92.3%

Description of Sand & Gravel Particles: Rounded ☒ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Notes / Deviations / References: ND=Not Determined.

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No. TR-D4318-T89-90
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

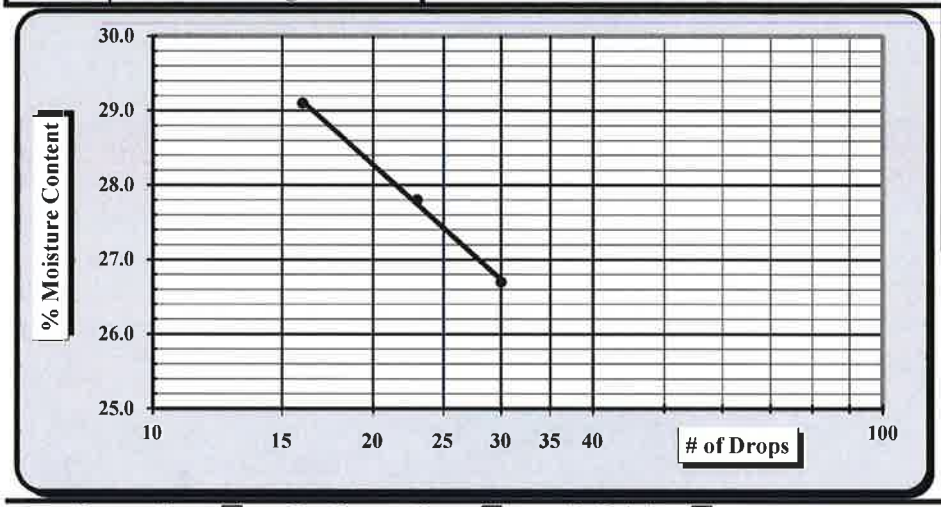
Test Methods: *ASTM D 4318* ☒ *AASHTO T 89* ☐ *AASHTO T 90* ☐ ***Quality Assurance***

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s)	11/15 - 11/22/16
Client Name:			
Client Address:			
Boring #:	B-10	Sample #: SS-1	Sample Date: 10/25/16
Location:	Site Borehole	Offset: N/A	Depth (ft): 1 - 2.5
Sample Description:	Dark Gray Sandy SILT (fines content visually/manually estimated)		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	1024	11/6/2016	Grooving tool	S-1	5/18/2016
LL Apparatus	13288	8/10/2016			
Oven	1454	10/7/2016			

		Liquid Limit						Plastic Limit		
	Pan # / Tare #:									
A	Tare Weight	13.00	12.98	13.03				12.93	13.01	
B	Wet Soil Weight + A	25.20	26.89	24.26				23.55	25.13	
C	Dry Soil Weight + A	22.63	23.86	21.73				21.40	22.71	
D	Water Weight (B-C)	2.57	3.03	2.53				2.15	2.42	
E	Dry Soil Weight (C-A)	9.63	10.88	8.70				8.47	9.70	
F	% Moisture (D/E)*100	26.7%	27.8%	29.1%				25.4%	24.9%	
N	# OF DROPS	30	23	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**25.2%**		



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	27
Plastic Limit	25
Plastic Index	2
Group Symbol	ML*
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☐ Dry Preparation ☐ Air Dried ☑ *Estimate the % Retained on the #40 Sieve:* 8%

Notes / Deviations / References:

* fines content visually/manually estimated

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No: TR-D6913-WH-1
Revision No. 0
Revision Date: 05/10/12

Sieve Analysis of Soils

ASTM D 6913

S&ME

Quality Assurance

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	1305-16-116	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s):	11/15 - 11/20/16
Client Name:			
Client Address:			
Boring No.: B-13	Sample: SS-14	Sample Date:	10/26/16
Location: Site-Borehole	Offset: N/A	Depth (ft):	58.5 - 60
Sample Description:	Dark Gray Silty SAND		

Description of Sand & Gravel Particles: Rounded ☒ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Particle Size Analysis / Without Hydrometer Analysis				*Material Excluded:*	
Tare No.	43	Tare Wt.	**129.11**	Mass of Sample after Wash + Tare Wt.	**295.04**
Total Sample Wet Wt. + Tare Wt.			**380.75**	Mass of Sample after Wash	**165.93**
Total Sample Dry Wt. + Tare Wt.			**326.55**	Mass passing #200	**31.51**
Total Sample Dry Weight			**197.44**	% Passing #200 **(D1140)**	**16.0%**

Sieve Size		**Retained Weight**	**% Retained Between Sieves**	**% Retained**	**% Passing**	**SPECS**
				Cumulative		
Standard	*mm.*	*Cumulative*	*Individual*	*Total Sample*		
2.0"	50.00	0.00	0.0%	0.0%	**100.0%**	**NA**
1.5"	37.50	0.00	0.0%	0.0%	**100.0%**	**NA**
1.0"	25.00	0.00	0.0%	0.0%	**100.0%**	**NA**
3/4"	19.00	0.00	0.0%	0.0%	**100.0%**	**NA**
1/2"	12.50	0.00	0.0%	0.0%	**100.0%**	**NA**
3/8"	9.50	0.00	0.0%	0.0%	**100.0%**	**NA**
#4	4.75	0.00	0.0%	0.0%	**100.0%**	**NA**
#10	2.000	0.00	0.0%	0.0%	**100.0%**	**NA**
#20	0.850	0.14	0.1%	0.1%	**99.9%**	**NA**
#40	0.425	0.43	0.1%	0.2%	**99.8%**	**NA**
#60	0.250	6.70	3.2%	3.4%	**96.6%**	**NA**
#100	0.150	135.16	65.1%	68.5%	**31.5%**	**NA**
#200	0.075	164.25	14.7%	83.2%	**16.8%**	**NA**
Pan	<0.075	165.75		**% Passing #200 (D6913) =**		**16.8%**

D2487	Maximum Particle Size	**#10**	Medium Sand	< 2.00 mm and > 0.425 mm (#40)	0.2%
Gravel	< 75 mm and > 4.75 mm (#4)	**0.0%**	Fine Sand	< 0.425 mm and > 0.075 mm (#200)	83.0%
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	**0.0%**	% Silt & Clay	< 0.075 mm	16.8%

Notes / Deviations / References:

D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Sieve Analysis of Soils

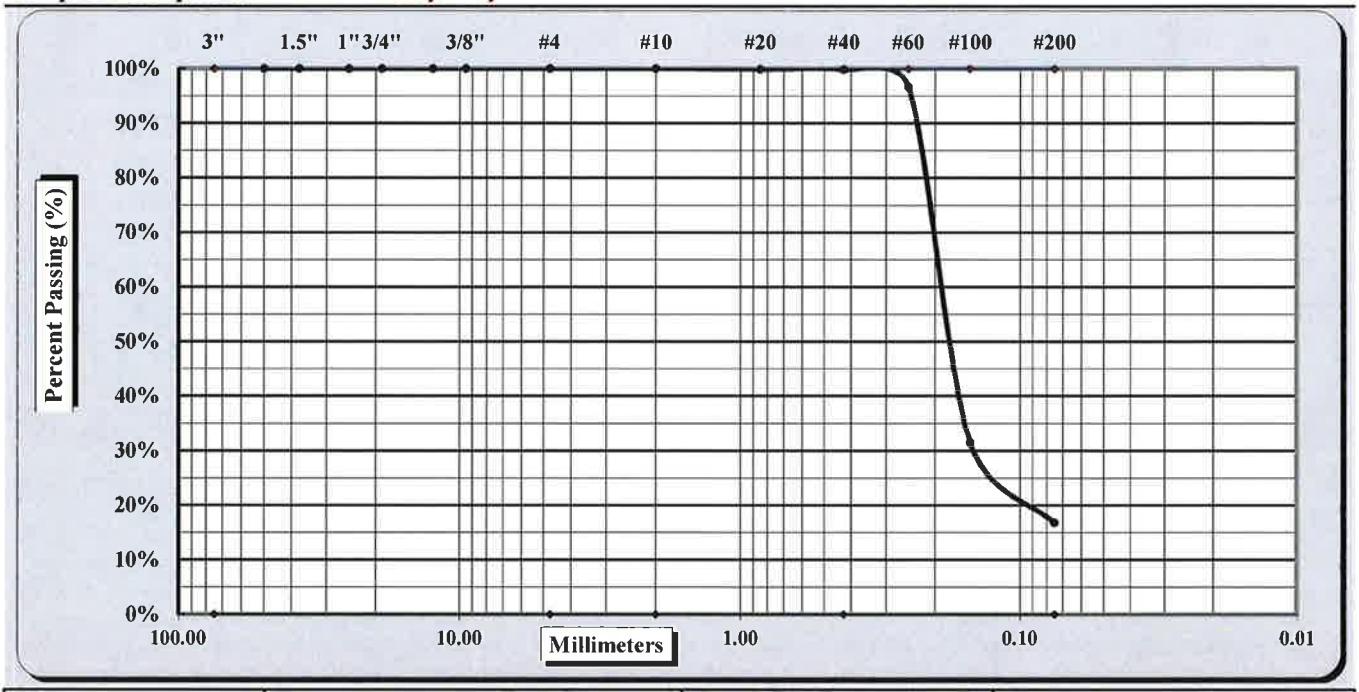
ASTM D 6913

Quality Assurance

S&ME, Inc. Raleigh, 3201 Spring Forest Road, Raleigh, North Carolina 27616

Project #:	**1305-16-116**	Report Date:	11/23/16
Project Name:	Brunswick WTP	Test Date(s):	11/15 - 11/20/16
Client Name:			
Client Address:			
Boring No.:	B-13	Sample: SS-14	Sample Date: 10/26/16
Location:	Site-Borehole	Offset: N/A	Depth (ft): 58.5 - 60

Sample Description: Dark Gray Silty SAND



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	#10	Coarse Sand	0.0%	Fine Sand	83.0%
Gravel	0.0%	Medium Sand	0.2%	Silt & Clay	16.8%
Liquid Limit	ND	Plastic Limit	ND	Plastic Index	ND
Specific Gravity	ND			Moisture Content	27.5%
Coarse Sand	0.0%	Medium Sand	0.2%	Fine Sand	83.0%

Description of Sand & Gravel Particles: Rounded ☒ Angular ☒

Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Notes / Deviations / References: ND=Not Determined.

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Mal Krajan, ET		Laboratory Manager	11/23/2016
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

BID FORM

PROJECT: Water Supply and Treatment System

CONTRACT: 4 – Reverse Osmosis Water Treatment Plant

BID FROM: _____

TABLE OF ARTICLES

	page
Article 1 – Bid Recipient	1
Article 2 – Bidder's Acknowledgements	1
Article 3 – Bidder's Representations	1
Article 4 – Bidder's Certification	2
Article 5 – Basis of Bid	3
Article 6 – Time of Completion	5
Article 7 – Attachments to this Bid	5
Article 8 – Defined Terms	7
Article 9 – Bid Submittal	7

ARTICLE 1 BID RECIPIENT

1.01 This Bid is Submitted To:
Brunswick Regional Water and Sewer H2GO
P.O. Box 2230
516 Village Road, N.E.
Leland, NC 28451

1.02 Undersigned bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with the Owner in the form included in the Bidding Documents to perform the Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in the Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 BIDDER'S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Advertisement and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 90 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, the other related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged.

Addenda _____

B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and is satisfied as to federal, state and local Laws and Regulations that may affect cost, progress, and performance, of the Work.

D. Bidder has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in SC-4.02, and (2) reports and drawings of Hazardous Environmental Conditions, if any, that have been identified in SC-4.06 as containing reliable "technical data".

E. Bidder has considered the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents; and (3) Bidder's safety precautions and programs.

F. Based on the information and observations referred to in Paragraph 3.01.E above, Bidder does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents.

G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.

J. Bidder will submit written evidence of its authority to do business in the state where the Project is located not later than the date of its execution of the Agreement.

ARTICLE 4 BIDDER'S CERTIFICATION

4.01 Bidder further represents that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;
2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;
3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels; and
4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 5 BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

A. For all Work, **other than Unit Price Work**, a Lump Sum of: _____

_____ Dollars ($_____)

B. Allowances

1. Cash Allowance No. 1 – Vertical Turbine Pumps $ 184,680.00
2. Cash Alowance No. 2 - Horizontal, Upflow Calcite Contactor Vessels $ 890,912.00
3. Contingency Allowance $ 350,000.00

C. For Unit Price Work, an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of that item as indicated below.

Item No.	Description	Unit	Estimated Quantity	Unit Price	Total Estimated Price
1.	Undercut Unsuitable Material and Backfill with Suitable Material	CY	2,000		
			Total Unit Price Bid		

D. Unit Prices have been computed in accordance with paragraph 11.03.B of the General Conditions.

E. Bidder acknowledges that estimated quantities are not guaranteed and are solely for the purpose of comparison of Bids, and final payment for Unit Price Bid items will be based on actual quantities, determined as provided in the Contract Documents. Determinations of actual quantities and classification are to be made by Engineer as provided in paragraph 9.07 of the General Conditions.

F. The Total for Lump Sum, Allowance and Unit Price Work of: _____

_____ Dollars ($_____)

ARTICLE 6 TIME OF COMPLETION

6.01 Bidder agrees that the Work will be completed and ready for final payment in accordance with paragraph 14.07 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 ATTACHMENTS TO THIS BID

7.01 The following documents are attached to and made a condition of this Bid. Failure to provide the documentation with the bid may be grounds for rejection of the bid.

A. Required Bid security in the form of a Bid Bond (EJCDC No. C-430) or Certified Check (circle type of security provided).

B. In accordance with GS 143-128.2(c), Bidder shall identify on its bid the minority businesses that it will use on the project and the total dollar value of the bid that will be performed by the minority businesses and list the good faith efforts (Affidavit A) made to solicit participation. A Bidder that will perform all of the work with its own workforce may submit an Affidavit (B) to that effect in lieu of the affidavit (A) required above.
   1. Identification of Minority Business Participation.
   2. Affidavit A, Listing of Good Faith Efforts; or Affidavit B, Intent to Perform Contract with Own Workforce.

C. In accordance with GS 64-26(a), Bidders shall submit the E-Verify Affidavit to document that the work authorization of their employees has been verified through E-Verify. The Affidavit shall also document that the Bidders subcontractors comply with E-Verify.

D. Iran Divestment Act Certification

E. A tabulation of Subcontractors required to be identified in the Bid.

F. Equipment Manufacturer's List (Section 00415)

G. Manufacturer's Qualification Documentation for Section 13203 – Horizontal Calcite Contactor Vessel (Pressure) System

7.02 Submit the Bidder's Checklist as provided in the bidding documents with the bid submittal. The Checklist shall be completed and included as the first page of the submittal.

7.03 After the bid opening the Owner will consider all bids and alternates and determine the lowest responsible, responsive bidder. Upon notification of being the apparent low Bidder, the Bidder shall then file within 72 hours of the notification of being the apparent lowest bidder, the following:

A. An Affidavit (C) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the goal established by the Owner and indicated in the Instruction to Bidders, paragraph Minority Participation Goals. This affidavit shall give rise to the presumption that the bidder has made the required good faith effort; or

B. Affidavit (D) of its good faith effort to meet the goal. The document must include evidence of all good faith efforts that were implemented, including any advertisements, solicitations and other specific actions demonstrating recruitment and selection of minority businesses for participation in the contract.

7.04 In accordance with GS 143-128 the Single Prime Contractor must identify the Contractors, if any, selected for the following subdivision of work:

A. General Construction

Name: _____

Address: _____

_____

N.C. License No.: _____

B. HVAC Construction

Name: _____

Address: _____

_____

N.C. License No.: _____

C. Plumbing Construction

Name: _____

Address: _____

_____

N.C. License No.: _____

D. Electrical Construction

Name: _____

Address: _____

_____

N.C. License No.: _____

7.05 Bidder understands that if this Bid is accepted by the Owner, Bidder shall not substitute for the subcontractors named in the Bid Documents except as allowed in the Supplementary Conditions.

ARTICLE 8 DEFINED TERMS

8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 9 BID SUBMITTAL

9.01 Contractor's License

A. Number: _____

B. Classification: _____

C. Limitation: _____

Employer's Tax ID No.: _____

Business Address

_____

_____

_____

_____

Phone No.:_____

Fax No.:_____

E-Mail Address:_____

9.02 This Bid Submitted by:

An Individual

Name: _____
(Type or print)

By: _____
(Individual's Signature)

Doing Business As: _____
(Type or print)

A Partnership

Partnership Name: _____

The Organization and Internal Affairs of the Partnership are governed by the laws of the State of: _____

By: _____
(Signature of general partner, attach evidence of authority to sign)

Name: _____
(Type or print)

Title: _____
(Type or print)

Attest: _____
(Signature of Corporate Secretary)

A Corporation

Corporation Name: _____

State of Incorporation: _____

Type (General Business, Profession, Service, Limited Liability):

_____

By: _____
(Signature, attach evidence of authority to sign)

Name: _____
(Type or print)

Title: _____
(Type or print)

Attest: _____ Corporate Seal
(Signature of Corporate Secretary)

Date of Qualification to do business in North Carolina is _____.

Limited Liability Company – LLC

Name of LLC: _____

Name of State under whose Laws the Limited Liability Company was formed: _____

By: _____
(Signature of Manager)

Name: _____
(Type or print)

Title: _____
(Type or print)

END OF DOCUMENT

BIDDER'S CHECKLIST

This checklist shall be included as the first page of the submitted bidding documents. As outlined in article 7 of the Bid Form the following items shall be included with the submitted bidding documents:

	-	Properly Executed Bid Form (Including the acknowledgement of all Addenda)
	A.	Required Bid security in the form of a Bid Bond (EJCDC No. C-430) or Certified Check (circle type of security provided); Bid Bond shall be include an executed Power of Attorney.
	B1.	Identification of Minority Business Participation
	B2.	Affidavit A, Listing of Good Faith Efforts; or Affidavit B, Intent to Perform Contract with Own Workforce
	C.	E-Verify Affidavit
	D.	Iran Divestment Act Certification
	E.	Subcontractors List
	F.	Equipment Manufacturer's List

SECTION 00415

EQUIPMENT MANUFACTURERS LIST

PART 1 GENERAL

1.01 SCOPE

A. Bidder shall be required to attach the Equipment Manufacturers List with the Bid Form to indicate the selected manufacturers for the requested major pieces of equipment.

1.02 REQUIREMENTS

A. The requirements as they apply to the submitted list are as follows:

1. Each Bidder shall enter in the space provided the names of the manufacturers of equipment which Bidder proposes to furnish. Not more than one manufacturer's name shall be listed for each item of equipment.
2. Failure to completely and accurately fill out the list shall disqualify the Bid as non-responsive.
3. Named manufacturers listed in the specific Specification Sections are acceptable provided the supplied equipment meets or exceeds the requirements of the Project Specifications.
4. "Or Equal" manufacturers may be listed in the blank provided for each item of equipment. The Bidder shall be required to follow the provisions for the approval of "Or Equal" pieces of equipment as outlined in the Instructions to Bidders, Article 11.
5. Upon award of a contract, the named equipment shall be furnished. Substitutions will be permitted only if the named equipment does not meet the requirements of the Contract Documents, the manufacturer is unable to meet the delivery requirements of the construction schedule, or the manufacturer is dilatory in complying with the requirements of the Contract Documents. Substitutions shall be subject to concurrence of the Owner and shall be confirmed by Change Order.
6. Preliminary acceptance of equipment listed by manufacturer's name shall not in any way constitute a waiver of the specifications covering such equipment and final acceptance will be based on full conformity with the Contract Documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

BRUNSWICK REGIONAL WATER AND SEWER H2GO

WATER SUPPLY AND TREATMENT SYSTEM

CONTRACT 4: REVERSE OSMOSIS WATER TREATMENT PLANT

EQUIPMENT MANUFACTURERS LIST

A. Section 11068 Submersible Well Pumps _____

B. Section 11094 Submersible Mixer _____

C. Section 11240 Caustic System Chemical System Supplier _____

D. Section 11242 Corrosion Inhibitor Chemical System Supplier _____

E. Section 11243 Hydrofluorosilicic Acid Chemical System Supplier _____

F. Section 11265 On-Site Sodium Hypochlorite Generation System _____

G. Section 11975 Carbon Dioxide Storage and Carbonic Acid System _____

H. Section 13121 Pre-Engineered Building Supplier _____

I. Section 13206 Pre-stressed Concrete Water Tank _____

J. Section 13445 SCADA System Integrator _____

K. Section 13602 FRP Building Supplier _____

L. Section 16230 Engine Generator System _____

Respectfully submitted:

(Type or Print Name)

_____

(Signature)

_____

(Title)

License Number: _____

Date: _____

(SEAL - if bid is by a Corporation)

BID BOND

Any singular reference to Bidder, Surety, Owner or other party shall be considered plural where applicable.

BIDDER *(Name and Address)*:

SURETY *(Name and Address of Principal Place of Business)*:

OWNER *(Name and Address)*:
Brunswick Regional Water and Sewer H2GO
PO Box 2230, 516 Village Road NE
Leland, NC 28451

BID
Bid Due Date:
Description *(Project Name and Include Location)*: Water Supply and Treatment System
Contract 4 – Reverse Osmosis Water Treatment Plant

BOND
Bond Number:
Date *(Not earlier than Bid due date)*:
Penal sum _____ $ _____
(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER	**SURETY**
_____ (Seal)	_____ (Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
_____	_____
Title	Title

Note: Above addresses are to be used for giving required notice.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1 Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2 All Bids are rejected by Owner, or

3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

PAGE FOR ATTACHING

POWER OF ATTORNEY
(Bid Bond)

Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid

Identification of Minority Business Participation

I,_____.
(Name of Bidder)

do hereby certify that on this project, we will use the following minority business enterprises as construction subcontractors, vendors, suppliers or providers of professional services.

Firm Name, Address and Phone #	Work type	*Minority Category

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

The total value of minority business contracting will be ($)_____.

Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid

State of North Carolina AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of_____

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

- ☐ **1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- ☐ **2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- ☐ **3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- ☐ **4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- ☐ **5 – (10 pts)** Attended prebid meetings scheduled by the public owner.
- ☐ **6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- ☐ **7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- ☐ **8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- ☐ **9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- ☐ **10 - (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date:_____ Name of Authorized Officer:_____

Signature:_____

Title:_____

SEAL

State of North Carolina, County of_____

Subscribed and sworn to before me this _____day of _____20____

Notary Public_____

My commission expires _____

MBForms 2002-R

Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid

State of North Carolina --AFFIDAVIT B-- Intent to Perform Contract with Own Workforce.

County of _____

Affidavit of _____
(Name of Bidder)

I hereby certify that it is our intent to perform 100% of the work required for the _____

_____ contract.
(Name of Project)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____

SEAL

State of North Carolina, County of _____

Subscribed and sworn to before me this _____ day of _____ 20___

Notary Public _____

My commission expires _____

Do not submit with bid Do not submit with bid Do not submit with bid Do not submit with bid

State of North Carolina - AFFIDAVIT C - Portion of the Work to be Performed by Minority Firms

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by minority businesses as defined in GS143-128.2(g) is equal to or greater than 10% of the bidders total contract price, then the bidder must complete this affidavit. This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification of being low bidder.

Affidavit of _____ I do hereby certify that on the
(Name of Bidder)

_____
(Project Name)

Project ID#_____ Amount of Bid $_____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. Attach additional sheets if required

Name and Phone Number	*Minority Category	Work description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date:_____ Name of Authorized Officer:_____

Signature:_____

Title:_____

SEAL

State of North Carolina, County of _____

Subscribed and sworn to before me this _____day of _____20____

Notary Public_____

My commission expires_____

Do not submit with the bid Do not submit with the bid Do not submit with the bid Do not submit with the bid Do not submit with the bid

State of North Carolina AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the goal of 10% participation by minority business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

(Name of Bidder)

Affidavit of: _____

I do certify the attached documentation as true and accurate representation of my good faith efforts.

(Attach additional sheets if required)

Name and Phone Number	*Minority Category	Work description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

Documentation of the Bidder's good faith efforts to meet the goals set forth in these provisions. Examples of documentation include, but are not limited to, the following evidence:

A. Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.

B. Copies of quotes or responses received from each firm responding to the solicitation.

C. A telephone log of follow-up calls to each firm sent a solicitation.

D. For subcontracts where a minority business firm is not considered the lowest responsible sub-bidder, copies of quotes received from all firms submitting quotes for that particular subcontract.

E. Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.

F. Copy of pre-bid roster.

G. Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.

H. Letter detailing reasons for rejection of minority business due to lack of qualification.

I. Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder.

Date:_____ Name of Authorized Officer:_____

Signature:_____

Title:_____

SEAL

State of North Carolina, County of _____

Subscribed and sworn to before me this _____day of _____20____

Notary Public_____

My commission expires _____

STATE OF NORTH CAROLINA

AFFIDAVIT

_____
COUNTY OR MUNICIPALITY

****

I, _____ (the individual attesting below), being duly authorized by and on behalf of _____ (the entity bidding on project hereinafter "Employer") after first being duly sworn hereby swears or affirms as follows:

1. Employer understands that E-Verify is the federal E-Verify program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program used to verify the work authorization of newly hired employees pursuant to federal law in accordance with NCGS §64-25(5).
2. Employer understands that Employers Must Use E-Verify. Each employer, after hiring an employee to work in the United States, shall verify the work authorization of the employee through E-Verify in accordance with NCGS§64-26(a).
3. Employer is a person, business entity, or other organization that transacts business in this State and that employs 25 or more employees in this State. (mark Yes or No)
   a. YES _____, or
   b. NO _____
4. Employer's subcontractors comply with E-Verify, and if Employer is the winning bidder on this project Employer will ensure compliance with E-Verify by any subcontractors subsequently hired by Employer.

This _____ day of _____, 20__.

_____
Signature of Affiant
Print or Type Name: _____

State of North Carolina County of _____

Signed and sworn to (or affirmed) before me, this the _____

day of _____, 20__.

My Commission Expires:

_____ _____
Notary Public

(Affix Official / Notarial Seal)

IRAN DIVESTMENT ACT CERTIFICATION
REQUIRED BY N.C.G.S. 147-86.59

N.C.G.S.147-86.60 prohibits the State of North Carolina, a North Carolina local government, or any other political subdivision of the State of North Carolina from contracting with any entity that is listed on the Final Divestment List created by the North Carolina State Treasurer pursuant to N.C.G.S. 147-86.58. N.C.G.S. 147-86.59 further requires that contractors with the State, a North Carolina local government, or any other political subdivision of the State of North Carolina must not utilize any subcontractor found on the State Treasurer's Final Divestment List.

As of the date of execution of this Agreement:

_____ hereby certifies that

_____ is not listed on the Final Divestment List created by the North Carolina State Treasurer and that

_____ will not utilize any subcontractors found on the Final Divestment List.

Notice of Award

Project: **Water Supply and Treatment System**	Date:
Owner: **Brunswick Regional Water & Sewer H2GO**	Owner's Contract No.: **n/a**
Contract: **4 – Reverse Osmosis Water Treatment Plant**	Engineer's Project No.: **3081-AB**
Bidder:	
Bidder's Address: (send Certified Mail, Return Receipt Requested)	

You are notified that your Bid dated _DATE_, for the above Contract has been considered. You are the Successful Bidder and are awarded a Contract for the following:

- Water Supply and Treatment System, Contract 4 – Reverse Osmosis Water Treatment Plant

The Contract Price of your Contract is _and 00/100 Dollars ($ Amount)_.

4 copies of the proposed Contract Documents (except Drawings) accompany this Notice of Award.

4 sets of the Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within 10 days of the date you receive this Notice of Award.

1. Deliver to the Owner 4 fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract Bonds as specified in the Instructions to Bidders, General Conditions Paragraph 5.01, and Supplementary Conditions Paragraph SC-5.01.
3. Other conditions precedent:

   None

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award and declare your Bid security forfeited.

Within 10 days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

Brunswick Regional Water & Sewer H2GO
Owner

By: _____
Authorized Signature

_____
Title

Copy to Engineer

Acceptance of Notice

Receipt of the above Notice of Award is hereby acknowledged by _____

this the _____ day of _____, 2020.

By: _____

Title: _____

EJCDC No. C-510 (2007 Edition) Prepared by the Engineers' Joint Contract Documents Committee and endorsed by the Associated General Contractors of America and the Construction Specifications Institute.

AGREEMENT

THIS AGREEMENT is by and between

Brunswick Regional Water and Sewer H2GO (Owner) and

_____ (Contractor).

Owner and Contractor hereby agree as follows:

ARTICLE 1 – WORK

Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

- Complete construction of five (5) water supply well sites consisting of two (2) deep wells and associated appurtenances per site.
- Construction of a 4 MGD reverse osmosis water treatment plant including, but not limited to, treatment plant building, two (2) reverse osmosis treatment trains, chemical feed and storage systems, calcite contactor vessels, 1 MG ground storage tank, high service pumps, instrumentation, SCADA system, sitework, roadwork, yard piping, electrical and all associated appurtenances.

ARTICLE 2- PROJECT

The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows:

Water Supply and Treatment System Contract 4 – Reverse Osmosis Treatment Plant

ARTICLE 3- ENGINEER

The Project has been designed by The Wooten Company, 120 North Boylan Avenue, Raleigh, North Carolina 27603, (Engineer) which is to act as Owner's representative, assume all duties and responsibilities and have the rights and authority assigned to Engineer in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE 4- CONTRACT TIMES

4.01 Time of the Essence

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 Days to Achieve Completion and Final Payment

A. The Work will be substantially completed within 420 days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within 450 days after the date when the Contract Times commence to run.

4.03 Liquidated Damages

A. Contractor and Owner recognize that time is of the essence as stated in this Agreement and that Owner will suffer financial loss if the Work is not completed

within the times specified in paragraph 4.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor shall pay Owner $750.00 for each day that expires after the time specified in paragraph 4.02 for Substantial Completion until the Work is substantially complete. After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner $750.00 for each day that expires after the time specified in Paragraph 4.02 above for completion and readiness for final payment until the Work is completed and ready for final payment.

ARTICLE 5- CONTRACT PRICE

Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to the following paragraphs:

A. For the Total Lump Sum Work, Allowance and Unit Price Work: & 00/100 Dollars ($ Amount)

ARTICLE 6- PAYMENT PROCEDURES

6.01 Submittal and Processing of Payments

A. Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Engineer will process Applications for Payment as provided in the General Conditions.

6.02 Progress Payments; Retainage

A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment as recommended by Engineer, on or about the 25th day of each month during performance of the Work as provided in paragraphs 6.02.A.1 below. All such payments will be measured by the schedule of values established in paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements:

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage as indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine, or Owner may withhold, in accordance with paragraph 14.02 of the General Conditions.

a. 95 % of Work completed (with the balance being retainage). If Work has been 50% completed as determined by Engineer, if the Contractor has provided a written request to reduce the retainage along with a consent of its surety to the Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, Owner, on

recommendation of Engineer, may determine that as long as the character and progress of the Work remain satisfactory to them, there will be no additional retainage on account of Work subsequently completed so that the retainage at the end of the project will be equal to 2.5%; and

b. 95 % of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

2. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to the Contractor to 100 percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 14.02.B.5 of the General Conditions and less 200 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

6.03 Final Payment

A. Upon final completion and acceptance of the Work in accordance with paragraph 14.07 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said paragraph 14.07.

ARTICLE 7 - INTEREST

All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the maximum rate 8 percent per annum in accordance with North Carolina General Statute 24-1.

ARTICLE 8 - CONTRACTOR'S REPRESENTATIONS

8.01 In order to induce Owner to enter into Agreement, Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents and other related data identified in the Bidding Documents.

B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has considered the information known to Contractor; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Contract Documents; and (3) Contractor's safety precautions and programs.

E. Based on the information and observations referred to in Paragraph 8.01.E above, Contractor does not consider that further examinations, investigations,

explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.

F. Contractor is aware of the general nature of work to be performed by Owner and others at the site that relates to the Work as indicated in the Contract Documents.

G. Contractor has given Engineer written notice of all conflicts, errors, ambiguities or discrepancies that Contractor has discovered in the Contract Documents and the written resolution thereof by Engineer is acceptable to Contractor.

H. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 9- CONTRACT DOCUMENTS

9.01 Contents

A. The Contract Documents consist of the following:

1. Addendum No. 1 dated **DATE** (pages 00490-1-1 to 00490-1-, inclusive)
2. This Agreement (pages 00520-1 to 00520-7)
3. Performance Bond (pages 00610-1 to 00610-3)
4. Payment Bond (pages 00615-1 to 00615-3)
5. Power of Attorney (page 00616-1)
6. Certificate of Insurance (page 00618-1)
7. General Conditions (pages 00700-1 to 00700-68)
8. Supplementary Conditions (pages 00800-1 to 00800-9)
9. Specifications as listed in the table of contents (pages 00010-1 to 00010-2) of the Project Manual.
10. Drawings consisting of sheets numbered 1 through 174 and are not attached to this Agreement, with each sheet bearing the following general title: Brunswick Regional Water and Sewer H2GO, Water Supply and Treatment System Contract 4 – Reverse Osmosis Water Treatment Plant.
11. Exhibits to this Agreement as follows:
    a. Contractor's Bid (pages 00410-1 to 00410-7, inclusive);
    b. Notice of Award (pages 00510-1)
    c. Exhibit A-1 to Agreement between Buyer and Seller, Assignment of Contract; Consent to Assignment; and Acceptance of Assignment
    d. Exhibit A-2 to Agreement between Buyer and Seller, Agreement to Assignment by Seller's Surety
12. The following that may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
    a. Notice to Proceed (pages 00550-1)

b. Work Change Directives;

c. Change Order;

B. The documents listed in paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 9.

D. The Contract Documents may only be amended, modified or supplemented as provided in paragraphs 3.04 of the General Conditions.

ARTICLE 10 - MISCELLANEOUS

10.01 Terms

A. Terms used in this Agreement will have the meanings indicated in the General Conditions.

10.02 Assignment of Contract

A. The contract between Owner as "Buyer" and Harn R/O Systems, Inc. (Reverse Osmosis Equipment Manufacturer (ROEM)) as "Seller" for procurement of goods and special services ("procurement contract") for Reverse Osmosis Equipment is hereby assigned to Contractor by Owner, and Contractor accepts such assignment. A form documenting the assignment is attached as an exhibit to this Agreement.

B. This assignment will occur on the Effective Date of the Agreement and will relieve the Owner as "buyer" from all further obligations and liabilities under the procurement contract. Contractor will assume full responsibility for the performance of "seller" as Contractor's Subcontractor or Supplier. Notwithstanding this assignment, all performance guarantees and warranties required by the procurement contract will continue to run for the benefit of the Owner and, in addition, for the benefit of the Contractor. Except as noted in the agreement between "buyer" and "seller", all rights, duties and obligations of Engineer to "buyer" and "seller" under the "procurement contract" will cease.

C. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.03 Successors and Assigns

A. Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

10.04 Severability

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

10.05 Contractor Certifications

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 10.05:

a. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;

b. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

c. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and

d. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

THIS AREA LEFT BLANK INTENTIONALLY

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in four counterparts. One counterpart each has been delivered to Owner and Contractor, and two counterparts to Engineer. All portions of the Contract Documents have been signed or have been identified by Owner and Contractor or identified by Engineer on their behalf.

This Agreement will be effective on DATE (which is the Effective Date of the Agreement).

OWNER:	CONTRACTOR:
Brunswick Regional Water & Sewer H2GO	_____
Name	Name
_____	_____
Title	Title
_____	_____
Signature	Signature
(SEAL)	(SEAL)

ATTEST:

_____	_____
Name	Name
_____	_____
Title	Title
_____	_____
Signature	Signature

Address for giving notices

Brunswick Regional Water and Sewer H2GO	_____
516 Village Road NE	_____
Leland, NC 28451	_____
	License No. _____

If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Agreement.

If Contractor is a corporation, partnership, or joint venture, attach evidence of authority to sign.

END OF DOCUMENT

Notice to Proceed

Project:: **Water Supply and Treatment System**	Date:
Owner: **Brunswick Regional Water & Sewer H2GO**	Owner's Contract No.: n/a
Contract: **4 – Reverse Osmosis Water Treatment Plant**	Engineer's Project No.: **3081-AB**
Contractor:	
Contractor's Address: (send Certified Mail, Return Receipt Requested)	

You are notified that the Contract Times under the above contract will commence to run on **DATE**. On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 4 of the Agreement, the number of days to achieve Substantial Completion is **420**, and the number of days to achieve readiness for final payment **450**. The date of completion of all work is therefore **DATE**.

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you must deliver to the Owner (with copies to Engineer and other identified additional insureds) certificates of insurance which you are required to purchase and maintain in accordance with the Contract Documents.

Also, before you may start any Work at the Site, you must :N/A

Owner: Brunswick Regional Water & Sewer H2GO
Given by:
Authorized Signature

Title

Date

Copy to Engineer

Acceptance of Notice

Receipt of the Notice of Proceed is hereby acknowledged by _____

this the _____ day of _____, 2020.

By:_____

Title:_____

EJCDC No. C-550 (2007 Edition) Prepared by the Engineers' Joint Contract Documents Committee and endorsed by the Associated General Contractors of America and the Construction Specifications Institute.

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

PERFORMANCE BOND

CONTRACTOR *(name and address)*:

SURETY *(name and address of principal place of business)*:

OWNER *(name and address)*:
Brunswick Regional Water and Sewer H2GO
PO Box 2230 / 516 Village Road, NE
Leland, NC 28451

CONSTRUCTION CONTRACT
Effective Date of the Agreement:
Amount: $
Description *(name and location)*: Water Supply and Treatment System: Contract 4 – Reverse Osmosis Water Treatment Plant, Leland, North Carolina

BOND
Bond Number:
Date *(not earlier than the Effective Date of the Agreement of the Construction Contract)*:
Amount: $
Modifications to this Bond Form: ☐ None ☐ See Paragraph 16

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	**SURETY**
_____ *(seal)*	_____ *(seal)*
Contractor's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	**By:** _____
Signature	Signature *(attach power of attorney)*
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	**Attest:** _____
Signature	Signature
_____	_____
Title	Title

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond shall arise after:

3.1 The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice shall indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 shall be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default;

3.2 The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

3.3 The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 shall not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

5.1 Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

5.2 Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

5.3 Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or

5.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or

5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:

7.1 the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

7.2 additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

7.3 liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years

after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

14. Definitions

14.1 Balance of the Contract Price: The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

14.2 Construction Contract: The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

14.3 Contractor Default: Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

14.4 Owner Default: Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

14.5 Contract Documents: All the documents that comprise the agreement between the Owner and Contractor.

15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

16. Modifications to this Bond are as follows:

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

PAYMENT BOND

CONTRACTOR *(name and address)*:

SURETY *(name and address of principal place of business)*:

OWNER *(name and address)*:
Brunswick Regional Water and Sewer H2GO
PO Box 2230 / 516 Village Road, NE
Leland, NC 28451

CONSTRUCTION CONTRACT
Effective Date of the Agreement:
Amount: $
Description *(name and location)*: Water Supply and Treatment System: Contract 4 – Reverse Osmosis Water Treatment Plant, Leland, North Carolina

BOND
Bond Number:
Date *(not earlier than the Effective Date of the Agreement of the Construction Contract)*:
Amount: $
Modifications to this Bond Form: ☐ None ☐ See Paragraph 18

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	**SURETY**
_____ *(seal)*	_____ *(seal)*
Contractor's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	**By:** _____
Signature	Signature *(attach power of attorney)*
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	**Attest:** _____
Signature	Signature
_____	_____
Title	Title

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.

2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond shall arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.

4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.

5. The Surety's obligations to a Claimant under this Bond shall arise after the following:

   5.1 Claimants who do not have a direct contract with the Contractor,

      5.1.1 have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and

      5.1.2 have sent a Claim to the Surety (at the address described in Paragraph 13).

   5.2 Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).

6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.

7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

   7.1 Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

   7.2 Pay or arrange for payment of any undisputed amounts.

   7.3 The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 shall not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation shall not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.

9. Amounts owed by the Owner to the Contractor under the Construction Contract shall be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfy obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.

11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

12. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or

(2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

13. Notice and Claims to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, shall be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. **Definitions**

16.1 **Claim:** A written statement by the Claimant including at a minimum:

1. The name of the Claimant;
2. The name of the person for whom the labor was done, or materials or equipment furnished;
3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
4. A brief description of the labor, materials, or equipment furnished;
5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
7. The total amount of previous payments received by the Claimant; and
8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.2 **Claimant:** An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond shall be to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.3 **Construction Contract:** The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

16.4 **Owner Default**: Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

16.5 **Contract Documents:** All the documents that comprise the agreement between the Owner and Contractor.

17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

18. Modifications to this Bond are as follows:

PAGE FOR ATTACHING

POWER OF ATTORNEY

PAGE FOR ATTACHING

CERTIFICATE OF INSURANCE

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

Contractor's Application for Payment No. 1

	Application Period:	Application Date:
To (Owner):	From (Contractor):	Via (Engineer): The Wooten Company
Project:	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.:

Application For Payment

Change Order Summary

Approved Change Orders		
Number	Additions	Deductions
TOTALS		
NET CHANGE BY CHANGE ORDERS		

1. **ORIGINAL CONTRACT PRICE**	$
2. **Net change by Change Orders**	$
3. **Current Contract Price (Line 1 ± 2)**	$
4. **TOTAL COMPLETED AND STORED TO DATE (Column F on Progress Estimate)**	$
5. **RETAINAGE:**	
a. 5% X _____ **Work Completed**	$
b. 5% X _____ **Stored Material**	$
c. **Total Retainage (Line 5a + Line 5b)**	$
6. **AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c)**	$
7. **LESS PREVIOUS PAYMENTS (Line 6 from prior Application)**	$
8. **AMOUNT DUE THIS APPLICATION**	$
9. **BALANCE TO FINISH, PLUS RETAINAGE (Column G on Progress Estimate + Line 5 above)**	$

Contractor's Certification

The undersigned Contractor certifies that to the best of its knowledge: (1) all previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with Work covered by prior Applications for Payment; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to Owner indemnifying Owner against any such Liens, security interest or encumbrances); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

By:	Date:

Payment of: $ _____
(Line 8 or other - attach explanation of the other amount)

is recommended by: _____ _____
(Engineer) (Date)

Payment of: $ _____
(Line 8 or other - attach explanation of the other amount)

is approved by: _____ _____
(Owner) (Date)

Approved by: _____ _____
Funding Agency (if applicable) (Date)

© 2010 National Society of Professional Engineers for EJCDC. All rights reserved.

Progress Estimate - Lump Sum Work

Contractor's Application

For (Contract):	Application Number: 1
Application Period:	Application Date:

A		B	C	D	E	F		G
Specification Section No.	Description	Scheduled Value ($)	Work Completed: From Previous Application (C+D)	Work Completed: This Period	Materials Presently Stored (not in C or D)	Total Completed and Stored to Date (C + D + E)	% (F / B)	Balance to Finish (B - F)

Progress Estimate - Unit Price Work

Contractor's Application

For (Contract):		Application Number: 1
Application Period:		Application Date:

A Contract Items						B Work Completed from Previous Applications		C Work Completed this Application		D Work Completed to Date		E	F		
Item		Bid Item Quantity	Unit	Unit Price	Bid Item Value ($)	Quantity	Amount	Quantity	Amount	Quantity	Amount	Materials Presently Stored (not in C)	Total Completed and Stored to Date (D + E)	% (F / A)	Balance to Finish (B - F)
Bid Item No.	Description														
1							$ -	8	$ -		$ -				
2							$ -		$ -		$ -				
3							$ -	1	$ -		$ -				
4							$ -		$ -		$ -				
5							$ -	1	$ -		$ -				
6							$ -	1	$ -		$ -				
7							$ -		$ -		$ -				
8							$ -		$ -		$ -				
9							$ -		$ -		$ -				
10							$ -		$ -		$ -				
11							$ -		$ -		$ -				
12							$ -		$ -		$ -				
13							$ -		$ -		$ -				
14							$ -		$ -		$ -				
15							$ -		$ -		$ -				
16							$ -		$ -		$ -				
17							$ -		$ -		$ -				
18							$ -		$ -		$ -				
19							$ -		$ -		$ -				
20							$ -		$ -		$ -				
21							$ -		$ -		$ -				
22							$ -		$ -		$ -				
23							$ -		$ -		$ -				
24							$ -		$ -		$ -				
25							$ -		$ -		$ -				
26							$ -		$ -		$ -				
27							$ -		$ -		$ -				
28							$ -		$ -		$ -				
29							$ -		$ -		$ -				
30							$ -		$ -		$ -				
31							$ -		$ -		$ -				
32							$ -		$ -		$ -				
33							$ -		$ -		$ -				
34							$ -		$ -		$ -				
35							$ -		$ -		$ -				
36							$ -		$ -		$ -				
37							$ -		$ -		$ -				
38							$ -		$ -		$ -				
39							$ -	1	$ -	1	$ -				
	Totals						$ -								

© 2010 National Society of Professional Engineers for EJCDC. All rights reserved.

Stored Material Summary

Contractor's Application

For (Contract):								Application Number: 1			
Application Period:								Application Date:			
A		B	C		D		E		F		G
					Stored Previously				Incorporated in Work		
Bid Item No.	Supplier Invoice No.	Submittal No. (with Specification Section No.)	Storage Location	Description of Materials or Equpment Stored	Date Placed into Storage (Month/Year)	Amount ($)	Amount Stored this Month ($)	Subtotal Amount Completed and Stored to Date (D + E)	Date (Month/ Year)	Amount ($)	Materials Remaining in Storage ($) (D + E - F)

APPENDIX E

MBE DOCUMENTATION FOR CONTRACT PAYMENTS

Prime Contractor/Architect: _____

Address & Phone: _____

Project Name: _____

Pay Application #: _____ Period: _____

The following is a list of payments to be made to minority business contractors on this project for the above-mentioned period.

Firm Name	*Minority Category	Payment Amount	Owner Use Only

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

Date: _____ Approved/Certified By: _____
Name

_____
Title

_____
Signature

****THIS DOCUMENT MUST BE SUBMITTED WITH EACH PAY REQUEST & FINAL PAYMENT****

NORTH CAROLINA SALES TAX AND USE REPORT

(Paid During This Estimate Period)

PAGE ____ of ____

PROJECT Water Supply and Treatment System Contract 4 – Reverse Osmosis Water Treatment Plant _____ COUNTY ESTIMATE NO. _____

CONTRACTOR _____ PERIOD ENDING _____

DATE	VENDOR NAME	INVOICE NUMBER	INVOICE AMOUNT	TYPE OF PROPERTY	STATE TAX	COUNTY TAX	TOTAL TAX	COUNTY OF SALE*

I certify that the above-listed vendors were paid sales tax upon purchase of building materials during the period covered by the construction estimate, and the property upon which such taxes were paid with or will be used in the performance of this contract. No tax on purchases or rentals of supplies, tools and/or equipment is included in the above list. All of the material above became a part of or is annexed to the building(s) or structure(s) being erected, altered or repaired. I certify that, to the best of my knowledge, the information provided here is true, correct, and complete

Sworn to and subscribed to before me this _____ day of _____, 2017.

_____
Notary Public

My commission expires: _____

Seal

_____
Contractor's Signature

_____
Print or Type Name of Above

*If this is an out-of-state vendor, the County of Sale should be the county to which the merchandise was shipped.

Certificate of Substantial Completion

Project: Water Supply and Treatment System	
Owner: Brunswick Regional Water & Sewer H2GO	Owner's Contract No.:: n/a
Contract: 4 – Reverse Osmosis Water Treatment Plant	Engineer's Project No.: 3081-AB

This tentative [definitive] Certificate of Substantial Completion applies to:

☒ All Work under the Contract Documents: ☐ The following specified portions:

_____

_____

_____

_____

_____
Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Project or portion thereof designated above is hereby declared and is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below.

The Owner developed a punch list. ~~A [tentative] [revised tentative] [definitive] list of items to be completed or corrected, is attached hereto.~~ This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

The responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as provided in the Contract Documents except as amended as follows:

☐ Amended Responsibilities ☒ Not Amended

Owner's Amended Responsibilities:

_____

_____

_____

Contractor's Amended Responsibilities:

_____

_____

_____

The following documents are attached to and made part of this Certificate:

_____

_____

_____

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

_____ _____
Executed by Engineer Date

_____ _____
Accepted by Contractor Date

_____ _____
Accepted by Owner Date

EJCDC No. C-625 (2007 Edition) Prepared by the Engineers' Joint Contract Documents Committee and endorsed by the Construction Specifications Institute.

CERTIFICATE OF OWNER'S ATTORNEY

I, the undersigned, _____,
the duly authorized and acting legal representative of _____
_____, do hereby certify as follows:

I have examined the attached Contract(s) and Performance and Payment Bonds and the manner of execution thereof, and I am of the opinion that each of the aforesaid agreements is adequate and has been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties named thereon; and that the foregoing agreements constitute valid and legally binding obligations upon the parties executing the same in accordance with terms, conditions, and provisions thereof.

Date _____

_____

PRE-AUDIT STATEMENT

This instrument has been pre-audited in the manner required by the Local Government Budget and Fiscal Control Act.

Brunswick Regional Water and Sewer H2GO

Date _____

By:_____

Title:_____

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

ACEC
American Council of Engineering Companies

The Associated General Contractors of America — Skill Responsibility Integrity

ASCE American Society of Civil Engineers

National Society of Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

AMERICAN SOCIETY OF CIVIL ENGINEERS

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A Practice Division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Endorsed by

CONSTRUCTION SPECIFICATIONS INSTITUTE

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor (EJCDC C-520 or C-525, 2007 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the Narrative Guide to the EJCDC Construction Documents (EJCDC C-001, 2007 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (EJCDC C-800, 2007 Edition).

Copyright © 2007 National Society of Professional Engineers
1420 King Street, Alexandria, VA 22314-2794
(703) 684-2882
www.nspe.org

American Council of Engineering Companies
1015 15th Street N.W., Washington, DC 20005
(202) 347-7474
www.acec.org

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400
(800) 548-2723
www.asce.org

Associated General Contractors of America
2300 Wilson Boulevard, Suite 400, Arlington, VA 22201-3308
(703) 548-3118
www.agc.org

The copyright for this EJCDC document is owned jointly by the four
EJCDC sponsoring organizations and held in trust for their benefit by NSPE.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

TABLE OF CONTENTS

Page

Article 1 – Definitions and Terminology 1
1.01 Defined Terms 1
1.02 Terminology 5

Article 2 – Preliminary Matters 6
2.01 Delivery of Bonds and Evidence of Insurance 6
2.02 Copies of Documents 6
2.03 Commencement of Contract Times; Notice to Proceed 6
2.04 Starting the Work 7
2.05 Before Starting Construction 7
2.06 Preconstruction Conference; Designation of Authorized Representatives 7
2.07 Initial Acceptance of Schedules 7

Article 3 – Contract Documents: Intent, Amending, Reuse 8
3.01 Intent 8
3.02 Reference Standards 8
3.03 Reporting and Resolving Discrepancies 9
3.04 Amending and Supplementing Contract Documents 9
3.05 Reuse of Documents 10
3.06 Electronic Data 10

Article 4 – Availability of Lands; Subsurface and Physical Conditions; Hazardous Environmental Conditions; Reference Points 11
4.01 Availability of Lands 11
4.02 Subsurface and Physical Conditions 11
4.03 Differing Subsurface or Physical Conditions 12
4.04 Underground Facilities 13
4.05 Reference Points 14
4.06 Hazardous Environmental Condition at Site 14

Article 5 – Bonds and Insurance 16
5.01 Performance, Payment, and Other Bonds 16
5.02 Licensed Sureties and Insurers 16
5.03 Certificates of Insurance 17
5.04 Contractor's Insurance 17
5.05 Owner's Liability Insurance 19
5.06 Property Insurance 19
5.07 Waiver of Rights 20
5.08 Receipt and Application of Insurance Proceeds 21

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

5.09 Acceptance of Bonds and Insurance; Option to Replace 21
5.10 Partial Utilization, Acknowledgment of Property Insurer 22

Article 6 – Contractor's Responsibilities 22
6.01 Supervision and Superintendence 22
6.02 Labor; Working Hours 22
6.03 Services, Materials, and Equipment 22
6.04 Progress Schedule 23
6.05 Substitutes and "Or-Equals" 23
6.06 Concerning Subcontractors, Suppliers, and Others 25
6.07 Patent Fees and Royalties 27
6.08 Permits 27
6.09 Laws and Regulations 28
6.10 Taxes 28
6.11 Use of Site and Other Areas 28
6.12 Record Documents 29
6.13 Safety and Protection 29
6.14 Safety Representative 30
6.15 Hazard Communication Programs 30
6.16 Emergencies 30
6.17 Shop Drawings and Samples 31
6.18 Continuing the Work 32
6.19 Contractor's General Warranty and Guarantee 33
6.20 Indemnification 33
6.21 Delegation of Professional Design Services 34

Article 7 – Other Work at the Site 35
7.01 Related Work at Site 35
7.02 Coordination 35
7.03 Legal Relationships 36

Article 8 – Owner's Responsibilities 36
8.01 Communications to Contractor 36
8.02 Replacement of Engineer 36
8.03 Furnish Data 36
8.04 Pay When Due 36
8.05 Lands and Easements; Reports and Tests 36
8.06 Insurance 36
8.07 Change Orders 37
8.08 Inspections, Tests, and Approvals 37
8.09 Limitations on Owner's Responsibilities 37
8.10 Undisclosed Hazardous Environmental Condition 37
8.11 Evidence of Financial Arrangements 37
8.12 Compliance with Safety Program 37

Article 9 – Engineer's Status During Construction 37
9.01 Owner's Representative 37

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

9.02 Visits to Site 37
9.03 Project Representative 38
9.04 Authorized Variations in Work 38
9.05 Rejecting Defective Work 38
9.06 Shop Drawings, Change Orders and Payments 39
9.07 Determinations for Unit Price Work 39
9.08 Decisions on Requirements of Contract Documents and Acceptability of Work 39
9.09 Limitations on Engineer's Authority and Responsibilities 39
9.10 Compliance with Safety Program 40

Article 10 – Changes in the Work; Claims 40
10.01 Authorized Changes in the Work 40
10.02 Unauthorized Changes in the Work 41
10.03 Execution of Change Orders 41
10.04 Notification to Surety 41
10.05 Claims 41

Article 11 – Cost of the Work; Allowances; Unit Price Work 42
11.01 Cost of the Work 42
11.02 Allowances 45
11.03 Unit Price Work 45

Article 12 – Change of Contract Price; Change of Contract Times 46
12.01 Change of Contract Price 46
12.02 Change of Contract Times 47
12.03 Delays 47

Article 13 – Tests and Inspections; Correction, Removal or Acceptance of Defective Work 48
13.01 Notice of Defects 48
13.02 Access to Work 48
13.03 Tests and Inspections 49
13.04 Uncovering Work 49
13.05 Owner May Stop the Work 50
13.06 Correction or Removal of Defective Work 50
13.07 Correction Period 50
13.08 Acceptance of Defective Work 51
13.09 Owner May Correct Defective Work 52

Article 14 – Payments to Contractor and Completion 52
14.01 Schedule of Values 52
14.02 Progress Payments 52
14.03 Contractor's Warranty of Title 55
14.04 Substantial Completion 55
14.05 Partial Utilization 56
14.06 Final Inspection 57
14.07 Final Payment 57
14.08 Final Completion Delayed 58

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

14.09 Waiver of Claims 58

Article 15 – Suspension of Work and Termination 59
15.01 Owner May Suspend Work 59
15.02 Owner May Terminate for Cause 59
15.03 Owner May Terminate For Convenience 60
15.04 Contractor May Stop Work or Terminate 60

Article 16 – Dispute Resolution 61
16.01 Methods and Procedures 61

Article 17 – Miscellaneous 61
17.01 Giving Notice 61
17.02 Computation of Times 62
17.03 Cumulative Remedies 62
17.04 Survival of Obligations 62
17.05 Controlling Law 62
17.06 Headings 62

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Asbestos*—Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. *Bid*—The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

6. *Bidder*—The individual or entity who submits a Bid directly to Owner.

7. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).

8. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.

9. *Change Order*—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

10. *Claim*—A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*—The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

12. *Contract Documents*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

13. *Contract Price*—The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

14. *Contract Times*—The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any; (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.

15. *Contractor*—The individual or entity with whom Owner has entered into the Agreement.

16. *Cost of the Work*—See Paragraph 11.01 for definition.

17. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

18. *Effective Date of the Agreement*—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

19. *Engineer*—The individual or entity named as such in the Agreement.

20. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.

21. *General Requirements*—Sections of Division 1 of the Specifications.

22. *Hazardous Environmental Condition*—The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto.

23. *Hazardous Waste*—The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

24. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

25. *Liens*—Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *Milestone*—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

27. *Notice of Award*—The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.

28. *Notice to Proceed*—A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

29. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

30. *PCBs*—Polychlorinated biphenyls.

31. *Petroleum*—Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

32. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

33. *Project*—The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. *Project Manual*—The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

35. *Radioactive Material*—Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

36. *Resident Project Representative*—The authorized representative of Engineer who may be assigned to the Site or any part thereof.

37. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

38. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

39. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

40. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

41. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.

42. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

43. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

44. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

45. *Successful Bidder*—The Bidder submitting a responsive Bid to whom Owner makes an award.

46. *Supplementary Conditions*—That part of the Contract Documents which amends or supplements these General Conditions.

47. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or Subcontractor.

48. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

49. *Unit Price Work*—Work to be paid for on the basis of unit prices.

50. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

51. *Work Change Directive*—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

A. The words and terms discussed in Paragraph 1.02.B through F are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives:*

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. *Day:*

1. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective:*

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents; or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

c. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

E. *Furnish, Install, Perform, Provide:*

1. The word "furnish," when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When "furnish," "install," "perform," or "provide" is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

2.04 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.07 *Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner.

C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 *Reference Standards*

A. Standards, Specifications, Codes, Laws, and Regulations

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard, specification, manual, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

1. *Contractor's Review of Contract Documents Before Starting Work*: Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. *Contractor's Review of Contract Documents During Performance of Work*: If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation , (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies:*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

a. the provisions of any standard, specification, manual, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference in the Contract Documents); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions; or

2. reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

A. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and

2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

4.03 *Differing Subsurface or Physical Conditions*

A. *Notice:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

1. is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *Engineer's Review*: After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner's obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer's findings and conclusions.

C. *Possible Price and Times Adjustments:*

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

   a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and

   b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:

   a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

   b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or

c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

a. reviewing and checking all such information and data;

b. locating all Underground Facilities shown or indicated in the Contract Documents;

c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction; and

d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated:*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 *Hazardous Environmental Condition at Site*

A. *Reports and Drawings:* The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.

D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.

E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered written notice to Contractor: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.

F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.

G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.

C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

A. Contractor shall deliver to Owner, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.

B. Owner shall deliver to Contractor, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.

C. Failure of Owner to demand such certificates or other evidence of Contractor's full compliance with these insurance requirements or failure of Owner to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Contractor's obligation to maintain such insurance.

D. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor.

E. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

5.04 *Contractor's Insurance*

A. Contractor shall purchase and maintain such insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or

b. by any other person for any other reason;

5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

3. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;

4. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

5. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

6. include completed operations coverage:

a. Such insurance shall remain in effect for two years after final payment.

b. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

5.05 *Owner's Liability Insurance*

A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

A. Unless otherwise provided in the Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;

2. be written on a Builder's Risk "all-risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions.

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup; and

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued.

B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors,

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other loss payee to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under this Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. Prior to commencement of the Work at the Site, Owner shall in writing advise Contractor whether or not such other insurance has been procured by Owner.

5.07 *Waiver of Rights*

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for:

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the loss payees, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.

B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

6.02 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05 *Substitutes and "Or-Equals"*

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.

1. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and

3) it has a proven record of performance and availability of responsive service.

b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. *Substitute Items:*

a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

b. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.

d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

1) shall certify that the proposed substitute item will:

a) perform adequately the functions and achieve the results called for by the general design,

b) be similar in substance to that specified, and

c) be suited to the same use as that specified;

2) will state:

a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time,

b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified, and

b) available engineering, sales, maintenance, repair, and replacement services; and

4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.

B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.

D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

E. *Engineer's Cost Reimbursement*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

F. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 *Concerning Subcontractors, Suppliers, and Others*

A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity; nor

2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner,

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.08 *Permits*

A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

6.09 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

6.11 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas:*

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

6.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

F. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. *Shop Drawings:*

a. Submit number of copies specified in the General Requirements.

b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples:*

a. Submit number of Samples specified in the Specifications.

b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Submittal Procedures:*

1. Before submitting each Shop Drawing or Sample, Contractor shall have:

a. reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

c. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review:*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures:*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 *Continuing the Work*

A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

6.19 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on representation of Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;

6. any inspection, test, or approval by others; or

7. any correction of defective Work by Owner.

6.20 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable .

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

A. Owner may perform other work related to the Project at the Site with Owner's employees, or through other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to Contractor prior to starting any such other work; and

2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.

C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;

2. the specific matters to be covered by such authority and responsibility will be itemized; and

3. the extent of such authority and responsibilities will be provided.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 *Legal Relationships*

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's wrongful actions or inactions.

C. Contractor shall be liable to Owner and any other contractor under direct contract to Owner for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's wrongful action or inactions.

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

8.02 *Replacement of Engineer*

A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

A. Owner's duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

8.06 *Insurance*

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

8.07 *Change Orders*

A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents.

8.12 *Compliance with Safety Program*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents.

9.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

9.06 *Shop Drawings, Change Orders and Payments*

A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.

D. In connection with Engineer's authority as to Applications for Payment, see Article 14.

9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question.

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

9.10 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Engineer has been informed pursuant to Paragraph 6.13.D.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

10.02 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.D.

10.03 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 *Claims*

A. *Engineer's Decision Required*: All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

B. *Notice:* Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).

C. *Engineer's Action*: Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

1. deny the Claim in whole or in part;

2. approve the Claim; or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 *Cost of the Work*

A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

    a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

    b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

    c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, express and courier services, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

B. *Costs Excluded:* The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A.

C. *Contractor's Fee:* When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

D. *Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

11.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances:*

1. Contractor agrees that:

a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. *Contingency Allowance:*

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

2. there is no corresponding adjustment with respect to any other item of Work; and

3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

   a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;

   b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

   c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;

   d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

   e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

   f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 *Notice of Defects*

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

13.03 *Tests and Inspections*

A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;

2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.

E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

1. repair such defective land or areas; or

2. correct such defective Work; or

3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and for the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

13.09 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct, or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 *Progress Payments*

A. *Applications for Payments:*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. *Review of Applications:*

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

   a. the Work has progressed to the point indicated;

   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and any other qualifications stated in the recommendation); and

   c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or

b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

   a. to supervise, direct, or control the Work, or

   b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

   c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

   d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or

   e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

   a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

   b. the Contract Price has been reduced by Change Orders;

   c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

   d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. *Payment Becomes Due:*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

D. *Reduction in Payment:*

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

   a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;

   b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

   c. there are other items entitling Owner to a set-off against the amount recommended; or

   d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1 and subject to interest as provided in the Agreement.

14.03 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the tentative certificate to Owner, notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will, within said 14 days, execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the tentative list.

14.05 *Partial Utilization*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 14.04.A through D for that part of the Work.

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 *Final Payment*

A. *Application for Payment:*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

   a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.6;

   b. consent of the surety, if any, to final payment;

   c. a list of all Claims against Owner that Contractor believes are unsettled; and

   d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. *Engineer's Review of Application and Acceptance:*

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Payment Becomes Due:*

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor's repeated disregard of the authority of Engineer; or

4. Contractor's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:

1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion);

2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere; and

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B and 15.02.C.

15.03 *Owner May Terminate For Convenience*

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.

B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions; or

2. agrees with the other party to submit the Claim to another dispute resolution process; or

3. gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended; or

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

17.06 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

Copyright © 2007 National Society of Professional Engineers for EJCDC. All rights reserved.

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (C-700, 2007 Edition) and other provisions of the Contract Documents as indicated below. All provisions, which are not so amended or supplemented, remain in full force and effect.

The terms used in these Supplementary Conditions will have the meanings indicated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings indicated below, which are applicable to both the singular and plural thereof.

TABLE OF CONTENTS

		Page
Article SC-1	Definition and Terminology	1
Article SC-2	Preliminary Matters	2
Article SC-3	Contract Documents: Intent, Amending, Reuse	2
Article SC-4	Availability of Lands, Subsurface and Physical Conditions, Reference Points	3
Article SC-5	Bonds and Insurance	4
Article SC-6	Contractor's Responsibilities	5
Article SC-7	Other Work	7
Article SC-9	Engineer's Status During Construction	7
Article SC-11	Cost of the Work; Cash Allowances; Unit Price Work	8
Article SC-12	Change of Contract Price; Change of Contract Times	8
Article SC-14	Payments to Contractor and Completion	9
Article SC-15	Suspension of Work and Termination	9
Article SC-16	Dispute Resolution	9

ARTICLE SC-1, DEFINITIONS AND TERMINOLOGY

The Specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

SC-1.01.A.3. Add the following language to the end of Paragraph 1.01.A.3:

The Application for Payment form to be used on this Project is EJCDC No. C-620. Contractor may use their standard computerized forms for providing detail payment breakdown as an attachment to summary sheet. Owner must approve all Applications for Payment before payment is made.

SC-1.01.A.9. Add the following language to the end of Paragraph 1.01.A.9:

The Change Order form to be used on this Project is EJCDC No. C-941.

Add the following definitions to the General Conditions:

A.52 The term "minority business" means a business:

a. In which at least fifty-one percent (51%) is owned by one or more minority persons or socially and economically disadvantaged individuals, or in the case of a

corporation, in which at least fifty-one percent (51%) of the stock is owned by one or more minority persons or socially and economically disadvantaged individuals; and

b. Of which the management and daily business operations are controlled by one or more of the minority persons or socially and economically disadvantaged individuals who own it.

A.53 The term "minority person" means a person who is a citizen or lawful permanent resident of the United States and who is:

a. Black, that is, a person having origins in any of the black racial groups in Africa;
b. Hispanic, that is, a person of Spanish or Portuguese culture with origins in Mexico, South or Central America, or the Caribbean Islands, regardless of race;
c. Asian American, that is, a person having origins in any of the original peoples of the Far East, Southeast Asia and Asia, the Indian subcontinent, or the Pacific Islands;
d. American Indian, that is, a person having origins in any of the original Indian peoples of North America; or
e. Female.

A.54 The term "socially and economically disadvantaged individual" means the same as defined in 15 U.S.C. 637; "Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities". "Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system has been impaired due to diminished capital and credit opportunities as compared to others in the same business area who are not socially disadvantaged."

A.55 Notice of Violation: A written notification from a governmental agency that the Owner has violated a law or regulation that the agency has jurisdiction over. Notice will take the form used by the agency and may outline action to be taken by the Owner to correct the violation and may include a monetary fine.

A.56 Regular Working Hours: Regular working hours for the project are defined as 8:00 am to 5:00 pm, Eastern Standard Time.

ARTICLE SC-2, PRELIMINARY MATTERS

SC-2.02 Delete the word "ten" and insert "five" in its place in paragraph 2.02.

SC-2.03.A Delete paragraph 2.03.A in its entirety and insert the following in its place:

2.03.A The Contract Times will commence to run on the day indicated in the Notice to Proceed. A Notice to Proceed will be issued at any time within 30 days after the Effective Date of the Agreement or a date agreed to by the Owner and Contractor.

ARTICLE SC-3, CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

SC-3.01.B Add the following paragraph 3.01.B.1 to the General Conditions:

3.01.B.1 Division 1, General Requirements, govern the execution of the work of all sections of the specifications.

ARTICLE SC-4, AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS

SC 4.02 Delete paragraph 4.02 in its entirety and insert the following in its place:

4.02 No reports or explorations or tests of subsurface conditions at or contiguous to the Site are known to the Owner or Engineer. Contractor shall have full responsibility with respect to subsurface conditions at the site with allowances as provided in the Contract Documents.

SC-4.04.A.2 The following shall be added to paragraph 4.04.A.2:

e. Contractor shall follow the North Carolina General Statutes, Chapter 87, Article 8 Underground Damage Prevention.

f. Notifying owners of underground facilities prior to start of Work.

g. Investigating ahead of the Work to verify the existence of Underground Facilities.

h. Assuming risks and repairing damage caused by the Work to existing Underground Facilities whether indicated or not in the Contract Documents. Repairs to Underground Facilities shall be done to the satisfaction of the Underground Facility owner and may require material and methods, which are better than the existing Facility. Underground Facility owner reserves the right to repair damage by the Contractor to their underground Facilities. If the Owner exercises this right, the owner's cost of this Work shall be deducted from the money due the Contractor.

i. Uncovering Underground Facilities, with that owners approval, that are located within the Work as necessary for Engineer to determine the requirements for the change in the work.

SC 4.06 Delete paragraph 4.06.A and 4.06.B in their entirety and insert the following:

A. No reports or drawings of Hazardous Environmental Conditions at or contiguous to the Site are known to the Owner or Engineer.

B. Not used.

SC-4.07 Add the following new paragraph after SC-4.06:

SC-4.07 Miscellaneous Site Conditions

A. The Contractor shall perform video inspections and take photographs of the proposed construction areas before disturbing the site in order to establish an accurate record of the pre-construction conditions for comparison to the final work. The Contractor shall provide the Owner with copies of all video and photographic records at the appropriate times (i.e., pre-construction and post-construction). The cost of video and photographic work shall be incidental to the contract and no separate payment will be made by the Owner.

ARTICLE SC-5, BONDS AND INSURANCE

SC-5.01 Add the following paragraphs immediately following paragraph 5.01.C

D. The Contractor shall provide the following Bonds in addition to the Performance and Payment Bonds required in the General Conditions:

1. A Performance and Indemnity Bond shall be expected and posted with the N.C. Division of Highways in the amount as required in the Project Encroachment Contract as attached to the end of this Section.

SC-5.04 Add the following new paragraphs immediately after paragraph 5.04.B:

C. Limits of liability for the insurance required by paragraph 5.04 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Worker's Compensation, and related coverage under paragraphs 5.04.A.1 and 5.04.A.2 of the General Conditions:

a. State:	Statutory - Per the Workers' Compensation Laws of the State of North Carolina.
b. Applicable Federal (e.g., Longshoremen's)	Statutory
c. Employers Liability:	$500,000

2. Contractor's General Liability under paragraphs 5.04.A.3 through 5.04.A.6 of the General Conditions, which shall include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of the Contractor:

a. General Aggregate	$2,000,000.00
b. Products & Completed Operations Aggregate	$1,000,000.00
c. Personal & Advertising Injury	$1,000,000.00
d. Each Occurrence (Bodily Injury & Property Damage)	$1,000,000.00
e. Property Damage liability insurance will provide Explosion, Collapse, and Under-ground coverages where applicable.	
f. Excess or Umbrella Liability	
1) General Aggregate	$5,000,000.00
2) Each Occurrence	$5,000,000.00

3. Automobile Liability under Paragraph 5.04.A.6 of the General Conditions:

a. Bodily Injury:	
Each person	$1,000,000.00
Each Accident	$1,000,000.00
b. Property Damage:	
Each Accident	$1,000,000.00
OR (i.e., either a. and b. or c.)	
c. Combined Single Limit of	$1,000,000.00

4. The Contractual Liability coverage required by Paragraph 5.04.B.3 of the General Conditions shall provide coverage for not less than the following amounts:

a.	Bodily Injury:	
	Each person	$2,000,000.00
	Each Accident	$2,000,000.00
b.	Property Damage:	
	Each Accident	$2,000,000.00
	Annual Aggregate	$2,000,000.00

SC-5.06.A Delete paragraph 5.06.A. in its entirety.

ARTICLE SC-6, CONTRACTOR'S RESPONSIBILITIES

SC-6.02 Add the following paragraphs after 6.02.B:

C. Overtime Work: If Contractor's Work requires inspection as determined by the Engineer more than 10 hours in a work day or 40 hours in a work week, Monday through Friday excluding holidays, or on the weekends he shall submit a written request to the Engineer five (5) working days prior to the scheduled Work. Contractor shall pay for the Resident Project Representative's time beyond the above hours at the rate of $75.00 / hour.

D. The above will not prevent the Contractor from working outside the above time that will not require the inspector to be present. Such work may include; start up, clean up, seeding, painting (after the base surface has been approved by the inspector), and similar items. Contractor shall obtain approval of Work to be performed outside of the above work hours.

E. Contractor shall not be charged for inspector's time for Work specifically identified by the Contract Documents to be performed outside the above Work time or on weekends.

SC-6.06.C.3 Add the following paragraph immediately after paragraph 6.06.C2:

3. Owner or Engineer may furnish to any such Subcontractor or Supplier to the extent practical, information about amounts paid to Contractor on account of Work performed for Contractor by a particular Subcontractor or Supplier.

SC-6.06 Add a new paragraph immediately after Paragraph 6.06.G:

H. The Contractor shall not award work valued at more than fifty (50%) percent of the Contract Price to Subcontractor(s), without prior written approval of the Owner.

SC-6.08 Add the following paragraph after 6.08.A:

B. Owner shall obtain and pay for the following permits (as needed):
1. NCDENR Erosion Control Permit
2. NCDEQ NPDES Permit
3. PWS Authorization to Construct Permit
4. State Stormwater Management Permit No. SW8 170319
5. Well Construction Permit

These permits are made part of this contract and attached to the end of this Section. This paragraph does not relieve Contractor of his responsibility to comply with applicable Laws and Regulations as stated in Paragraph 6.09.

SC-6.09 Add the following paragraph(s) after 6.09.C:

D. Contractor shall be responsible for conforming to the requirements of the approved sedimentation control plan, the rules and regulations of the Erosion Control Laws of the State of North Carolina, specifically the Sedimentation Pollution Control Act of 1973 (G.S. 113A) as amended, and the local jurisdiction where the project is located as it relates to land disturbing activities undertaken by Contractor. Contractor shall be responsible to Owner for any fines imposed on Owner as a result of Contractor's failure to comply with the above as it is further described in the Erosion Control Section of the Specifications.

E. Contractor shall be responsible for conforming to the requirements (including associated construction costs) of the N.C. Department of Transportation Encroachment Agreement, and all other local, state, and federal permits associated with the project.

F. Should the Contractor cause the Owner to receive a Notice of Violation from a governmental agency, Contractor shall pay costs associated with Notice of Violation within ten (10) days of receipt of written notification. Costs shall include, but not be limited to:
   1. Fines imposed on the Owner by the agency.
   2. Required legal newspaper publications concerning violation.
   3. Required mailings to customers concerning notification of violation.

G. Notice of Violation may include, but not be limited to, the following problems:
   1. Sewage spill.
   2. Inadequate erosion control measures.
   3 Equipment failure during the warranty period.

H. In the event of a sewage spill during construction, Contractor shall take the following steps as a minimum:
   1. Take immediate action to contain the spill.
   2. Notify the Owner and Engineer within 30 minutes of realizing a spill has occurred.
   3. Clean up the spill as directed by the Owner. Contractor shall bare all costs associated with cleanup.

SC-6.12 Add a new paragraph after paragraph 6.12.A:

B. Record Documents shall be updated daily. Should the Engineer determine that the Record Documents are not being properly maintained, approval of future payment requests shall be withheld.

SC-6.17 Add the following new paragraphs immediately after Paragraph 6.17.E:

F. Contractor shall furnish required submittals with sufficient information and accuracy in order to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing subsequent submittals of Shop

Drawings, samples or other items requiring approval and Contractor shall reimburse Owner for Engineer's charges for such time.

G. In the event that Contractor requests a substitution for a previously approved item, Contractor shall reimburse Owner for Engineer's charges for such time unless the need for such substitution is beyond the control of Contractor.

ARTICLE SC-7, OTHER WORK

SC-7.04 Add the following new paragraph immediately after paragraph GC-7.03:

SC-7.04 Claims Between Contractors

A. Should Contractor cause damage to the work or property of any other contractor at the Site, or should any claim arising out of Contractor's performance of the Work at the Site be made by any other contractor against Contractor, Owner, Engineer, or the construction coordinator, Contractor shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by arbitration or at law.

B. Contractor shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner, Engineer, the construction coordinator and the officers, directors, partners, employees, agents and other consultants and subcontractors of each and any of them from and against all claims, costs, losses and damages (including, but not limited to, fees and charges of engineers, architects, attorneys, and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any other contractor against Owner, Engineer, Engineer's Consultants, or the construction coordinator to the extent said claim is based on or arises out of Contractor's performance of the Work. Should another contractor cause damage to the Work or property of Contractor or should the performance of work by any other contractor at the Site give rise to any other Claim, Contractor shall not institute any action, legal or equitable, against Owner, Engineer, or the construction coordinator or permit any action against any of them to be maintained and continued in its name or for its benefit in any court or before any arbiter which seeks to impose liability on or to recover damages from Owner, Engineer, or the construction coordinator on account of any such damage or Claim.

C. If Contractor is delayed at any time in performing or furnishing Work by any act or neglect of another contractor, and Owner and Contractor are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, Contractor may make a Claim for an extension of times in accordance with Article 12. An extension of the Contract Times shall be Contractor's exclusive remedy with respect to Owner, Engineer, and construction coordinator for any delay, disruption, interference, or hindrance caused by any other contractor. This paragraph does not prevent recovery from Owner, Engineer, or construction coordinator for activities that are their respective responsibilities.

ARTICLE SC-9, ENGINEER'S STATUS DURING CONSTRUCTION

SC-9.03.A Add the following language at the end of paragraph 9.03.A:

The Engineer will provide Project Representative services for this project. The Duties, Responsibilities, and Limitations of Authority of the Project Representative will be as stated in the Agreement Between Owner and Engineer, as amended and executed for this specific Project.

ARTICLE SC-11, COST OF THE WORK; CASH ALLOWANCES; UNIT PRICE WORK

SC-11.01.A.5.c, Delete Paragraph 11.01.A.5.c in its entirety and insert the following in its place:

C. Construction Equipment and Machinery:

1. Rentals of all construction equipment and machinery, and the parts thereof in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

2. Costs for equipment and machinery owned by Contractor will be paid at a rate shown for such equipment in the Rental Rate Blue Book (latest edition). An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs. Costs will include the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, shall cease to accrue when the use thereof is no longer necessary for the changed Work. Equipment or machinery with a value of less than $1,000 will be considered small tools.

SC-11.03.D.1 Delete Paragraph 11.03.D.1 in its entirety and insert the following in its place:

1. if the Bid price of a particular item of Unit Price Work amounts to 5 percent or more of the Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by Contractor differs by more than 25 percent from the estimated quantity of such item indicated in the Agreement; and

ARTICLE SC-12, CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

SC-12.02 Add the following paragraph after 12.02.B:

C. Time Extension: Contract time extensions for weather delays do not entitle Contractor to "extended overhead" recovery.

SC-12.03 Add the following paragraphs after 12.03.E:

F. Time extension for weather delays due to rain shall only be considered for above average precipitation. NOAA Report No. 20 shall be used to determine the average number of days with precipitation greater than or equal to 0.10 inch for each month. A link to this report is as follows: http://cdo.ncdc.noaa.gov/climatenormals/clim20/state-pdf/nc.pdf .

G. Claims for additional Contract Time for delays beyond the Contractor's control shall be submitted in accordance with Article 10 of the General Conditions with the Contractor's

monthly pay request. Submittal shall include the number of days requested and the reason for the delay. Engineer shall notify the Owner and Contractor of his decision in accordance with Article 10 of the General Conditions. Approval of time shall be included in a Change Order.

ARTICLE SC-14, PAYMENTS TO CONTRACTOR AND COMPLETION

SC-14.02.A Add the following to the end of paragraph 14.02.A.3:

No payments will be made that would deplete the retainage, place in escrow any funds that are required for retainage, or invest the retainage for the benefit of the Contractor.

SC-14.02.A Add the following new paragraph after paragraph 14.02.A.3:

4. The Application for Payment form to be used on this project is EJCDC No. C-620.

SC-14.02.C Delete paragraph 14.02.C.1 in its entirety and insert the following in its place:

1. The Application for Payment with Engineer's recommendations will be presented to the Owner and Agency for consideration. If both the Owner and Agency find the Application for Payment acceptable, the recommended amount less any reduction under the provisions of Paragraph 14.02.D will become due 20 days after the Application for Payment is presented to the Owner, and the Owner will make payment to the Contractor.

ARTICLE SC-15, SUSPENSION OF WORK AND TERMINATION

SC-15.01.A, Delete "90" and replace with "30".

SC-15.03, Delete this Article in its entirety.

SC-15.04, Delete Paragraph 15.04.A in its entirety and replace with the following:

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 30 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

   1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work:

   2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers and others; and

4. reasonable expenses directly attributable to termination.

ARTICLE SC-16, DISPUTE RESOLUTION

SC-16.01.A, Delete the second and third sentence in Paragraph 16.01 A.

SC-16.01.B, Delete Paragraph 16.01.B in its entirety and replace it with the following:

B. Disputes shall be resolved in accordance with the dispute resolution process adopted on February 26, 2002 by the N. C. State Building Commission. The "Rules Implementing Mediated Settlement Conferences in North Carolina Public Construction Projects" are attached to this section.

SC-16.01.C, Delete Paragraph 16.01.C in its entirety and replace it with the following:

C. All parties agree that only the North Carolina courts shall have jurisdiction over the Contract and any controversies arising out of this Contract and this agreement shall be governed by and construed in accordance with the laws of the State of North Carolina.

END OF DOCUMENT

Energy, Mineral and Land Resources
ENVIRONMENTAL QUALITY

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
TRACY DAVIS

March 22, 2017

LETTER OF RECEIPT OF EROSION CONTROL PLAN

Brunswick Regional Water and Sewer H2GO
Bob Walker
Po Box 2230
Leland, NC 28451

RE: Project Name: CONTRACT 4 - REVERSE OSMOSIS WATER TREATMENT PLANT
Project ID: BRUNS-2017-062
County: Brunswick, City: Leland, Address: Gregory Rd.
Submitted By: K. Echols
Date Received by LQS: March 21, 2017
Plan Type: Institutional

Dear Sir:

This office has received a soil erosion and sediment control plan for the project listed above which was submitted as required by the North Carolina Sedimentation Pollution Control Act (G.S. 113A-57 (4)).

The Act requires that all persons disturbing an area of one or more acres of land must obtain approval of a soil erosion control plan prior to the commencement of the land-disturbing activity (G.S. 113A-54(d) (4)). The Act further states that this plan must be filed a minimum of 30 days prior to the activity and the approving authority must approve or disapprove the submitted plan within 30 days of receipt. Failure of the approving authority to approve or disapprove the submitted plan within the 30-day period will be deemed approval of the plan.

Commencement or continuation of a land-disturbing activity under the jurisdiction of this Act prior to the approval of an erosion and sediment control plan is a violation of the Act.

We have performed a preliminary review of your submitted plan and have determined that

additional information will be necessary before a final review can be completed. Enclosed is a checklist of items that must be submitted before we can complete the review process. Failure to provide the additional information may result in disapproval of your plan.

The approval of an erosion and sediment control plan is conditioned on the applicant's compliance with Federal and State water quality laws, regulations and rules.

If you have questions please do not hesitate to contact this office. Your cooperation in this matter is appreciated and we look forward to working with you on this project.

Sincerely,

Creighton Brown

Land Quality Section

cc: K. Matthew Echols, 120 NORTH BOYLAN AVE, RALEIGH NC 27603

CHECKLIST OF ADDITIONAL ITEMS

In order for this office to complete its review of the referenced project in accordance with GS 113A-50 to 66 of the Sedimentation Pollution Control Act of 1973 and associated administrative rules Title 15A, North Carolina Administrative Code (NCAC), Chapter 4, please provide the additional or revised information in accordance with the following comments **by April 10, 2017**:

Deed - Please provide a copy of the most current Deed for the site.

Construction Sequence - Please provide construction sequence for the project.

Soil Type - Provide soil information: type, special characteristics.

Soil Preparation - Please provide method of soil preparation

Seeding Specifications - Provide seed type and rates (permanent)

Soil Amendments - Provide fertilizer type and rates

7 and 14 Day Ground Stabilization Areas - Please provide NPDES Ground stabilization deadlines.

Based upon our review of the submitted project documents, the following recommendations are offered for your consideration and do not require a response:

Water Resources
ENVIRONMENTAL QUALITY

ROY COOPER
Governor

MICHAEL S. REGAN
Acting Secretary

S. JAY ZIMMERMAN
Director

May 8, 2017

Mr. Bob Walker, Executive Director
H2GO Brunswick Regional Water and Sewer
P.O. Box 2230
Leland, North Carolina 28451

Subject: Final New NPDES Permit
Permit NC0089613
Brunswick Regional Water and Sewer H2GO
Water Treatment Plant
Brunswick County
Facility Classification PC-1

Dear Mr. Walker:

Division personnel have reviewed and approved your application for an NPDES wastewater permit for the Brunswick Regional Water and Sewer H2GO proposed reverse osmosis water treatment plant. Accordingly, we are forwarding the attached NPDES permit. This permit is issued pursuant to the requirements of North Carolina General Statute 143-215.1 and the Memorandum of Agreement between North Carolina and the U.S. Environmental Protection Agency dated October 15, 2007 (or as subsequently amended).

This final permit contains the following changes from your draft permit sent on August 24, 2016:

- Special Condition A. (7.), Additional Monitoring Requirements, was added requiring H2GO to submit the results from the 1-year supplemental monitoring program to verify the CORMIX predictions for mixing and dilution of the concentrate discharge.
- The Supplement to Permit Cover Sheet on page 2 of the NPDES permit was revised to state that the concentrate and occasional flush waters will be discharged through a diffuser into the Brunswick River using available Reverse Osmosis treatment unit water pressure.
- The upstream and downstream sampling requirements for pH were reduced to 2/month to be consistent with the other upstream and downstream sampling requirements. See A. (1.) and A.(2.).
- Special Condition A. (5.) ELECTRONIC REPORTING OF DISCHARGE MONITORING REPORTS was revised since the deadline of Nov. 21, 2016 has passed

and starting with the effective date of this permit Discharge Monitoring Reports are to be submitted electronically.

The effluent limitations and monitoring requirements listed in this permit are based on the 2009 Water Treatment Plant Permitting Strategy developed as part of an inter-agency workgroup tasked to define pollutants of concern contained in wastewaters discharged from membrane and ion exchange water treatment plants. All limits and monitoring are in accordance with the strategy and NCAC TI5A: 2B .0500. See Sections A.(1.) and A.(2.) of the permit.

If any parts, measurement frequencies or sampling requirements contained in this permit are unacceptable to you, you have the right to an adjudicatory hearing upon written request within thirty (30) days following receipt of this letter. This request must be in the form of a written petition, conforming to Chapter 150B of the North Carolina General Statutes, and filed with the Office of Administrative Hearings (6714 Mail Service Center, Raleigh, North Carolina 27699-6714). Unless such demand is made, this decision shall be final and binding.

Please note that this permit is not transferable except after notice to the Division. The Division may require modification or revocation and reissuance of the permit. This permit does not affect the legal requirements to obtain other permits which may be required by the Division of Water Resources or any other Federal, State, or Local governmental permits that may be required.

If you have any questions concerning this permit, please contact Julie Grzyb at (919) 807-6390 or via email at Julie.grzyb@ncdenr.gov.

Sincerely,

JC, Deputy Dir. /for 552

S. Jay Zimmerman, P.G.
Director, Division of Water Resources, NCDEQ

Hardcopy: NPDES Files
Central Files
DWR/Wilmington Regional Office / Water Quality

Ecopy: US EPA Region 4
DWR/Ecosystems Branch/Monitoring Coalition
DWR/Aquatic Toxicology Branch/Susan Meadows
DWR/PWS, Heidi Cox (draft permit)
Carl Scharfe, P.E., The Wooten Company
Bob Walker, Executive Director, H2GO Brunswick Regional Water & Sewer
Debra Wilson, District manager, NC DCM
Kathy Matthews, US Fish & Wildlife Service, kathryn_matthews@fws.gov
Fritz Rohde, NOAA_NMFS Southeast Region, fritz.rohde@noaa.gov

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER RESOURCES

PERMIT

TO DISCHARGE WASTEWATER UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of North Carolina General Statute 143-215.1, other lawful standards and regulations promulgated and adopted by the North Carolina Environmental Management Commission, and the Federal Water Pollution Control Act, as amended, the

Brunswick Regional Water and Sewer H2GO

is hereby authorized to discharge wastewater from a facility located at the

Brunswick Regional Water and Sewer H2GO WTP
146 Gregory Road, Belville
Brunswick County

to receiving waters designated as the Brunswick River in the Cape Fear River Basin in accordance with effluent limitations, monitoring requirements, and other applicable conditions set forth in Parts I, II, and III hereof.

This permit shall become effective June 1, 2017.

This permit and authorization to discharge shall expire at midnight on November 30, 2021.

Signed this day May 8, 2017.

S. Jay Zimmerman, P.G.
Director, Division of Water Resources
By Authority of the Environmental Management Commission

SUPPLEMENT TO PERMIT COVER SHEET

Brunswick Regional Water and Sewer H2GO

is hereby authorized to:

1. Discharge membrane concentrate wastewater from a 4 MGD potable water treatment plant at an estimated flow of 1.0 MGD. Spent cleaning solution and rinse waters will be neutralized and discharged to the sanitary sewer which discharges to the Belville WWTP. The concentrate and occasional flush waters will be discharged through a diffuser into the Brunswick River using available Reverse Osmosis treatment unit water pressure.

2. Upon notification to the Division of startup of an expanded potable water treatment plant capacity, from 4 MGD to 8 MGD, discharge approximately 2.0 MGD of membrane concentrate wastewaters through a diffuser to the Brunswick River.

   This facility is located at 146 Gregory Road in Belville, Brunswick County; and

3. Discharge said wastewaters through an extended discharge pipe with a diffuser (Outfall 001, approximately 351 feet from the shoreline), at the location specified on the attached map, into the Brunswick River, a Class SC waterway within the Cape Fear River Basin.

PART I

A.(1.) EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS (4 MGD Potable Water Treatment Plant) [15A NCAC 02B .0400 et seq., 02B .0500 et seq.]

(a.) Beginning on the effective date of this permit and lasting until expansion to greater than a 4 MGD water purification system or permit expiration, whichever comes first, the Permittee is authorized to discharge membrane **concentrate wastewater and flush wastewaters** through a diffuser from **Outfall 001.** Such discharges shall be limited and monitored[1] by the Permittee as specified below:

EFFLUENT CHARACTERISTICS (Parameter Codes)	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS		
	Monthly Average	Weekly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location[2]
Flow, MGD (50050)				Continuous	Recording	E
Total Residual Chlorine[3] (50060)			13 µg/L	Weekly	Grab	E
pH (00400)	≥ 6.8 and ≤ 8.5 Standard Units			Weekly	Grab	E
pH, Standard Units (00400)				2/Month	Grab	U, D
Temperature, °C (00010)				2/Month	Grab	E, U, D
Conductivity, µmhos/cm (00095)				2/Month	Grab	E, U, D
Dissolved Oxygen, mg/L (00300)				2/Month	Grab	E, U, D
Salinity (parts per thousand or psu) (00480)				2/Month	Grab	E, U, D
Total Dissolved Solids, mg/L (70295)				2/Month	Grab	E
Turbidity, NTU (00070)				2/Month	Grab	E
Total Arsenic[4], µg/L (00978)				Monthly	Grab	E
Total Chloride[4], mg/L (00940)				Monthly	Grab	E
Total Copper[4], µg/L (01042)				Monthly	Grab	E
Total Zinc [4], µg/L (00600)				Monthly	Grab	E
Ammonia Nitrogen, mg/L (00610)				Monthly	Grab	E
Total Nitrogen[5], mg/L (00600)				Monthly	Grab	E
TKN [5], mg/L (00625)	Monitor & Report			Monthly	Grab	E
NO_2-N + NO_3-N [5], mg/L (00630)	Monitor & Report			Monthly	Grab	E
Total Phosphorus, mg/L (00665)				Monthly	Grab	E
Whole Effluent Toxicity[6] (TGP3E)				Quarterly	Grab	E

NOTES:

1. Submit discharge monitoring reports electronically using NC DWR's eDMR application system. See Special Condition A (5).
2. Sample Locations: E- Effluent prior to leaving the facility site and being discharged to the river, U-Upstream. D-Downstream. See special condition A. (3) for instream monitoring requirements.
3. Limit and monitor only if the facility adds chlorine or chlorine derivatives to water that is eventually discharged. The Division shall consider all effluent TRC values reported below 50 ug/l to be in compliance with the permit. However, the Permittee shall continue to record and submit all values reported by a North Carolina certified laboratory (including field certified), even if these values fall below 50 ug/l.
4. Sample these parameters in conjunction with Toxicity sampling, when toxicity samples are being collected.
5. For a given wastewater sample, TN = TKN + (NO3-N + NO2-N), where TN is total nitrogen, TKN is total Kjeldahl Nitrogen, and (NO3-N + NO2-N) are nitrate/nitrite nitrogen, respectively.
6. Chronic Toxicity Monitoring P/F (*Mysidopsis bahia*) @ 2.1 %; January, April, July, and October (see Condition A.(4) of this permit). Samples shall coincide with sampling for other parameters.

(b.) All effluent samples collected shall be representative of the discharge.

(c.) Discharge shall contain no floating solids or visible foam in other than trace amounts.

A.(2.) EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS (8 MGD Potable Water Treatment Plant) [15A NCAC 02B .0400 et seq., 02B .0500 et seq.]

(a.) Beginning upon expansion from a 4 MGD water purification system to an 8 MGD water purification system and lasting until permit expiration, the Permittee is authorized to discharge membrane **concentrate wastewater and flush waters** through a diffuser from **Outfall 001.** Such discharges shall be limited and monitored[1] by the Permittee as specified below:

EFFLUENT CHARACTERISTICS (Parameter Codes)	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS		
	Monthly Average	Weekly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location[2]
Flow, MGD (50050)				Continuous	Recording	E
Total Residual Chlorine[3] (50060)			13 µg/L	Weekly	Grab	E
pH (00400)	≥ 6.8 and ≤ 8.5 Standard Units			Weekly	Grab	E
pH, Standard Units (00400)				2/Month	Grab	U, D
Temperature, °C (00010)				2/Month	Grab	E, U, D
Conductivity, µmhos/cm (00095)				2/Month	Grab	E, U, D
Dissolved Oxygen, mg/L (00300)				2/Month	Grab	E, U, D
Salinity (parts per thousand or psu) (00480)				2/Month	Grab	E, U, D
Total Dissolved Solids, mg/L (70295)				2/Month	Grab	E
Turbidity, NTU (00070)				2/Month	Grab	E
Total Arsenic[4], µg/L (00978)				Monthly	Grab	E
Total Chloride[4], mg/L (00940)				Monthly	Grab	E
Total Copper[4], µg/L (01042)				Monthly	Grab	E
Total Zinc [4], µg/L (00600)				Monthly	Grab	E
Ammonia Nitrogen, mg/L (00610)				Monthly	Grab	E
Total Nitrogen[5], mg/L (00600)				Monthly	Grab	E
TKN [5], mg/L (00625)	Monitor & Report			Monthly	Grab	E
NO_2-N + NO_3-N [5], mg/L (00630)	Monitor & Report			Monthly	Grab	E
Total Phosphorus, mg/L (00665)				Monthly	Grab	E
ChronicToxicity[6] (TGP3E)				Quarterly	Grab	E

NOTES:

1. Submit discharge monitoring reports electronically using NC DWR's eDMR application system. See Special Condition A (5).
2. Sample Locations: E- Effluent prior to leaving the facility site and being discharged to the river, U-Upstream. D-Downstream. See special condition A. (3) for instream monitoring requirements.
3. Limit and monitor only if the facility adds chlorine or chlorine derivatives to water that is eventually discharged. The Division shall consider all effluent TRC values reported below 50 ug/l to be in compliance with the permit. However, the Permittee shall continue to record and submit all values reported by a North Carolina certified laboratory (including field certified), even if these values fall below 50 ug/l.
4. Sample these parameters in conjunction with Toxicity sampling, when toxicity samples are being collected.
5. For a given wastewater sample, TN = TKN + (NO3-N + NO2-N), where TN is total nitrogen, TKN is total Kjeldahl Nitrogen, and (NO3-N + NO2-N) are nitrate/nitrite nitrogen, respectively.
6. Chronic Toxicity Monitoring P/F (*Mysidopsis bahia*) @ 2.1%; January, April, July, and October (see Condition A.(4) of this permit). Samples shall coincide with sampling for other parameters.

(b.) All effluent samples collected shall be representative of the discharge.

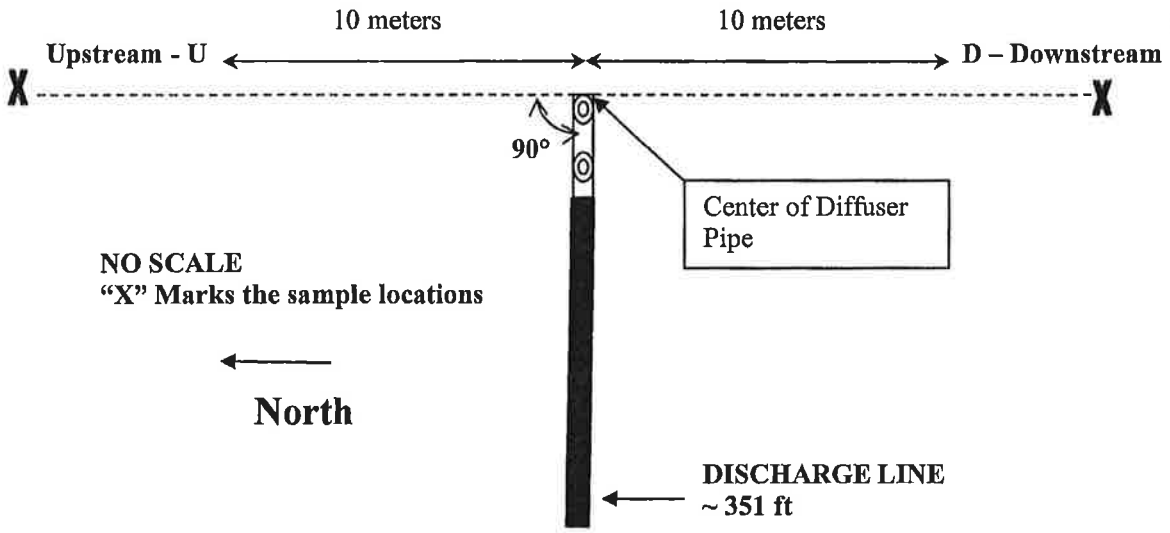
(c.) Discharge shall contain no floating solids or visible foam in other than trace amounts.

A.(3.) INSTREAM SAMPLE LOCATIONS

[15A NCAC 02B .0500 et seq.]

(a.) The Permittee shall collect grab samples at the designated locations and frequency during a continuous discharge event after a minimum of 1 hour of continuous discharge has occurred. Effort should be made to collect the sample several feet below the surface water level or at the median water depth of the river at the point at which the sample is being taken. Every effort should be made to replicate the same sample location and depth each time instream samples are taken. To provide a point of comparison the required effluent grab sample should be collected at the same time.

(b.) In accordance with 15A NCAC 2B .0505 (c)(4), stream sampling may be discontinued when flow conditions or extreme weather conditions could result in injury or death of the person(s) collecting the samples. In such cases, on each day that sampling is discontinued, written justification for the discontinuance shall be specified in the monitoring report for the month in which the event occurred. This provision also applies to influent and effluent sampling.



Location Description:

U = upstream 10 meters, perpendicular to diffuser and at the mid-point of the diffuser, approximately 380 feet offshore;

D = downstream 10 meters, perpendicular to diffuser and at the mid-point of the diffuser, approximately 380 feet offshore.

A.(4.) CHRONIC TOXICITY PASS/FAIL PERMIT LIMIT (QUARTERLY)

[15A NCAC 02B .0200 et seq.]

The effluent discharge shall at no time exhibit observable inhibition of reproduction or significant mortality to *Mysidopsis bahia* at an effluent concentration of **2.1** % at discharge flows of 1 MGD (4 MGD potable design) and 2 MGD (8 MGD potable design).

The permit holder shall perform at a minimum, *quarterly* monitoring using procedures described below to establish compliance with the permit condition. The tests will be performed **during the months of January, April, July, and October.** These months signify the first month of each three-month toxicity testing quarter assigned to the facility. Effluent sampling for this testing must be obtained during representative effluent discharge and shall be performed at the NPDES permitted final effluent discharge below all treatment processes.

If the test procedure performed as the first test of any single quarter results in a failure or ChV below the permit limit, then multiple-concentration testing shall be performed at a minimum, in each of the two following months. as described in EPA Method 1007.0, Mysid, *Mysidopsis bahia*, Survival, Growth, and Fecundity Test, as described in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Third Edition*, EPA821-R-02-014, October 2002.

The test procedure will be based on EPA Method 1007.0, Mysid, *Mysidopsis bahia*, Survival, Growth, and Fecundity Test, as described in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Third Edition*, EPA-821-R-02-014, The procedure will be performed as written with the following exceptions:

- **At 1 or 2 MGD discharge flows (4 MGD potable design or 8 MGD potable design):** The test treatments will consist of a control and a **2.1** % effluent concentration ("pass/fail,") or a control and five effluent concentrations, one of which will be 1 % and one of which will be **4** %.
- Mortality for pass/fail tests will be evaluated using the t test described in Section 11.3 in Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Fifth Edition. EPA—821-R-02-012, October 2002, applying an alpha level of 0.05.
- The growth endpoint for pass/fail tests will be determined using Appendix G of *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Third Edition*, EPA-821-R-02-014, October 2002, applying an alpha level of 0.01.
- Mortality and growth endpoints for multiple-concentration tests will be determined using hypothesis testing as described in EPA Method 1007.0, Mysid, *Mysidopsis bahia*, Survival, Growth, and Fecundity Test, as described in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Third Edition*, EPA-821-R-02-014, October 2002.
- Fecundity will not be evaluated.

All toxicity testing results required as part of this permit condition will be entered on the Effluent Discharge Monitoring Form (MR-1) for the months in which tests were performed. For pass/fail results, report using the parameter code **TGP3E** and the **DWR Form AT-4** (original), which is to be sent to the address below. Additionally, for reporting Chronic Value results use the parameter code **THP3E** and **DWR Form AT-6** (original), which is to be sent to the following address:

Attention: North Carolina Division of Water Resources
Water Sciences Section
1623 Mail Service Center

Completed Aquatic Toxicity Test Forms shall be filed with the Water Sciences Section no later than 30 days after the end of the reporting period for which the report is made.

Test data shall be complete, accurate, include all supporting chemical/physical measurements and all concentration/response data, and be certified by laboratory supervisor and ORC or approved designate signature. Total residual chlorine of the effluent toxicity sample must be measured and reported if chlorine is employed for disinfection of the waste stream.

Should there be no discharge of flow from the facility during a month in which toxicity monitoring is required, the permittee will complete the information located at the top of the aquatic toxicity (AT) test form indicating the facility name, permit number, pipe number, county, and the month/year of the report with the notation of "No Flow" in the comment area of the form. The report shall be submitted to the Water Sciences Section at the address cited above.

Should the permittee fail to monitor during a month in which toxicity monitoring is required, monitoring will be required during the following month. Assessment of toxicity compliance is based on the toxicity testing quarter, which is the three month time interval that begins on the first day of the month in which toxicity testing is required by this permit and continues until the final day of the third month.

Should any test data from this monitoring requirement or tests performed by the North Carolina Division of Water Resources indicate potential impacts to the receiving stream, this permit may be re-opened and modified to include alternate monitoring requirements or limits.

NOTE: Failure to achieve test conditions as specified in the cited document, such as minimum control organism survival, minimum control organism reproduction, and appropriate environmental controls, shall constitute an invalid test and will require immediate follow-up testing to be completed no later than the last day of the month following the month of the initial monitoring.

A.(5.) ELECTRONIC REPORTING OF DISCHARGE MONITORING REPORTS
[G.S. 143-215.1(b)]

Federal regulations require electronic submittal of all discharge monitoring reports (DMRs) and program reports. The final NPDES Electronic Reporting Rule was adopted and became effective on December 21, 2015.

NOTE: This special condition supplements or supersedes the following sections within Part II of this permit (*Standard Conditions for NPDES Permits*):

- Section B. (11.) Signatory Requirements
- Section D. (2.) Reporting
- Section D. (6.) Records Retention
- Section E. (5.) Monitoring Reports

1. **Reporting Requirements [Supersedes Section D. (2.) and Section E. (5.) (a)]**

   The permittee shall report discharge monitoring data electronically using the NC DWR's Electronic Discharge Monitoring Report (eDMR) internet application.

   Monitoring results obtained during the previous month(s) shall be summarized for each month and submitted electronically using eDMR. The eDMR system allows permitted facilities to enter monitoring data and submit DMRs electronically using the internet. Until such time that the state's eDMR application is compliant with EPA's Cross-Media Electronic Reporting Regulation (CROMERR), permittees will be required to submit all discharge monitoring data to the state electronically using eDMR and will be required to complete the eDMR submission by printing, signing, and submitting one signed original and a copy of the computer printed eDMR to the following address:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

If a permittee is unable to use the eDMR system due to a demonstrated hardship or due to the facility being physically located in an area where less than 10 percent of the households have broadband access, then a temporary waiver from the NPDES electronic reporting requirements may be granted and discharge monitoring data may be submitted on paper DMR forms (MR 1, 1.1, 2, 3) or alternative forms approved by the Director. Duplicate signed copies shall be submitted to the mailing address above. See "How to Request a Waiver from Electronic Reporting" section below.

Regardless of the submission method, the first DMR is due on the last day of the month following the issuance of the permit or in the case of a new facility, on the last day of the month following the commencement of discharge.

Starting on **December 21, 2020**, the permittee must electronically report the following compliance monitoring data and reports, when applicable:

- Sewer Overflow/Bypass Event Reports;
- Pretreatment Program Annual Reports; and
- Clean Water Act (CWA) Section 316(b) Annual Reports.

The permittee may seek an electronic reporting waiver from the Division (see "How to Request a Waiver from Electronic Reporting" section below).

2. Electronic Submissions

In accordance with 40 CFR 122.41(l)(9), the permittee must identify the initial recipient at the time of each electronic submission. The permittee should use the EPA's website resources to identify the initial recipient for the electronic submission.

Initial recipient of electronic NPDES information from NPDES-regulated facilities means the entity (EPA or the state authorized by EPA to implement the NPDES program) that is the designated entity for receiving electronic NPDES data [see 40 CFR 127.2(b)].

EPA plans to establish a website that will also link to the appropriate electronic reporting tool for each type of electronic submission and for each state. Instructions on how to access and use the appropriate electronic reporting tool will be available as well. Information on EPA's NPDES Electronic Reporting Rule is found at: http://www2.epa.gov/compliance/final-national-pollutant-discharge-elimination-system-npdes-electronic-reporting-rule.

Electronic submissions must start by the dates listed in the "Reporting Requirements" section above.

3. How to Request a Waiver from Electronic Reporting

The permittee may seek a temporary electronic reporting waiver from the Division. To obtain an electronic reporting waiver, a permittee must first submit an electronic reporting waiver request to the Division. Requests for temporary electronic reporting waivers must be submitted in writing to the Division for written approval at least sixty (60) days prior to the date the facility would be required under this permit to begin submitting monitoring data and reports. The duration of a temporary waiver shall not exceed 5 years and shall thereupon expire. At such time, monitoring data and reports shall be submitted electronically to the Division unless the permittee re-applies for and is granted a new temporary electronic reporting waiver by the Division. Approved electronic reporting waivers are not transferrable. Only permittees with an approved

reporting waiver request may submit monitoring data and reports on paper to the Division for the period that the approved reporting waiver request is effective.

Information on eDMR and the application for a temporary electronic reporting waiver are found on the following web page:

http://deq.nc.gov/about/divisions/water-resources/edmr

4. **Signatory Requirements [Supplements Section B. (11.) (b) and Supersedes Section B. (11.) (d)]**

All eDMRs submitted to the permit issuing authority shall be signed by a person described in Part II, Section B. (11.)(a) or by a duly authorized representative of that person as described in Part II, Section B. (11.)(b). A person, and not a position, must be delegated signatory authority for eDMR reporting purposes.

For eDMR submissions, the person signing and submitting the DMR must obtain an eDMR user account and login credentials to access the eDMR system. For more information on North Carolina's eDMR system, registering for eDMR and obtaining an eDMR user account, please visit the following web page:

http://deq.nc.gov/about/divisions/water-resources/edmr

Certification. Any person submitting an electronic DMR using the state's eDMR system shall make the following certification [40 CFR 122.22]. NO OTHER STATEMENTS OF CERTIFICATION WILL BE ACCEPTED:

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

5. **Records Retention [Supplements Section D. (6.)]**

The permittee shall retain records of all Discharge Monitoring Reports, including eDMR submissions. These records or copies shall be maintained for a period of at least 3 years from the date of the report. This period may be extended by request of the Director at any time [40 CFR 122.41].

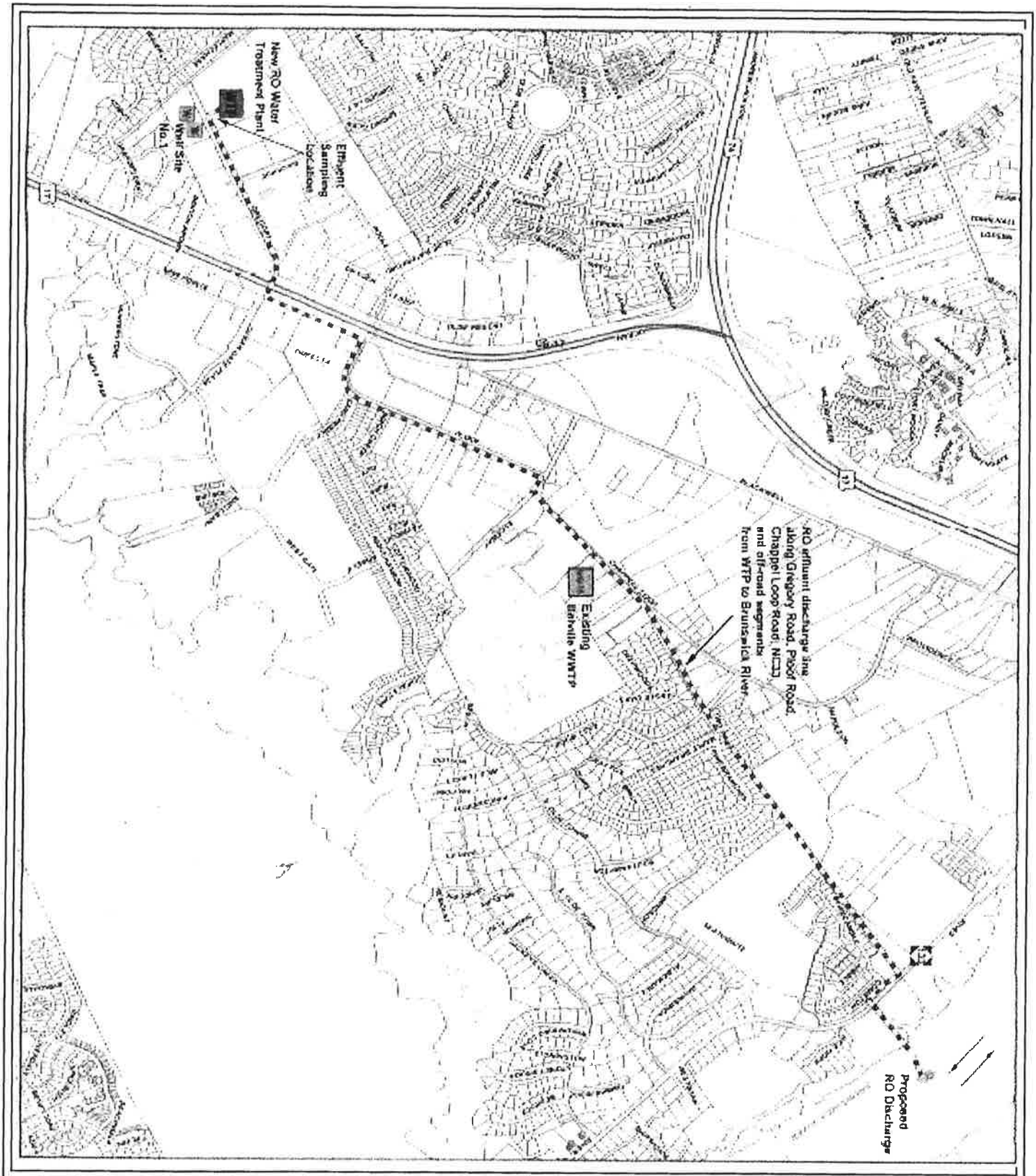
A.(6.) REPORTING REQUIREMENTS AFTER COMMENCEMENT OF DISCHARGE [G.S. 143-215.3(a)(2)]

In accordance with 40 CFR CFR 122.21(k)(5)(vi), no later than 2 years after the commencement of discharge from the proposed facility the applicant is required to complete and submit items V and VI of NPDES application Form 2C. Please note that all data generated must be reported to the approved detection level or lower reporting level of the procedure. Please send the report to the following address:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: NPDES Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

A. (7.) ADDITIONAL REPORTING REQUIREMENTS [G.S. 143-215.3(a)(2)]

H2GO in conjunction with UNCW Center for Marine Science and the Lower Cape Fear River Program Advisory Board and Technical Committee will be conducting a 1-year supplemental monitoring program to verify the CORMIX predictions for mixing and dilution of the concentrate discharge. The results from the 1-year supplemental monitoring program shall be submitted to the Division for review within 60 days of completion of the study. This permit may be re-opened to include additional monitoring or modifications to implement changes needed based on the program findings.

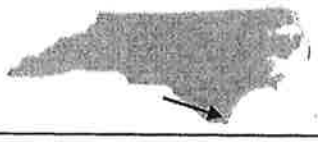


Quad: Wilmington, N.C.
Latitude: 34°13'05"
Longitude: 77°58'42"
Stream Class: SC
Subbasin/HUC: 30617/03030005
Receiving Stream: Brunswick River

NC0089613

Brunswick Regional Water & Sewer H2GO WTP

Facility Location



North

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
LINDA CULPEPPER
Director

NORTH CAROLINA
Environmental Quality

SEP 19 2019
THE WOOTEN COMPANY

September 13, 2019

BRUNSWICK REGIONAL WATER & SEWER H2GO
ATTN: BOB WALKER, EXECUTIVE DIRECTOR
P O BOX 2230
LELAND, NC 28451

Re: **Extension of Authorization to Construct (Reissued)**
4.0 MGD REVERSE OSMOSIS WTP
Serial No.: 17-00286
Water System Name: BRUNSWICK REGIONAL WATER AND SEWER H2GO

Dear Applicant:

This letter is in response to a request for an Extension of the Authorization to Construct for **4.0 Mgd Reverse Osmosis Wtp, Serial No. 17-00286.** The Authorization to Construct is extended and will expire on August 29, 2022.

The "Extension of the Authorization to Construct" is valid for 36 months from the issue date. The "Extension of the Authorization to Construct" and the engineering plans and specifications approval letter shall be posted at the primary entrance of the job site before and during construction.

Upon completion of the construction or modification, **and prior to placing the new construction or modification into service**, the applicant must submit an Engineer's Certification and Applicant's Certification to the Public Water Supply Section.

- **Engineer's Certification**: in accordance with Rule .0303 (a), the applicant shall submit a certification statement signed and sealed by a registered professional engineer stating that construction was completed in accordance with approved engineering plans and specifications, including any provisions stipulated in the Department's engineering plan and specification approval letter.
- **Applicant's Certification:** in accordance with Rule .0303 (c), the applicant shall submit a signed certification statement indicating that the requirements for an Operation and Maintenance Plan and Emergency Management Plan have been satisfied in accordance with Rule .0307 (d) and (e) and that the system has a certified operator in accordance with Rule .1300. The "Applicant's Certification" form is available at http://www.ncwater.org/ (click on Public Water Supply Section, Plan Review, Plan Review Forms).

If this "Authorization to Construct" is for a new public water system, the owner must submit a completed **application for an Operating Permit** and the appropriate fee. For a copy of the application for an Operating Permit please call (919) 707-9085.

Once the certifications and permit application and fee (if applicable) are received and determined adequate, the Department will issue a Final Approval letter to the applicant. In accordance with Rule .0309 (a), **no portion of this project shall be placed into service until the Department has issued Final Approval.**

Please contact us at (919) 707-9100 if you have any questions or need additional information.

Sincerely,

RW Midgette

Robert W. Midgette, P.E.
Chief, Public Water Supply Section

cc: Heidi Cox, Regional Engineer, Wilmington Regional Office
Brunswick County Health Department
THE WOOTEN COMPANY Carl S

North Carolina Department of Environmental Quality | Division of Water Resources
512 North Salisbury Street | 1634 Mail Service Center | Raleigh, North Carolina 27699-1634
919.707.9000

Water Resources
ENVIRONMENTAL QUALITY

ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

S. JAY ZIMMERMAN
Director

June 8, 2017

Brunswick Regional Water and Sewer H2GO
Attention: Bob Walker, Executive Director
Post Office Box 2230
Leland, North Carolina 28451

Re: Engineering Plans and Specifications Approval
Groundwater System
4.0 MGD Reverse Osmosis WTP
Brunswick Regional Water and Sewer H2GO
Water System No.: NC0410070
Brunswick County
Serial No.: 17-00286

Dear Applicant:

Enclosed please find one copy of the "Application for Approval..." together with one copy of the referenced engineering plans and specifications bearing the Division of Water Resources stamp of approval for the referenced project. These engineering plans and specifications are approved under Division of Water Resources Serial Number 17-00286, dated June 8, 2017.

Engineering plans and specifications prepared by Charles W. Davis, P.E., Carl W. Scharfe, P.E. and other professional engineers with The Wooten Company call for the construction of 4.0 million gallons per day (MGD) capacity Reverse Osmosis (RO) membrane filtration (nanofiltration) water treatment plant (WTP) for treating groundwater from the wells that will be approved later. Groundwater from the Lower Pee Dee and Black Creek aquifers will be treated by the proposed RO treatment plant. Therefore, the total production capacity from the wells will be determined later when the wells are reviewed and approved. Plans and specifications for the proposed RO WTP which will be located at 146 Gregory Road call for the following:

1. A raw water meter vault with a meter, valves and other appurtenances.
2. Two 1,750 GPM capacity each, horizontal 0.5-micron cartridge filter vessels to filter brackish groundwater.
3. Two Reverse Osmosis (RO) treatment trains, each treatment train consisting of 33X15 vessel two stage array, membrane elements, pressure vessels, integral second stage energy recovery device, permeate and concentrate collection piping, cleaning delivery and return piping and other associated manual and automated valves, controls and instrumentation.

Permeate per train will be capable of turn down flux of 13 gallons per square foot per day (gfd) with 1,215 GPM flow and a design flux of 15 gfd with 1,389 GPM, minimum flux of 9.64 gfd, 80% recovery, maximum RO feed pump discharge pressure of 315 PSIG, membrane diameter of 8-inches, membrane length of 40-inches, each pressure vessel with 7 membrane elements, membrane array of 33 in first stage and 15 in second stage, 7 vessels placed in vertical and 8 vessels in horizontal position.

4. RO flush and clean system consisting of 8,500 gallons RO flush water tank (permeate water from the RO units to use for RO cleaning purposes), two flush pumps, motorized flush valves, instrumentation and controls.
5. Membrane Cleaning System consisting of one 3,650 gallons cleaning tank, one 3,650 gallons waste tank, cleaning pumps and other related appurtenances.
6. Two 2,778 GPM each capacity, horizontal upflow calcite pressure vessels each with 12 feet diameter and 36 feet length with minimum empty bed contact time of 8 minutes per cell, with three separate sealed compartments/cells in each vessel, total of 60-inches of calcite bed depth with backwash system to add hardness and alkalinity to RO permeate.
7. Two scale inhibitor storage tanks (220 gallon and 300 gallon), transfer and feeding system.
8. Carbonic acid feeding system to feed it to the RO permeate water to lower the pH consisting of CO2 storage tank, carbonic acid generation system, a feed panel, transfer and feeding system with automatic sensors and analyzers.
9. Sodium hypochlorite generating packaged system and feeding system consisting of two 2,500-gallon high density linked polyethylene (HDLPE) with interior anti-oxidant resistant liner hypochlorite storage tanks, one 575 gallons HDLPE brine storage tank, hypochlorite generating system with sensors and automatic analyzers, metering pumps and feeding system.
10. Caustic (sodium hydroxide) feeding system consisting of one 6,500-gallon carbon steel storage tank and chemical metering skid with two metering pumps.
11. Corrosion inhibitor (poly orthophosphate) feeding system consisting of one 4,600 gallon cross linked HDPE storage tank with accessories and feeding skid with two metering pumps.
12. Hydrofluorosilicic Acid (fluoride) feeding system consisting of one 405 gallon HDPE cross-linked, double walled storage tank, two metering pumps and feeding system.
13. Two calcite filtration pressure vessels (12 feet diameter and 36 feet long) with backwash system and backwash water to the backwash waste storage tank and then to a sanitary sewer manhole to send the waste to the wastewater treatment facility.
14. Finished water meter vault with a meter, injection points for corrosion inhibitor, caustic, sodium hypochlorite, and fluoride treatment.
15. One 1 million-gallon (MG) capacity finished water circular pre-stressed concrete (AWWA D110) ground storage tank with interior baffle curtains.
16. High service pump station consisting of three (3) vertical turbine pumps, each with a capacity of 2,250 GPM, 250 feet TDH, 250 HP to pump water from the finished water storage to the distribution system.
17. One existing elevated storage tank.

18. Backwash waste storage tank with two (2), 50 GPM, 10 feet TDH, centrifugal submersible backwash water pumps to pump waste out with a submersible mixer.
19. Installation of 10-inch water main around the building, with a DCVA.
20. Installation of backup engine generation system.
21. Supervisory Control and Data Acquisition (SCADA) system, a treatment building and various other related appurtenances.

Concentrate from the RO treatment will be discharged to the Brunswick River with an NPDES permit (NC0089613).

Please note that in accordance with 15A NCAC 18C .0309(a), no construction, alteration, or expansion of a water system shall be placed into service or made available for human consumption until the Public Water Supply Section has issued Final Approval. Final Approval will be issued and mailed to the applicant upon receipt of both an Engineer's Certification and an Applicant's Certification submitted in accordance with 15A NCAC 18C .0303 (a) and (c).

These plans and specifications in the foregoing application are approved insofar as the protection of public health is concerned as provided in the rules, standards and criteria adopted under the authority of Chapter 130A-317 of the General Statutes. This approval does not constitute a warranty of the design, construction or future operation of the water system.

One copy of the "Application for Approval..." and a copy of the plans and specifications with a seal of approval from the department are enclosed. One copy of the enclosed documents in a digital format (CD) is being forwarded to our Wilmington Regional Office. The second copy of the CD is being retained in our office.

If Public Water Supply Section can be of further service, please call (919) 707-9100.

Sincerely,

SMBhatta /for

Robert W. Midgette, P.E.
Operations Branch Head
Public Water Supply Section

RWM/SMB

Enclosures: Approval Document

cc: Heidi Cox, Wilmington Regional Office
Brunswick County Health Department
The Wooten Company
Linda Raynor, Compliance Services Branch, Public Water Supply Section

Water Resources
ENVIRONMENTAL QUALITY

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
S. JAY ZIMMERMAN
Director

June 08, 2017

BRUNSWICK REGIONAL WATER & SEWER H2GO
BOB WALKER, EXECUTIVE DIRECTOR
P O BOX 2230
LELAND, NC 28451

Re: **Authorization to Construct (This is not a Final Approval)**
ATC Date: June 08, 2017
4.0 MGD REVERSE OSMOSIS WTP
Serial No: **17-00286** Water System No: **NC0410070**
Brunswick County

Dear Applicant:

This letter is to confirm that a complete Engineer's Report and a Water System Management Plan have been received, and that engineering plans and specifications have been approved by the Department for **4.0 MGD REVERSE OSMOSIS WTP, Serial No.: 17-00286.**

The Authorization to Construct is valid for 24 months from the **Issue Date** (refer to next page). Authorization to Construct may be extended if the Rules Governing Public Water Supplies and site conditions have not changed (see Rule .0305). The Authorization to Construct and the engineering plans and specifications approval letter shall be posted at the primary entrance of the job site before and during construction.

Upon completion of the construction or modification, and prior **to placing the new construction or modification into service**, the applicant must submit an Engineer's Certification and Applicant's Certification to the Public Water Supply Section.

- **Engineer's Certification:** in accordance with Rule .0303 (a), the applicant shall submit a certification statement signed and sealed by a registered professional engineer stating that construction was completed in accordance with approved engineering plans and specifications, including any provisions stipulated in the Department's engineering plan and specification approval letter.
- **Applicant's Certification:** in accordance with Rule .0303 (c), the applicant shall submit a signed certification statement indicating that the requirements for an Operation and Maintenance Plan and Emergency Management Plan have been satisfied in accordance with Rule .0307 (d) and (e) and that the system has a certified operator in accordance with Rule .1300. The "Applicant Certification" form is available at **http://deq.nc.gov/node/82930#planreview** (click on Plan Review Forms, under Plan Review heading).

If this Authorization to Construct is for a new public water system, the owner must submit a completed **application for an Operating Permit** and the appropriate fee. For a copy of the application for an Operating Permit please call (919) 707-9085.

Once the certifications and permit application and fee, (if applicable), are received and determined adequate, the Department will issue a Final Approval letter to the applicant. In accordance with Rule .0309 (a), **no portion of this project shall be placed into service until the Department has issued Final Approval.**

Sincerely,

RW Midgette

Robert W. Midgette, P.E., Operations Branch Head
Public Water Supply Section
Division of Water Resources

cc: HEIDI COX, Regional Engineer
THE WOOTEN COMPANY

North Carolina Department of Environmental Quality
Division of Water Resources

Public Water System Authorization to Construct

Project Applicant:	**BRUNSWICK REGIONAL WATER & SEWER H2GO**
Public Water System Name and Water System No.:	**BRUNSWICK REGIONAL WATER AND SEWER H2GO** **NC0410070**
Project Name:	**4.0 MGD REVERSE OSMOSIS WTP**
Serial No.:	**17-00286**
Issue Date:	**June 08, 2017**
Expiration Date:	24 Months after Issue Date

In accordance with NCAC 18C .0305, this Authorization to Construct must be posted at the primary entrance to the job site during construction.

cc: CARL SCHARFE, PE
THE WOOTEN COMPANY
120 N BOYLAN AVENUE

RALEIGH, NC 27603

Energy, Mineral & Land Resources
ENVIRONMENTAL QUALITY

ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

TRACY DAVIS
Director

June 27, 2017

Brunswick Regional Water and Sewer, H2GO
Attention: Bob Walker, Executive Director
P.O. Box 2230
Leland, NC 28451

Subject: **State Stormwater Management Permit No. SW8 170319**
Brunswick Water and Sewer H2GO Water Supply & Treatment, Contract 4
Low Density Project
Brunswick County

Dear Mr. Walker:

The Wilmington Regional Office received a complete Stormwater Management Permit Application for the subject project on June 19, 2017. Staff review of the plans and specifications has determined that the project, as proposed, will comply with the Stormwater Regulations set forth in Title 15A NCAC 2H.1000 effective January 1, 2017. We are forwarding Permit No. SW8 170319, dated June 27, 2017, for the construction, operation and maintenance of the built-upon areas and vegetated conveyance system associated with the subject project.

This permit shall be effective from the date of issuance until rescinded and shall be subject to the conditions and limitations as specified therein, and does not supersede any other agency permit that may be required. Please pay special attention to the permit conditions regarding the limitation of built-upon area, modification of the project, the operation and maintenance of the vegetated conveyance system, and the procedures for changing ownership of and/or transferring the permit. Please also pay attention to the permit conditions that requires the recordation of deed restrictions and protective covenants, easements, and the maintenance agreement, which must all be provided along with certification upon completion of the project. Failure to comply with these requirements will result in future compliance problems.

If any parts, requirements, or limitations contained in this permit are unacceptable, you have the right to request an adjudicatory hearing by filing a written petition with the Office of Administrative Hearings (OAH). The written petition must conform to Chapter 150B of the North Carolina General Statutes and must be filed with the OAH within thirty (30) days of receipt of this permit. You should contact the OAH with all questions regarding the filing fee (if a filing fee is required) and/or the details of the filing process at 6714 Mail Service Center, Raleigh, NC 27699-6714, or via telephone at 919-431-3000, or visit their website at www.NCOAH.com. Unless such demands are made this permit shall be final and binding.

If you have any questions, or need additional information, please contact Steve Pusey in the Wilmington Regional Office, at (910) 796-7215.

Sincerely,

For Tracy Davis, P.E., Director
Division of Energy, Mineral and Land Resources

GDS/sgp: \\\Stormwater\Permits & Projects\2017\I70319 LD\2017 06 permit 170319

cc: K. Matthew Echols, PE – The Wooten Company
Brunswick County Building Inspections
NCDOT District Engineer
Brunswick County Engineering
Wilmington Regional Office Stormwater File

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF ENERGY, MINERAL AND LAND RESOURCES

STATE STORMWATER MANAGEMENT PERMIT

LOW DENSITY DEVELOPMENT

In accordance with the provisions of Article 21 of Chapter 143, General Statutes of North Carolina as amended, and other applicable Laws, Rules and Regulations

PERMISSION IS HEREBY GRANTED TO

Brunswick Regional Water and Sewer H2GO

Water Supply and Treatment System – Contract 4: RO Water Treatment Plant and Wells

148 Gregory Road, Belville, Brunswick County

FOR THE

construction, operation and maintenance of a 24% low-density project in compliance with the provisions of Title 15A NCAC 2H .1000 effective January 1, 2017 (the "stormwater rules") and the approved stormwater management plans, application, supplement, specifications, and other supporting data (the "approved plans and specifications") as attached and/or on file with and approved by the Division of Energy, Mineral and Land Resources (the "Division" or "DEMLR") and considered an enforceable part of this permit.

The permit shall be effective from the date of issuance until rescinded and shall be subject to the following specific conditions and limitations:

I. DESIGN STANDARDS

1. This permit is effective only with respect to the management of stormwater described in the approved plans and specifications. The overall percent of built-upon area (BUA) permitted for the project must not exceed 24% per the requirements of the stormwater rules. This permit covers the construction of a total of 105,351 square feet of BUA, which includes 97,507 square feet of proposed BUA and 7,844 square feet of future BUA allocation.

2. A 50-foot wide vegetative setback must be provided and maintained adjacent to all surface waters, measured horizontally from the normal pool elevation of impounded structures, from the top of bank of each side of streams or rivers, and from the mean high waterline of tidal waters, perpendicular to the shoreline in accordance with the stormwater rules and the approved plans and specifications. All stormwater runoff, including roof drains, shall be released as dispersed flow no closer than at the edge of the vegetated setback. At no time shall stormwater runoff be piped into or through the setback.

3. This project has maximized dispersed flow of stormwater runoff through vegetated areas and minimized the channelization of flow. Stormwater runoff that could not be released as dispersed flow may be transported by vegetated conveyances with minimum side slopes of 3:1 (H:V) designed to not erode during the peak flow from the 10-year storm event as defined in the stormwater rules and approved by the Division.

4. No piping shall be allowed except those minimum amounts necessary to direct stormwater runoff beneath a built-upon area such as a road or driveway when it cannot be avoided.

5. The peak flow from the 10-year storm event shall not cause erosion downslope of the stormwater outlet discharge point.

II. SCHEDULE OF COMPLIANCE

1. The project shall be constructed in accordance with the conditions of this permit and the approved plans and specifications.

2. Vegetated areas and vegetated conveyances shall be entirely constructed, vegetated, and operational prior to the construction of any development, per the approved plans and specifications.

3. During construction, erosion shall be kept to a minimum and any eroded areas of the vegetated areas or vegetated conveyance system will be repaired immediately.

4. All vegetated conveyance systems, stormwater collection systems, and/or maintenance accesses must be located in public rights-of-way, dedicated common areas that extend to the nearest public right-of-way, and/or permanent recorded easements that extend to the nearest public right-of-way for the purpose of inspection, operation, maintenance, and repair.

5. The permittee shall at all times provide and perform the maintenance necessary, as listed in the signed Operation and Maintenance Agreement titled Swale System Maintenance Requirements, a part of the Low Density Supplement, to assure that the permitted vegetated conveyance system functions at the approved design condition. The approved Operation and Maintenance Agreement is incorporated by reference into this permit and must be followed in its entirety and maintenance must occur at the scheduled intervals.

6. The Operation and Maintenance Agreement must be recorded with the local Office of the Register of Deeds.

7. The final plats for the project must be recorded with the Office of the Register of Deeds. The recorded plat must reference the Operation and Maintenance Agreement and must also show all public rights-of-way, dedicated common areas, and/or permanent drainage easements, in accordance with the approved plans.

8. The permittee is responsible for verifying that the proposed built-upon area for the entire project does not exceed the maximum allowed by this permit.

9. Upon completion of the project, the permittee shall determine whether or not the project is in compliance with the permitted plans and take the necessary following actions:
   a. If the permittee determines that the project is in compliance with the permitted plans, then within 45 days of completion, the permittee shall submit to the Division one hard copy and one electronic copy of the following:
      i. The completed and signed Designer's Certification provided in Attachment A noting any deviations from the approved plans and specifications. Deviations may require approval from the Division;
      ii. A copy of the recorded maintenance agreement;
      iii. Unless already provided, a copy of the recorded deed restrictions and protective covenants; and
      iv. A copy of the recorded plat delineating the public rights-of-way, dedicated common areas and/or permanent recorded easements, when applicable.
   b. If the permittee determines that the project is not in compliance with the permitted plans, the permittee shall submit an application to modify the permit within 30 days of completion of the project or provide a plan of action, with a timeline, to bring the site into compliance.

10. No person or entity, including the permittee, shall alter any component shown in the approved plans and specifications, except for minimum driveway crossings. Prior to the construction of any modification to the approved plans, the permittee shall submit to the Director, and shall have received approval for modified plans, specifications, and calculations including, but not limited to, those listed below:
    a. Any modification to the approved plans and specifications, regardless of size.
    b. Redesign or addition to the approved amount of built-upon area.
    c. Further development, subdivision, acquisition, lease or sale of any, all or part of the project area as reported in the approved plans and specifications.
    d. Filling in, piping, altering, modifying, removing, relocating, redirecting, or resizing of any component of the approved vegetated conveyance system shown on the approved plan, except for a minimum driveway crossing.
    e. The construction of any allocated future BUA.
    f. The construction of any permeable pavement for BUA credit that was not included in the approved plans and specifications. The request must include a soils report identifying the type of soil, the Seasonal High Water Table elevation and the infiltration rate.
    g. The construction of any 57 stone area or trails to be considered a permeable surface that were not included in the approved plans and specifications.
    h. Other modifications as determined by the Director.

11. The Director may notify the permittee when the permitted site does not meet one or more of the minimum requirements of the permit. Within the time frame specified in the notice, the permittee shall submit a written time schedule to the Director for modifying the site to meet minimum requirements. The permittee shall provide copies of modified plans and certification in writing to the Director that the changes have been made.

12. Prior to transfer of the permit, the vegetated conveyance system will be inspected by Division personnel. The project and the vegetated conveyance system must be in compliance with all permit conditions. Any items not in compliance must be repaired, replaced or restored to design condition prior to the transfer.

III. GENERAL CONDITIONS

1. Any individual or entity found to be in noncompliance with the provisions of a stormwater management permit or the requirements of the stormwater rules is subject to enforcement procedures as set forth in NCGS 143 Article 21.

2. The issuance of this permit does not preclude the permittee from complying with and obtaining any and all other permits or approvals that are required in order for this development to take place, as required by any statutes, rules, regulations, or ordinances, which may be imposed by any other Local, State or Federal government agency having jurisdiction. Any activities undertaken at this site that cause a water quality violation or undertaken prior to receipt of the necessary permits or approvals to do so are considered violations of NCGS 143-215.1, and subject to enforcement procedures pursuant to NCGS 143-215.6.

3. In the event that the project fails to meet the requirements of a low density project, the permittee shall take immediate corrective actions. This includes actions required by this Division and the stormwater rules such as the construction of an additional or replacement vegetated conveyance system and/or stormwater control measures. These additional or replacement measures shall receive a permit from the Division prior to construction.

4. This permit is not transferable to any person or entity except after notice to and approval by the Director. The permittee shall submit a completed and signed State Stormwater Request Form for Permit Transfer or Permit Information Update, accompanied by the supporting documentation as listed on the form, to the Division at least 60 days prior to any one or more of the following events:
   a. An ownership change including the sale or conveyance of the project area in whole or in part, except in the case of an individual lot sale that is made subject to the recorded deed restrictions and protective covenants;
   b. Bankruptcy;
   c. Foreclosure, subject to the requirements of Session Law 2013-121;
   d. Dissolution of the partnership or corporate entity, subject to NCGS 57D-2-01(e) and NCGS 57D-6-07;
   e. A name change of the current permittee;
   f. A name change of the project;
   g. A mailing address change of the permittee;

5. The permittee is responsible for compliance with all of these terms and conditions until such time as the Division approves the transfer request. Neither the sale of the project, in whole or in part, nor the conveyance of common area to a third party constitutes an approved transfer of the permit.

6. The permittee grants Division staff permission to enter the property during normal business hours for the purposes of inspecting all components of the permitted project.

7. The permit issued shall continue in force and effect until the permittee files a request with the Division for a permit modification, transfer, or rescission; however, these actions do not stay any permit conditions.

8. Approved plans, application, supplements, calculations, operation and maintenance agreement, and specifications for this project are incorporated by reference and are enforceable parts of the permit. A copy of this permit, application, supplements, operation and maintenance agreement, and approved plans and specifications shall be maintained on file by the permittee at all times.

9. Unless specified elsewhere, permanent seeding requirements for the vegetated areas must follow the guidelines established in the North Carolina Erosion and Sediment Control Planning and Design Manual.

10. The issuance of this permit does not prohibit the Director from reopening and modifying the permit, revoking and reissuing the permit, or terminating the permit for cause as allowed by the laws, rules, and regulations contained in Title 15A NCAC 2H.1000 and NCGS 143-215.1 et.al.

Permit issued this the 27th day of June, 2017.

NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

for Tracy Davis, P.E., Director
Division of Energy, Mineral and Land Resources
By Authority of the Environmental Management Commission

Permit Number SW8 170319

Attachment A

Designer's Certification Form

Stormwater Permit Number SW8 170319
Water Supply and Treatment System – Contract 4: RO Water Treatment Plant and Wells
Brunswick County

Designer's Certification – Low Density Project

I, _____, as a duly registered_____ in the State of North Carolina, having been authorized to observe (periodically/ weekly/full time) the construction of the project,

_____ (Project)

for _____(Project Owner) hereby state that, to the best of my abilities, due care and diligence was used in the observation of the project construction such that project and the stormwater system has been built in accordance with the approved plans and specifications.

Required Items to be checked for this certification to be considered complete are listed below.

Please note any deviations from approved plans and specifications here:

SEAL

Signature _____

Registration Number _____

Date _____

Certification Requirements:

_____1. The project contains no more than the maximum permitted amount of built-upon area.
_____2. All of the built-upon area associated with this permit has been constructed and is graded in accordance with the approved plans and specifications.
_____3. The vegetated conveyance system has been constructed in accordance with the approved plans and specifications and adequately conveys the stormwater runoff.
_____4. Vegetated slopes are no steeper than 3:1.
_____5. The project has been stabilized with permanent vegetation such that sediment is not leaving the lot.
_____6. Roof drains are released no closer than the edge of the vegetated setback and the runoff is allowed to flow through as dispersed flow.

cc: NCDEQ-DEMLR
Brunswick County Building Inspection

DEMLR USE ONLY		
Date Received	Fee Paid	Permit Number
3/21/17	$65.00 #54752	SWU 170319

Applicable Rules: ☐ Coastal SW – 1995 ☐ Coastal SW – 2008 ☐ Ph II - Post Construction
(select all that apply) ☐ Non-Coastal SW- HQW/ORW Waters ☐ Universal Stormwater Management Plan
☐ Other WQ Mgmt Plan: _____

State of North Carolina
Department of Environment and Natural Resources
Division of Energy, Mineral and Land Resources

STORMWATER MANAGEMENT PERMIT APPLICATION FORM

This form may be photocopied for use as an original

I. GENERAL INFORMATION

1. Project Name (subdivision, facility, or establishment name - should be consistent with project name on plans, specifications, letters, operation and maintenance agreements, etc.):

   Brunswick Regional Water and Sewer H2GO Water Supply and Treatment System - Contract 4: RO Water Treatment Plant

2. Location of Project (street address):

   148 Gregory Road (WTP & Well 1), 148 Buckeye Rd. (Well 2), 180 Goodman Rd. (Well 3), 2551 Tara Forest Dr NE (Well 4), 980 Nuns Trail NE (Well 5)

   City: Belville County: Brunswick Zip: 28451

3. Directions to project (from nearest major intersection):

   Driving west from Wilmington at the US 17-S/US-74 split, take the US-17 exit toward Shallotte/Myrtle Beach. Follow US-17 S/Ocean Hwy E for approximately 0.8 miles, and turn right onto Gregory Road. After 300 ft, veer left to stay on Gregory Rd, then continue 0.4 miles. The WTP site is on the right.

4. Latitude: 34° 12' 56.7073" N Longitude: 078° 01' 49.3620" W of the main entrance to the project.

II. PERMIT INFORMATION:

1.a. Specify whether project is (check one): ☒New ☐Modification ☐ Renewal w/ Modification†

†*Renewals with modifications also requires SWU-102 – Renewal Application Form*

b. If this application is being submitted as the result of a **modification** to an existing permit, list the existing permit number N/A, its issue date (if known) N/A, and the status of construction: ☐Not Started ☐Partially Completed* ☐ Completed* **provide a designer's certification*

2. Specify the type of project (check one):
   ☒Low Density ☐High Density ☐Drains to an Offsite Stormwater System ☐Other

3. If this application is being submitted as the result of a **previously returned application or a letter from DEMLR requesting a state stormwater management permit application**, list the stormwater project number, if assigned, N/A and the previous name of the project, if different than currently proposed, N/A.

4.a. Additional Project Requirements (check applicable blanks; information on required state permits can be obtained by contacting the Customer Service Center at 1-877-623-6748):

   ☐CAMA Major ☒Sedimentation/Erosion Control: 11 ac of Disturbed Area
   ☐NPDES Industrial Stormwater ☐404/401 Permit: Proposed Impacts _____

b. If any of these permits have already been acquired please provide the Project Name, Project/Permit Number, issue date and the type of each permit: N/A

5. Is the project located within 5 miles of a public airport? ☒No ☐Yes
   If yes, see S.L. 2012-200, Part VI: http://portal.ncdenr.org/web/lr/rules-and-regulations

III. CONTACT INFORMATION

1.a. Print Applicant / Signing Official's name and title (specifically the developer, property owner, lessee, designated government official, individual, etc. who owns the project):

Applicant/ Organization: Brunswick Regional Water and Sewer H2GO

Signing Official & Title: Bob Walker, Executive Director

b. Contact information for person listed in item 1a above:

Street Address: 516 Village Road NE

City: Leland State: NC Zip: 28451

Mailing Address (*if applicable*): P.O. Box 2230

City: Leland State: NC Zip: 28451

Phone: (910) 371-9949 Fax: (910) 371-6441

Email: bwalker@h2goonline.com

c. Please check the appropriate box. The applicant listed above is:

☒ The property owner (Skip to Contact Information, item 3a)

☐ Lessee* (Attach a copy of the lease agreement and complete Contact Information, item 2a and 2b below)

☐ Purchaser* (Attach a copy of the pending sales agreement and complete Contact Information, item 2a and 2b below)

☐ Developer* (Complete Contact Information, item 2a and 2b below.)

2.a. Print Property Owner's name and title below, if you are the lessee, purchaser or developer. (This is the person who owns the property that the project is located on):

Property Owner/ Organization: _____

Signing Official & Title: _____

b. Contact information for person listed in item 2a above:

Street Address: _____

City: _____ State: _____ Zip: _____

Mailing Address (*if applicable*): _____

City: _____ State: _____ Zip: _____

Phone: ( ) _____ Fax: ( ) _____

Email: _____

3.a. (Optional) Print the name and title of another contact such as the project's construction supervisor or other person who can answer questions about the project:

Other Contact Person/ Organization: _____

Signing Official & Title: _____

b. Contact information for person listed in item 3a above:

Mailing Address: _____

City: _____ State: _____ Zip: _____

Phone: ( ) _____ Fax: ( ) _____

Email: _____

4. Local jurisdiction for building permits: Town of Belville

Point of Contact: Athina Williams Phone #: (910) 371-2456

RECEIVED
MAR 21 2016
BY: _____

IV. PROJECT INFORMATION

1. In the space provided below, briefly summarize how the stormwater runoff will be treated.

   Low density with grassed swales

2. a. **If claiming vested rights**, identify the supporting documents provided and the date they were approved:
   - ☐ Approval of a Site Specific Development Plan or PUD — Approval Date: _____
   - ☐ Valid Building Permit — Issued Date: _____
   - ☐ Other: _____ — Date: _____

   b. **If claiming vested rights**, identify the regulation(s) the project has been designed in accordance with:
   ☐ Coastal SW - 1995 ☐ Ph II - Post Construction

3. Stormwater runoff from this project drains to the Cape Fear River basin.

4. Total Property Area: 25.3 acres

5. Total Coastal Wetlands Area: 0 acres

6. Total Surface Water Area: 0 acres

7. Total Property Area (4) - Total Coastal Wetlands Area (5) - Total Surface Water Area (6) = Total Project Area*: 25.3 (includes well sites) acres

   * *Total project area shall be calculated to exclude the following: the normal pool of impounded structures, the area between the banks of streams and rivers, the area below the Normal High Water (NHW) line or Mean High Water (MHW) line, and coastal wetlands landward from the NHW (or MHW) line. The resultant project area is used to calculate overall percent built upon area (BUA). Non-coastal wetlands landward of the NHW (or MHW) line may be included in the total project area.*

8. Project percent of impervious area: (Total Impervious Area / Total Project Area) X 100 = ~~10.8~~ 9.5 % SW

9. How many drainage areas does the project have? 1 *(For high density, count 1 for each proposed engineered stormwater BMP. For low density and other projects, use 1 for the whole property area)*

10. Complete the following information for each drainage area identified in Project Information item 9. If there are more than four drainage areas in the project, attach an additional sheet with the information for each area provided in the same format as below.

Basin Information	Drainage Area 1	Drainage Area 2	Drainage Area 3	Drainage Area 4
Receiving Stream Name	Jackeys Creek (WTP)	Jackey's Creek (Wells 1&2)	Morgan's Branch (Wells 3&4)	Sturgeon Creek (Well 5)
Stream Class *	C; Sw	C; Sw	C; Sw	C; Sw
Stream Index Number *	18-77-3	18-77-3	18-81-7	18-77-1
Total Drainage Area (sf)	759,526	175,982	105,415	63,598
On-site Drainage Area (sf)	759,526	175,982	105,415	63,598
Off-site Drainage Area (sf)	0	0	0	0
Proposed Impervious Area** (sf)	82,397	8,912	10,186	3,856
% Impervious Area** (total)	10.8	~~9.2~~ 5.1	~~9.2~~ 9.7	~~9.1~~ 6.1 SW

Impervious** Surface Area	Drainage Area 1	Drainage Area 2	Drainage Area 3	Drainage Area 4
On-site Buildings/Lots (sf)	15,520	0	0	0
On-site Streets (sf)	41,422	7,612	8,886	3,206
On-site Parking (sf)	1,641	0	0	0
On-site Sidewalks (sf)	2,872	0	0	0
Other on-site (sf)	13,098	1,300	1,300	650
Future (sf)	7,844	0	0	0
Off-site (sf)	0	0	0	0
Existing BUA*** (sf)	0	0	0	0
Total (sf):	82,397	8,912	10,186	3,856

* *Stream Class and Index Number can be determined at: http://portal.ncdenr.org/web/wq/ps/csu/classifications*

** *Impervious area is defined as the built upon area including, but not limited to, buildings, roads, parking areas, sidewalks, gravel areas, etc.*

11. How was the off-site impervious area listed above determined? Provide documentation. Examination of existing contours shows there is no off-site drainage to the site.

Projects in Union County: *Contact DEMLR Central Office staff to check if the project is located within a Threatened & Endangered Species watershed that may be subject to more stringent stormwater requirements as per 15A NCAC 02B .0600.*

V. SUPPLEMENT AND O&M FORMS

The applicable state stormwater management permit supplement and operation and maintenance (O&M) forms must be submitted for each BMP specified for this project. The latest versions of the forms can be downloaded from http://portal.ncdenr.org/web/wq/ws/su/bmp-manual.

VI. SUBMITTAL REQUIREMENTS

Only complete application packages will be accepted and reviewed by the Division of Energy, Mineral and Land Resources (DEMLR). A complete package includes all of the items listed below. A detailed application instruction sheet and BMP checklists are available from http://portal.ncdenr.org/web/wq/ws/su/statesw/forms_docs. **The complete application package should be submitted to the appropriate DEMLR Office.** (The appropriate office may be found by locating project on the interactive online map at http://portal.ncdenr.org/web/wq/ws/su/maps.)

Please **indicate that the following required information have been provided by initialing** in the space provided for each item. All original documents MUST be signed and initialed in **blue ink. Download the latest versions for each submitted application package** from http://portal.ncdenr.org/web/wq/ws/su/statesw/forms_docs.

Initials

1. *Original and one copy* of the Stormwater Management Permit Application Form.
2. *Original and one copy* of the signed and notarized Deed Restrictions & Protective Covenants Form. *(if required as per Part VII below)*
3. *Original* of the applicable Supplement Form(s) (sealed, signed and dated) **and** O&M agreement(s) for each BMP.
4. Permit application processing fee of $505 *payable to NCDENR.* (For an Express review, refer to http://www.envhelp.org/pages/onestopexpress.html for information on the Express program and the associated fees. Contact the appropriate regional office Express Permit Coordinator for additional information and to schedule the required application meeting.)
5. A detailed narrative (one to two pages) describing the stormwater treatment/ management for the project. This is required in addition to the brief summary provided in the Project Information, item 1.
6. A USGS map identifying the site location. If the receiving stream is reported as class SA or the receiving stream drains to class SA waters within ½ mile of the site boundary, include the ½ mile radius on the map.
7. Sealed, signed and dated calculations (one copy).
8. Two sets of plans folded to 8.5" x 14" (sealed, signed, & dated), including:
   a. Development/ Project name.
   b. Engineer and firm.
   c. Location map with named streets and NCSR numbers.
   d. Legend.
   e. North arrow.
   f. Scale.
   g. Revision number and dates.
   h. Identify all surface waters on the plans by delineating the normal pool elevation of impounded structures, the banks of streams and rivers, the MHW or NHW line of tidal waters, and any coastal wetlands landward of the MHW or NHW lines.
      - Delineate the vegetated buffer landward from the normal pool elevation of impounded structures, the banks of streams or rivers, and the MHW (or NHW) of tidal waters.
   i. Dimensioned property/ project boundary with bearings & distances.
   j. Site Layout with all BUA identified and dimensioned.
   k. Existing contours, proposed contours, spot elevations, finished floor elevations.
   l. Details of roads, drainage features, collection systems, and stormwater control measures.
   m. Wetlands delineated, or a note on the plans that none exist. (Must be delineated by a qualified person. Provide documentation of qualifications and identify the person who made the determination on the plans.
   n. Existing drainage (including off-site), drainage easements, pipe sizes, runoff calculations.
   o. Drainage areas delineated (included in the main set of plans, not as a separate document).

RECEIVED
MAR 21 2016

p. Vegetated buffers (where required).

9. Copy of any applicable soils report with the associated SHWT elevations (Please identify elevations in addition to depths) as well as a map of the boring locations with the existing elevations and boring logs. Include an 8.5"x11" copy of the NRCS County Soils map with the project area clearly delineated. For projects with infiltration BMPs, the report should also include the soil type, expected infiltration rate, and the method of determining the infiltration rate. **(Infiltration Devices submitted to WiRO:** *Schedule a site visit for DEMLR to verify the SHWT prior to submittal, (910) 796-7378.)*
10. A copy of the most current property deed. Deed book: 3622 Page No: 0459
11. For corporations and limited liability corporations (LLC): Provide documentation from the NC Secretary of State or other official documentation, which supports the titles and positions held by the persons listed in Contact Information, item 1a, 2a, and/ or 3a per 15A NCAC 2H.1003(e). The corporation or LLC must be listed as an active corporation in good standing with the NC Secretary of State, otherwise the application will be returned. http:/ / www.secretary.state.nc.us/ Corporations/ CSearch.aspx

VII. DEED RESTRICTIONS AND PROTECTIVE COVENANTS

For all subdivisions, outparcels, and future development, the appropriate property restrictions and protective covenants are required to be recorded prior to the sale of any lot. If lot sizes vary significantly or the proposed BUA allocations vary, a table listing each lot number, lot size, and the allowable built-upon area must be provided as an attachment to the completed and notarized deed restriction form. The appropriate deed restrictions and protective covenants forms can be downloaded from http://portal.ncdenr.org/web/lr/state-stormwater-forms_docs. Download the latest versions for each submittal.

In the instances where the applicant is different than the property owner, it is the responsibility of the property owner to sign the deed restrictions and protective covenants form while the applicant is responsible for ensuring that the deed restrictions are recorded.

By the notarized signature(s) below, the permit holder(s) certify that the recorded property restrictions and protective covenants for this project, if required, shall include all the items required in the permit and listed on the forms available on the website, that the covenants will be binding on all parties and persons claiming under them, that they will run with the land, that the required covenants cannot be changed or deleted without concurrence from the NC DEMLR, and that they will be recorded prior to the sale of any lot.

VIII. CONSULTANT INFORMATION AND AUTHORIZATION

Applicant: Complete this section if you wish to designate authority to another individual and/ or firm (such as a consulting engineer and/ or firm) so that they may provide information on your behalf for this project (such as addressing requests for additional information).

Consulting Engineer: K. Matthew Echols, P.E.

Consulting Firm: The Wooten Company

Mailing Address: 120 N Boylan Avenue

City: Raleigh State: NC Zip: 27603

Phone: (919) 828-0531 Fax: (919) 834-3589

Email: mechols@thewootencompany.com

IX. PROPERTY OWNER AUTHORIZATION *(if Contact Information, item 2 has been filled out, complete this section)*

I, *(print or type name of person listed in Contact Information, item 2a)* Bob Walker, certify that I own the property identified in this permit application, and thus give permission to *(print or type name of person listed in Contact Information, item 1a)* K. Matthew Echols with *(print or type name of organization listed in Contact Information, item 1a)* The Wooten Company to develop the project as currently proposed. A copy of the lease agreement or pending property sales contract has been provided with the submittal, which indicates the party responsible for the operation and maintenance of the stormwater system.

RECEIVED
MAR 21 2016
BY:

As the legal property owner I acknowledge, understand, and agree by my signature below, that if my designated agent (entity listed in Contact Information, item 1) dissolves their company and/or cancels or defaults on their lease agreement, or pending sale, responsibility for compliance with the DEMLR Stormwater permit reverts back to me, the property owner. As the property owner, it is my responsibility to notify DEMLR immediately and submit a completed Name/Ownership Change Form within 30 days; otherwise I will be operating a stormwater treatment facility without a valid permit. I understand that the operation of a stormwater treatment facility without a valid permit is a violation of NC General Statue 143-215.1 and may result in appropriate enforcement action including the assessment of civil penalties of up to $25,000 per day, pursuant to NCGS 143-215.6.

Signature: Bob Walker Date: 3-14-17

I, Teresa H. Long, a Notary Public for the State of North Carolina, County of Brunswick, do hereby certify that Bob Walker personally appeared before me this 14th day of March, 2017, and acknowledge the due execution of the application for a stormwater permit. Witness my hand and official seal, Teresa H. Long

SEAL

My commission expires 10-05-2018

X. APPLICANT'S CERTIFICATION

I, *(print or type name of person listed in Contact Information, item 1a)* Bob Walker certify that the information included on this permit application form is, to the best of my knowledge, correct and that the project will be constructed in conformance with the approved plans, that the required deed restrictions and protective covenants will be recorded, and that the proposed project complies with the requirements of the applicable stormwater rules under 15A NCAC 2H .1000 and any other applicable state stormwater requirements.

Signature: Bob Walker Date: 3-14-17

I, Teresa H. Long, a Notary Public for the State of North Carolina, County of Brunswick, do hereby certify that Bob Walker personally appeared before me this 14th day of March, 2017, and acknowledge the due execution of the application for a stormwater permit. Witness my hand and official seal, Teresa H. Long

SEAL

My commission expires 10-05-2018

Permit No. SW8 151349
(to be provided by DEMLR)

State of North Carolina
Department of Environment and Natural Resources
Division of Energy, Mineral and Land Resources

STORMWATER MANAGEMENT PERMIT APPLICATION FORM

LOW DENSITY SUPPLEMENT

This form may be photocopied for use as an original

A low density project is one that meets the appropriate criteria for built upon area and transports stormwater runoff primarily through vegetated conveyances. Low density projects should not have a discrete stormwater collection system as defined by 15A NCAC 2H .1002(18). Low density requirements and density factors can be found in Session Law 2008-211, 15A NCAC 2H .1000, Session Law 2006-246 and the State of North Carolina Stormwater Best Management Practice Manual. Curb and gutter systems are allowed provided they meet the requirements in 15A NCAC 2H .1008(g).

I. PROJECT INFORMATION

Project Name : Water Supply and Treatment System - Contract 4: RO Water Treatment Plant

Contact Person: Bob Walker, Executive Director Phone Number: (910)371-9949

Number of Lots: 1 Allowable Built Upon Area (BUA) Per Lot*: N/A

Number of Dwelling Units Per Acre**: N/A

Low Density Development (*check one*): ☒ *without* curb & gutter ☐ *with* curb & gutter, outlets to (*check one*):

☐ Swales ☐ Vegetated Area

***If lot sizes are not uniform, attach a table indicating the number of lots, lot sizes and allowable built upon area for each lot. The attachment must include the project name, phase, page numbers and provide area subtotals and totals. BUA shall be shown in units of square feet.**

****(Phase II Post-Construction [non-SA] only)**

RECEIVED
DEC 21 2015

II. BUILT UPON AREA

Refer to DEMLR's forms and applications website for specific language that must be recorded in the deed restrictions for all subdivided projects. (http://portal.ncdenr.org/web/lr/state-stormwater-forms_docs)

Complete the following calculation in the space provided below where:

- SA Site Area - the total project area above Mean High Water.
- DF Density Factor - the appropriate percent built upon area divided by 100.
- RA Road Area - the total impervious surface occupied by roadways.
- OA Other Area - the total area of impervious surfaces such as clubhouses, tennis courts, sidewalks, etc.
- No. of Lots - the total number of lots in the subdivision.
- BUA per Lot - the computed allowable built upon area for each lot including driveways and impervious surfaces located between the front lot line and the edge of pavement.
- Total allowable lot BUA - the computed allowable built upon area for all lots combined.
- Total BUA from lot listing - the sum of built upon area allocated for each lot on the list of non-uniform lots.

Calculation:

For uniform lot sizes:

(SA: _____ ft² x DF: _____) – (RA: _____ ft²) – (OA: _____ ft²) = BUA per Lot = _____ ft²
(No of Lots: _____)

For non-uniform lot sizes:

a. (SA: 757,944 ft² x DF: 0.24) – (RA: 0 ft²) – (OA: 0 ft²) = Total allowable lot BUA = 181,906 ft²

b. Total BUA from lot listing: 82, 397sf. **b must be ≤ a**

III. DESIGN INFORMATION

Complete the following table. If additional space is needed the information should be provided in the same format as Table 1 and attached to this form. Rainfall intensity data can be found in Appendix 8.03 of the State of North Carolina Erosion and Sediment Control Planning and Design Manual or at http://hdsc.nws.noaa.gov/hdsc/pfds/

Table 1. Swale design information based on the **10-year storm**.

Swale No.	Drainage Area (ac)	Impervious Area (ac)	Grassed Area (ac)	C	Q (cfs)	Slope (%)	V_{allow} (fps)	V_{actual} (fps)	Flow Depth (ft)
1	0.425	0.283	0.142	0.75	0.98	1.3	2.5	1.16	0.07
2	0.189	0.110	0.079	0.75	0.43	0.9	2.5	0.76	0.05
3	0.189	0.133	0.076	0.75	0.43	0.7	2.5	0.68	0.05
4	0.394	0.263	0.131	0.75	0.90	0.8	2.5	0.93	0.07
5	0.191	0.152	0.039	0.85	0.50	2.9	2.5	1.53	0.06
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

RECEIVED

IV. REQUIRED ITEMS CHECKLIST

The following checklist outlines design requirements per the North Carolina Administrative Code Section 15A NCAC 2H .1000, NCDENR BMP Manual (2007), Session Law 2006-246, and Session Law 2008-211.

Please indicate the page or plan sheet numbers where the supporting documentation can be found. **An incomplete submittal package will result in a request for additional information. This will delay final review and approval of the project.** Initial in the space provided to indicate that the following requirements have been met and supporting documentation is provided as necessary. If the applicant has designated an agent on the Stormwater Management Permit Application Form, the agent may initial below. **If any item is not met, then justification must be attached.** *Only complete items n through p for projects with curb outlets.*

Initials	Page/Plan Sheet No.		
_____	N/A	a.†	For projects in the 20 coastal counties: Per NCAC 2H.1005, a 50 foot wide vegetative buffer is provided adjacent to surface waters. For Redevelopment projects, a 30' wide vegetative buffer adjacent surface waters is provided.
_____	N/A	b.†	For HQW or ORW projects outside the 20 coastal counties: A 30 foot wide vegetative buffer is provided adjacent to surface waters.
_____	N/A	c.†	For Phase II Post-Construction projects: All built upon area is located at least 30 feet landward of all perennial and intermittent surface waters.
_____	N/A	d.	Deed restriction language as required on form SWU-101 shall be recorded as a restrictive covenant. A copy of the recorded document shall be provided to DWQ within 30 days of platting and prior to the sale of any lots.
_____	_____	e.	Built upon area calculations are provided for the overall project and all lots.
_____	N/A	f.	Project conforms to low density requirements within the ORW AEC. (if applicable per 15A NCAC 2H .1007)
_____	_____	g.	Side slopes of swales are no steeper than 3:1; *or no steeper than 5:1 for curb outlet swales.*
_____	_____	h.	Longitudinal slope of swales is no greater than 5%; *for non-curb outlet projects*, calculations for shear stress and velocity are provided if slope is greater than 5%.
_____	_____	i.	At a minimum, swales are designed to carry the 10 year storm velocity at a non-erosive rate.
_____	N/A	j.	Swales discharging to wetlands are designed to flow into and through the wetlands at a non-erosive velocity (for this flow requirement into wetlands, non-erosive is velocity ≤ 2 ft/s).
_____	_____	k.	Swale detail and permanent vegetation is specified on the plans.
_____	_____	l.	Swale detail provided on plans; includes grass type(s) for permanent vegetative cover.
_____	N/A	m.	Swales are located in recorded drainage easements.
_____	N/A	n.††	Length of swale or vegetated area is at least 100 feet for each curb outlet.
_____	_____	o.††	The system takes into account the run-off at ultimate built-out potential from all surfaces draining to the system (delineate drainage area for each swale).
_____	N/A	p.††	Curb outlets direct flow to a swale or vegetated area.

† **Projects in the Neuse, Tar-Pamlico, Catawba River basins, and Randleman Lake may require additional buffers.**

†† **Only complete these items for projects with curb outlets.**

RECEIVED
BY: _____

V. SWALE SYSTEM MAINTENANCE REQUIREMENTS

1. Mowing will be accomplished as needed according to the season. Grass height will not exceed six inches at any time; and grass will not be mowed too close to the ground or "scalped".

2. Swales will be inspected monthly or after every runoff producing rainfall event for sediment build-up, erosion, and trash accumulation.

3. Accumulated sediment and trash will be removed as necessary. Swales will be reseeded or sodded following sediment removal.

4. Eroded areas of the swales will be repaired and reseeded. Swales will be revegetated as needed and in a timely manner based on the monthly inspections. Side slopes must be maintained at the permitted slope.

5. Catch basins, curb cuts, velocity reduction devices, and piping will be inspected monthly or after every significant runoff producing rainfall event. Trash and debris will be cleared away from grates, curb cuts, velocity reduction devices and piping.

6. Swales will not be altered, piped, or filled in without approval from NCDENR Division of Energy, Mineral and Land Resources.

I acknowledge and agree by my signature below that I am responsible for the performance of the six maintenance procedures listed above. I agree to notify DEMLR of any problems with the system or prior to any changes to the system or responsible party.

Print Name and Title: Bob Walker, Executive Director

Address: 516 Village Road NE / P.O. Box 2230, Leland, NC 28451

Phone: 910-371-9949 Date: 3-14-17

Signature: Bob Walker

Note: The legally responsible party should not be a homeowners association unless more than 50% of the lots have been sold and a resident of the subdivision has been named the president.

I, Teresa H. Long, a Notary Public for the State of North Carolina, County of Brunswick, do hereby certify that Bob Walker personally appeared before me this 14th day of March, 2017, and acknowledge the due execution of the forgoing swale maintenance requirements.

Witness my hand and official seal,

Teresa H. Long

Notary signature

SEAL My commission expires 10-05-2018

RECEIVED
MAR 21 2017
BY

DocuSign Envelope ID: 80E7A9A8-8270-4227-8DD5-D520201D984C

PERMIT NO. WS0801044

NORTH CAROLINA
ENVIRONMENTAL MANAGEMENT COMMISSION
DEPARTMENT OF ENVIRONMENTAL QUALITY
RALEIGH, NORTH CAROLINA

PERMIT FOR THE CONSTRUCTION OF A WELL OR WELL SYSTEM
In accordance with the provisions of Article 7, Chapter 87, North Carolina General Statutes, and other applicable Laws, Rules and Regulations

PERMISSION IS HEREBY GRANTED TO
Brunswick Regional Water and Sewer H2GO

FOR THE CONSTRUCTION OF eight (8) large capacity water supply wells in accordance with the application received on September 4, 2019 in conformity with specifications and supporting data, all of which are filed with the Department of Environmental Quality and are considered part of the Permit. The wells will be located at the following locations in Leland, Brunswick County:

Site #2 (148 Buckeye Road):
Well 02P Lower Peedee Aquifer Well N34°12'12.1912", W78°03'26.7298"
Well 02B Black Creek Aquifer Well N34°12'11.8652", W78°03'26.4572"

Site #3 (180 Goodman Road):
Well 03P Lower Peedee Aquifer Well N34°11'47.6416", W78°04'33.8105"
Well 03B Black Creek Aquifer Well N34°11'47.2328", W78°04'33.9113"

Site #4 (2551 Tara Forest Drive):
Well 04P Lower Peedee Aquifer Well N34°13'05.2237", W78°03'40.0561"
Well 04B Black Creek Aquifer Well N34°13'05.8091", W78°03'39.6082"

Site #5 (980 Nuns Trail NE):
Well 05P Lower Peedee Aquifer Well N34°13'57.9671", W78°03'35.4847"
Well 05B Black Creek Aquifer Well N34°13'58.0664", W78°03'35.0219"

This Permit is for well construction only and does not waive any provisions or requirements of the Water Use Act of 1967, or any other applicable laws and regulations. Well construction shall be in compliance with the North Carolina Well Construction Regulations and Standards.

This Permit will be effective from the date of its issuance until September 17, 2020, and shall be subject to other specified conditions, limitations, or exceptions as follows:

1. The well(s) shall be constructed in accordance with 15A NCAC 02C .0100.
2. The well(s) shall be constructed and located as shown on the attachments submitted as part of the permit application.
3. A well construction record and copies of well logs, if generated, shall be submitted to the Division.
4. A 24-hour yield test shall be conducted for each well in accordance with 15 NCAC 2C .0110(b) and submitted within 30 days of completion.
5. Well construction records (form GW-1) for the well must be supplied to the Division of Water Resources' Information Processing Unit within 30 days of well completion.
6. Issuance of this Permit does not obligate reimbursement from State trust funds, if the well is being installed as part of an investigation for contamination from an underground storage tank or dry cleaner incident.

DocuSign Envelope ID: 80E7A9A8-8270-4227-8DD5-D520201D984C

7. Issuance of this Permit does not supersede any other agreement, permit, or requirement issued by another agency.
8. The well shall have a Well Contractor Identification Plate in accordance with 15A NCAC 02C.0108 (o).
9. When a well is discontinued or abandoned, it shall be abandoned in accordance with 15A NCAC 02C.0113 and a well abandonment record (form GW-30) shall be submitted to the Division of Water Resources' Information Processing Unit within 30 days of well abandonment.

If any requirements or limitations of this Permit are unacceptable, you have the right to an adjudicatory hearing upon written request within 30 days. The request must be in the form of a written petition conforming to Chapter 150B of the North Carolina General Statutes and filed with the Office of Administrative Hearings, 6714 Mail Service Center, Raleigh, North Carolina 27699-6714. Unless such demand is made, this Permit is final and binding.

Permit issued this 17th day of September 2019

NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

DocuSigned by:
Morella Sanchez King
E3ABA14AC7DC434...

Morella Sanchez King, PhD, PE, Regional Supervisor
Division of Water Resources
By Authority of the Environmental Management Commission

cc: Skipper's Well Drilling and Pump Service
DWR files (Laserfiche upload)

RULES IMPLEMENTING MEDIATED SETTLEMENT CONFERENCES IN NORTH CAROLINA PUBLIC CONSTRUCTION PROJECTS

Adopted
February 26, 2002

Table of Rules

Rule

1. Initiating Mediated Settlement Conferences
   - A. Purpose of Mandatory Settlement Conferences.
   - B. Initiating the Dispute Resolution Process.

2. Selection of Mediator
   - A. Selection of Certified Mediator by Agreement of the Parties.
   - B. Nomination and Court Approval of a Non-Certified Mediator.
   - C. Appointment of Mediator by the SCO.
   - D. Mediator Information Directory.
   - E. Disqualification of Mediator.

3. The Mediated Settlement Conference
   - A. Where Conference is to be Held.
   - B. When Conference is to be Held.
   - C. Request to Extend Deadline for Completion.
   - D. Recesses.
   - E. The Mediated Settlement Conference shall not be cause for the Delay of the Construction Project which is the focus of the Dispute.

4. Duties of Parties and Other Participants in Formal Dispute Resolution Process
   - A. Attendance.
   - B. Finalizing Agreement.
   - C. The Mediation Fee shall be paid in accordance with G.S. 143-128(g).
   - D. Failure to Compensate Mediator.

5. Authority and Duties of Mediators
   - A. Authority of Mediator.
   - B. Duties of Mediator.

6. Compensation of the Mediator
   - A. By Agreement.
   - B. By Appointment.

7. Mediator Certification

8. Rule Making

9. Definitions

10. Time Limits

RULE 1. INITIATING MEDIATED SETTLEMENT CONFERENCES

A. **Purpose of Mandatory Settlement Conferences**. Pursuant to G.S. 143-128(g) 143-135.26(11), these Rules are promulgated to implement a system of settlement events which are designated to focus the parties' attention on settlement rather than on claim preparation and to provide a structured opportunity for settlement negotiations to take place. Nothing herein is intended to limit or prevent the parties from engaging in settlement procedures voluntarily at any time prior to or during commencement of the dispute resolution process.

B. **Initiating the Dispute Resolution Process**
   1) Any party to a public construction contract governed by Article 8. Ch. 143 of the General Statutes and identified in G.S. 143-128(g) and who is a party to a dispute arising out of the construction process in which the amount in controversy is at least $15,000 may submit a written request to the public owner for mediation of the dispute.
   2) Prior to submission of a written request for mediation to the public owner, the parties requesting mediation,
      a) If a prime contractor, must have first submitted its claim to the Project Designer for review as set forth in Exhibit A. If the dispute is not resolved through the Project Designer's instructions, then the dispute becomes ripe for mediation in the Formal Dispute Resolution Process, and the party may submit his written request for mediation to the public owner.
      b) If the party requesting mediation is a subcontractor, it must first have submitted its claim for mediation to the prime contractor with whom it has a contract. If the dispute is not resolved through the Prime Contractor's involvement, then the dispute becomes ripe for mediation in the Formal Dispute Resolution Process, and the party may submit its written request for mediation to the public owner.
      c) If the party requesting mediation is the Project Designer, then it must first submit its claim to the public owner to resolve. If the dispute is not resolved with the public owner's involvement, then the Project Designers' dispute is ripe for mediation in the Formal Dispute Resolution Process, and the Project Designer may submit its written request to the public owner for mediation.

RULE 2. SELECTION OF MEDIATOR

A. **Selection of Certified Mediator by Agreement of the Parties**. The parties may select a mediator certified pursuant to the Rules by agreement within 21 days of requesting mediation. The requesting party shall file with the State Construction Office (hereinafter collectively referred to as the "SCO") or public owner if a non-State project a Notice of Selection of Mediator by Agreement within 10 days of the request; however, any party may file the notice. Such notice shall state the name, address and telephone number of the mediator selected; state the rate of compensation of the mediator; state that the mediator and opposing counsel have agreed upon the selection and rate of compensation; and state that the mediator is certified pursuant to these Rules.

B. **Nomination and Public Owner Approval of a Non-Certified Mediator.** The parties may select a mediator who does not meet the certification requirements of these rules but who, in the opinion of the parties and the SCO or public owner, is otherwise qualified by training or experience to mediate the action.

If the parties select a non-certified mediator, the requesting party shall file with the SCO a Nomination of Non-Certified Mediator within 10 days of the request. Such nomination shall state the name, address and telephone number of the mediator; state the training, experience or other qualifications of the mediator; state the rate of compensation of the mediator; and state that the mediator and opposing counsel have agreed upon the selection and rate of compensation.

The SCO or public owner shall rule on said nomination, shall approve or disapprove of the parties' nomination and shall notify the parties of its decision.

C. **Appointment of Mediator by the SCO**. If the parties cannot agree upon the selection of a mediator, the party or party's attorney shall so notify the SCO or public owner and request, on behalf of the parties, that the SCO or public owner appoint a mediator. The request for appointment must be filed within 10 days after request to mediate and shall state that the parties have had a full and frank discussion concerning the selection of a mediator and have been unable to agree. The request shall state whether any party prefers a certified attorney mediator, and if so, the SCO or public owner shall appoint a certified attorney mediator. If no preference is expressed, the SCO or public owner may appoint a certified attorney mediator or a certified non-attorney mediator.

D. **Mediator Information Directory**. To assist the parties in the selection of a mediator by agreement, the parties are free to utilize the list of certified mediators maintained in any county participating in the Superior Court Mediation Settlement Conference Program.

E. **Disqualification of Mediator**. Any party may request replacement of the mediator by the SCO or public owner for good cause. Nothing in this provision shall preclude mediators from disqualifying themselves.

RULE 3. THE MEDIATED SETTLEMENT CONFERENCE

A. **Where Conference is to be Held**. Unless all parties and the mediator otherwise agree, the mediated settlement conference shall be held in the county where the project is located. The mediator shall be responsible for reserving a place and making arrangements for the conference and for giving timely notice of the time and location of the conference to all attorneys, unrepresented parties and other persons and entities required to attend.

B. **When Conference is to be Held**. The deadline for completion of the mediation shall be not less than 30 days nor more than 60 days after the naming of the mediator.

C. **Request to Extend Deadline for Completion**. A party, or the mediator, may request the SCO or public owner to extend the deadline for completion of the conference. Such request shall state the reasons the extension is sought and

shall be served by the moving party upon the other parties and the mediator. If any party does not consent to the request, said party shall promptly communicate its objection to the SCO or public owner.

The SCO or public owner may grant the request by setting a new deadline for completion of the conference.

D. **Recesses.** The mediator may recess the conference at any time and may set times for reconvening. If the time for reconvening is set before the conference is recessed, no further notification is required for persons present at the conference.

E. **The mediated settlement conference shall not be cause for the delay of the construction project which is the focus of the dispute.**

RULE 4. DUTIES OF PARTIES AND OTHER PARTICIPANTS IN FORMAL DISPUTE RESOLUTION PROCESS

A. **Attendance.**
1) All parties to the dispute originally presented to the Designer or Prime Contractor for initial resolution must attend the mediation. Failure of a party to a construction contract to attend the mediation will result in the public owner's withholding of monthly payment to that party until such party attends the mediation.
2) Attendance shall constitute physical attendance, not by telephone or other electronic means. Any attendee on behalf of a party must have authority from that party to bind it to any agreement reached as a result of the mediation.
3) Attorneys on behalf of parties may attend the mediation but are not required to do so.
4) Sureties or insurance company representatives are not required to attend the mediation unless any monies paid or to be paid as a result of any agreement reached as a result of mediation require their presence or acquiescence. If such agreement or presence is required, then authorized representatives of the surety or insurance company must attend the mediation.

B. **Finalizing Agreement.** If an agreement is reached in the conference, parties to the agreement shall reduce its terms to writing and sign it along with their counsel.

C. **The mediation fee shall be paid in accordance with G.S. 143-128(g).**

D. **Failure to compensate mediator.** Any party's failure to compensate the mediators in accordance with G.S. 143-128(g) shall subject that party to a withholding of said amount of money from the party's monthly payment by the public owner.

Should the public owner fail to compensate the mediator, it shall hereby be subject to a civil cause of action from the mediator for the 1/3 portion of the mediator's total fee as required by G.S. 143-128(g).

RULE 5. AUTHORITY AND DUTIES OF MEDIATORS

A. **Authority of Mediator.**

1) *Control of Conference.* The mediator shall at all times be in control of the conference and the procedures to be followed.
2) *Private Consultation.* The mediator may communicate privately with any participant or counsel prior to and during the conference. The fact that private communications have occurred with a participant shall be disclosed to all other participants at the beginning of the conference.
3) *Scheduling the Conference.* The mediator shall make a good faith effort to schedule the conference at a time that is convenient with the participants, attorneys and mediator. In the absence of agreement, the mediator shall select the date for the conference.

B. **Duties of Mediator.**

1) The mediator shall define and describe the following at the beginning of the conference:
   a) The process of mediation;
   b) The difference between mediation and other forms of conflict resolution;
   c) The costs of the mediated settlement conference;
   d) That the mediated settlement conference is not a trial, the mediator is not a judge, and the parties retain their legal rights if they do not reach settlement;
   e) The circumstances under which the mediator may meet and communicate privately with any of the parties or with any other person;
   f) Whether and under what conditions communications with the mediator will be held in confidence during the conference;
   g) The inadmissibility of conduct and statements as provided by G.S. 7A-38.1(1);
   h) The duties and responsibilities of the mediator and the participants; and
   i) That any agreement reached will be reached by mutual consent.
2) *Disclosure.* The mediator has a duty to be impartial and to advise all participants of any circumstance bearing on possible bias, prejudice or partiality.
3) *Declaring Impasse.* It is the duty of the mediator timely to determine that an impasse exists and that the conference should end.
4) *Reporting Results of Conference.* The mediator shall report to the SCO or public owner within 10 days of the conference whether or not an agreement was reached by the parties. If an agreement was reached, the report shall state the nature of said agreement. The mediator's report shall inform the SCO or public owner of the absence of any party known to the mediator to have been absent from the mediated settlement conference without permission. The SCO or public owner may require the mediator to provide statistical data for evaluation of the mediated settlement conference program.
5) *Scheduling and Holding the Conference.* It is the duty of the mediator to schedule the conference and conduct it prior to the deadline of completion set by the rules. Deadlines for completion of the conference shall be strictly observed by the mediator unless said time limit is changed by a written order of the SCO or public owner.

RULE 6. COMPENSATION OF THE MEDIATOR

A. **By Agreement.** When the mediator is stipulated by the parties, compensation shall be as agreed upon between the parties and the mediator provided that the provision of G.S. 143-128(g) are observed.
B. **By Appointment.** When the mediator is appointed by the SCO or public owner, the parties shall compensate the mediator for mediation services at the rate in accordance with the rate charged for Superior Court mediation. The parties shall also pay to the mediator a one-time per case administrative rate in accordance with the rate charged for Superior Court mediation, which is due upon appointment.

RULE 7. MEDIATOR CERTIFICATION.

All mediators certified in the Formal Dispute Resolution Program shall be properly certified in accordance with the rules certifying mediators in Superior Court in North Carolina. * When selecting mediators, the parties may designate a preference for mediators with a background in construction law or public construction contracting. Such requirements, while preferred, are not mandatory under these rules.

All mediators chosen must either demonstrate they are certified in accordance with the Rules Implementing Scheduled Mediated Settlement Conference in Superior Court or must gain the consent of the SCO or public owner to mediate any dispute in accordance with these rules.

* Except when otherwise allowed by the SCO or public owner upon the request of the parties to the mediation.

RULE 8. RULE MAKING

These Rules are subject to amendment by rule making by the State Building Commission.

These Rules are mandated for State projects when the contracting state entity has not otherwise adopted its own dispute resolution provision. These rules are optional for all other projects subject to Article 8, Ch. 143 of the General Statutes.

RULE 9. DEFINITIONS

When the phrase "SCO or public owner" is used in these rules, "SCO" shall apply to state projects, "public owner" shall apply to non-state public projects.

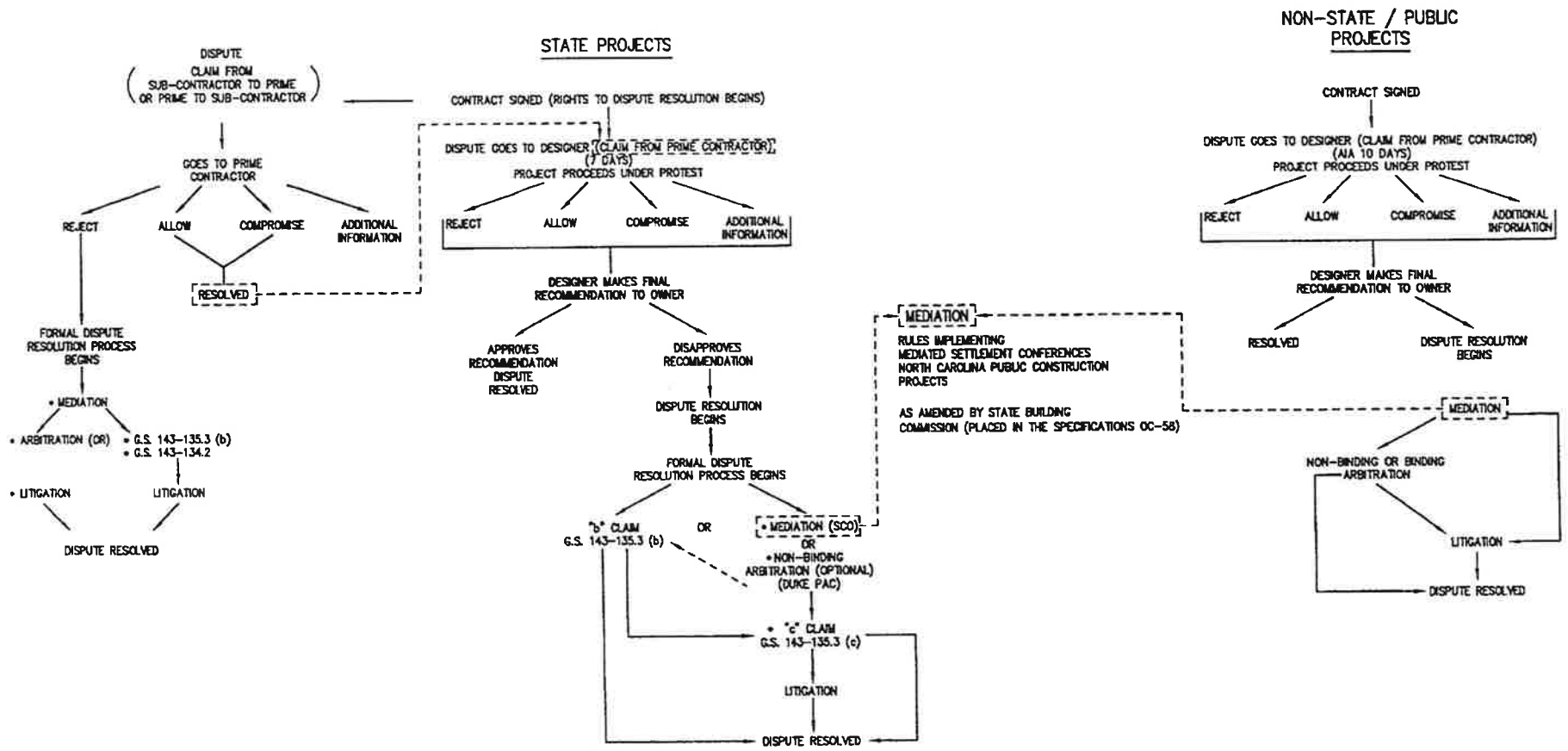
RULE 10. TIME LIMITS

On state contracts, any time limit provided for by these Rules may be waived or extended by the SCO for good cause shown.

On non-state contracts, any time limit provided for by these Rules may be waived or extended by the mediator it appoints for good cause shown. If the mediator has not yet been appointed, the designer of record shall decide all waivers or extensions of time for good cause shown.

Exhibit A

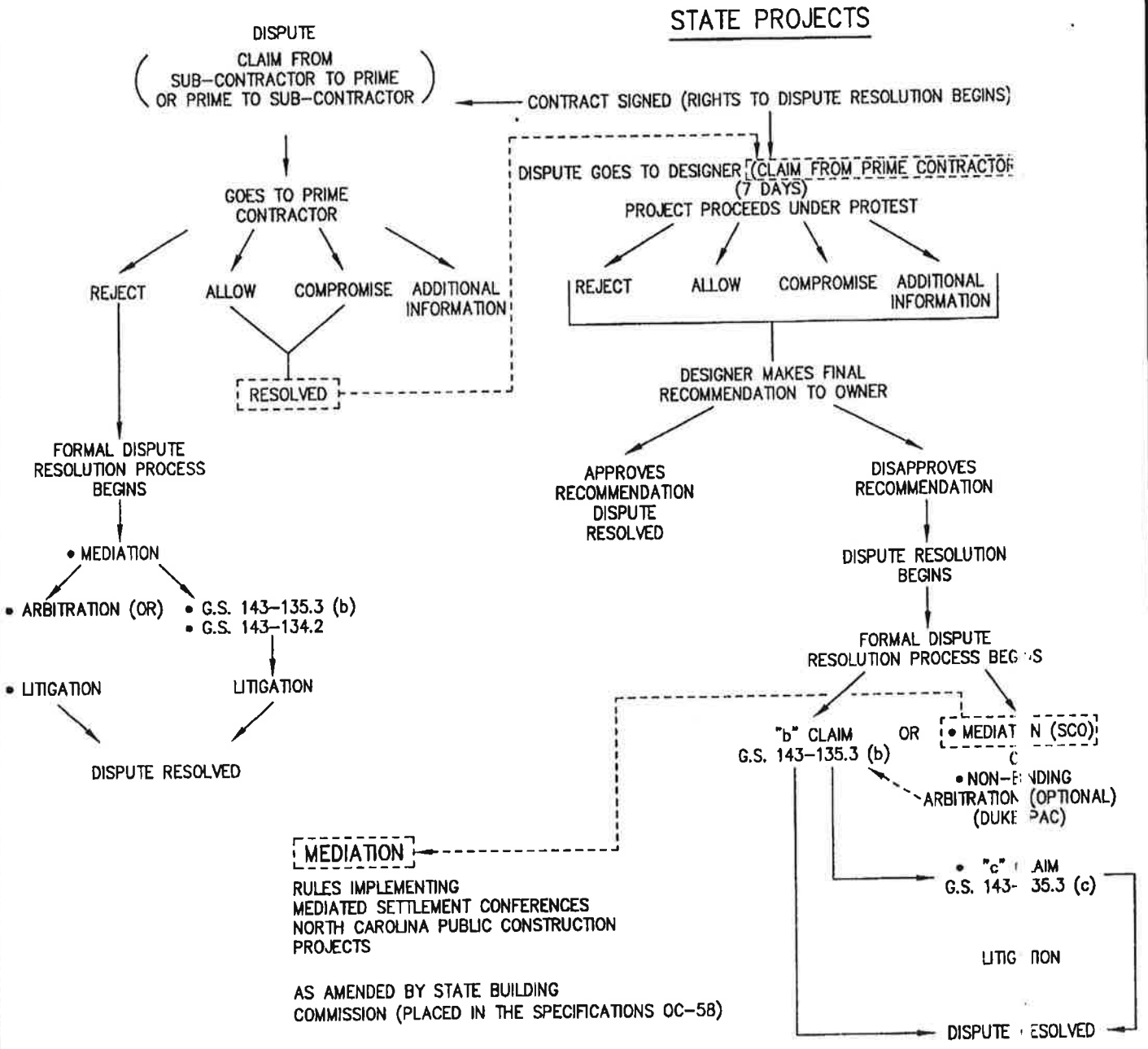
DISPUTE RESOLUTION



2/26/02

Exhibit A

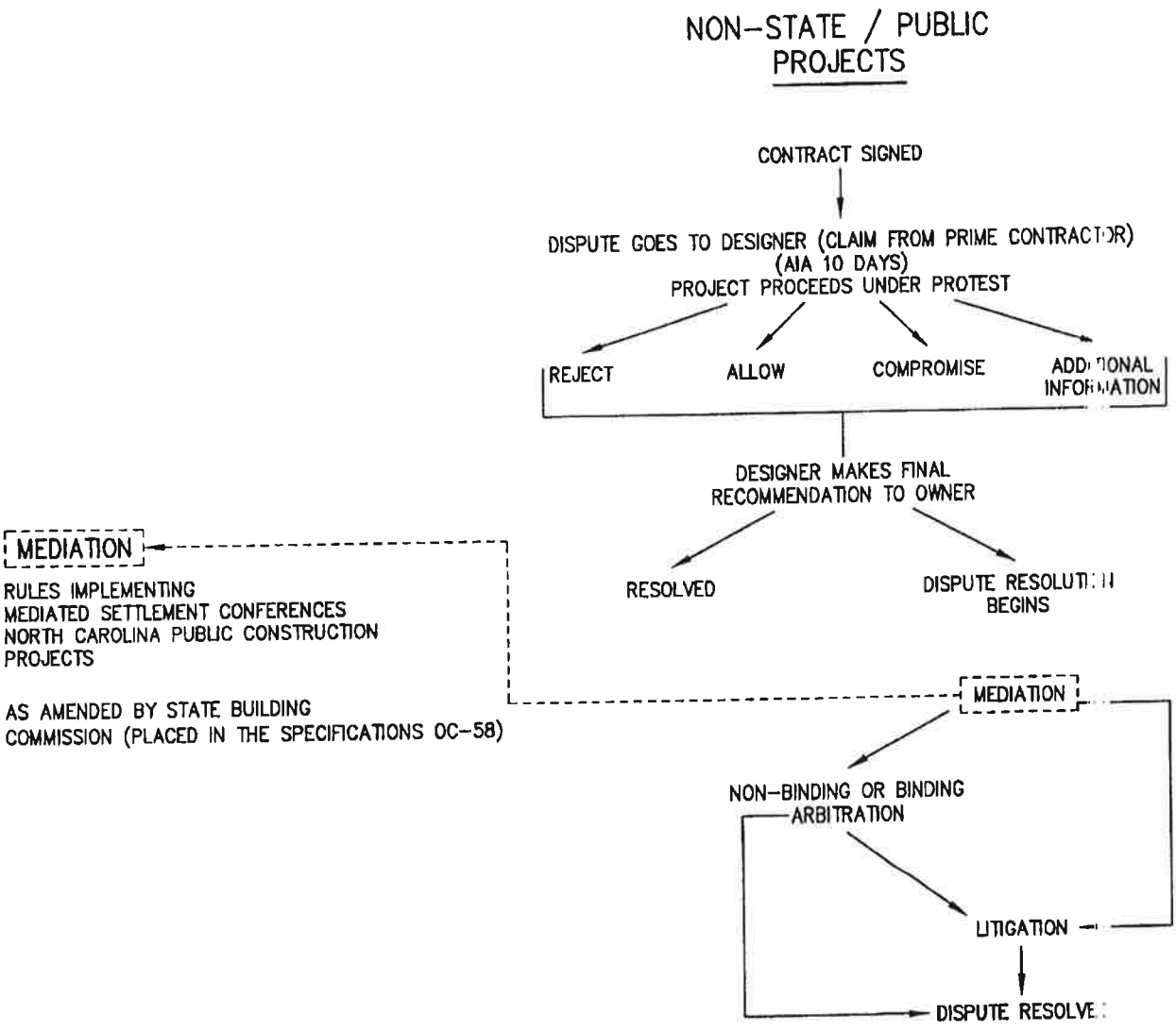
DISPUTE RESOLUTION



/26/02

Exhibit A

DISPUTE RESOLUTION



Work Change Directive

No. _____

Date of Issuance: _____ Effective Date: _____

Project:	Owner:	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

Contractor is directed to proceed promptly with the following change(s):

Item No.	Description

Attachments (list documents supporting change):

_____

_____

Purpose for Work Change Directive:

Authorization for Work described herein to proceed on the basis of Cost of the Work due to:

- ☐ Nonagreement on pricing of proposed change.
- ☐ Necessity to expedite Work described herein prior to agreeing to changes on Contract Price and Contract Time.

Estimated change in Contract Price and Contract Times:

Contract Price $_____ (increase/decrease) Contract Time _____ (increase/decrease)
days

Recommended for Approval by Engineer:	Date
Authorized for Owner by:	Date
Received for Contractor by:	Date
Received by Funding Agency (if applicable):	Date:

Change Order

No. _____

Date of Issuance: _____ Effective Date: _____

Project:	Owner:	Owner's Contract No.:
Contract: N/A		Date of Contract:
Contractor:		Engineer's Project No.:

The Contract Documents are modified as follows upon execution of this Change Order:

Description:

Attachments (list documents supporting change):

CHANGE IN CONTRACT PRICE:	**CHANGE IN CONTRACT TIMES:**
Original Contract Price: $_____	Original Contract Times: ☐ Working days ☐ Calendar days Substantial completion (days or date): _____ Ready for final payment (days or date): _____
[Increase] [Decrease] from previously approved Change Orders No. _____ to No. _____: $_____	[Increase] [Decrease] from previously approved Change Orders No. _____ to No. _____: Substantial completion (days): _____ Ready for final payment (days): _____
Contract Price prior to this Change Order: $_____	Contract Times prior to this Change Order: Substantial completion (days or date): _____ Ready for final payment (days or date): _____
[Increase] [Decrease] of this Change Order: $_____	[Increase] [Decrease] of this Change Order: Substantial completion (days or date): _____ Ready for final payment (days or date): _____
Contract Price incorporating this Change Order: $_____	Contract Times with all approved Change Orders: Substantial completion (days or date): _____ Ready for final payment (days or date): _____

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By: _____	By: _____	By: _____
Engineer (Authorized Signature)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Date: _____	Date: _____	Date: _____

Approved by Funding Agency (if applicable):

_____ Date: _____

Change Order

Instructions

A. GENERAL INFORMATION

This document was developed to provide a uniform format for handling contract changes that affect Contract Price or Contract Times. Changes that have been initiated by a Work Change Directive must be incorporated into a subsequent Change Order if they affect Price or Times.

Changes that affect Contract Price or Contract Times should be promptly covered by a Change Order. The practice of accumulating Change Orders to reduce the administrative burden may lead to unnecessary disputes.

If Milestones have been listed in the Agreement, any effect of a Change Order thereon should be addressed.

For supplemental instructions and minor changes not involving a change in the Contract Price or Contract Times, a Field Order should be used.

B. COMPLETING THE CHANGE ORDER FORM

Engineer normally initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by Contractor, or requests from Owner, or both.

Once Engineer has completed and signed the form, all copies should be sent to Owner or Contractor for approval, depending on whether the Change Order is a true order to the Contractor or the formalization of a negotiated agreement for a previously performed change. After approval by one contracting party, all copies should be sent to the other party for approval. Engineer should make distribution of executed copies after approval by both parties.

If a change only applies to price or to times, cross out the part of the tabulation that does not apply.

SECTION 01100

SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

A. Work described in this Project Manual includes the provision of labor, materials, equipment, and services required to complete the Water Supply and Treatment System Contract 4 – Reverse Osmosis Water Treatment Plant for Brunswick Regional Water and Sewer H2GO, Leland, North Carolina.

B. Contractor shall contact Andrew Thompson, Brunswick County Code Enforcement, for building and trade permits required for the project. Contact information is as follows: 75 Court House Dr. NE, Bolivia, NC 28422, 910-253-2200.

1.02 CONTRACTS

A. Project construction will be let under one Contract with construction including, but not limited to, the following major work items:
   1. Reverse Osmosis Equipment
      a. Reverse Osmosis equipment has been procured directly by Brunswick Regional Water and Sewer H2GO and fabricated by Harn R/O Systems, Inc., 310 Center Court, Venice, Florida, 34285, 941-488-9671, (fax) 941-488-9400. Primary contact is Ron Castle, roncastle@harnrosystems.com. This procurement contract will be assigned to the Contract 4 Contractor as part of the work incorporated into construction of the Reverse Osmosis Water Treatment Plant. The Harn Scope of Supply dated 6/17/17 is provided as Attachment 1 to this Specification Section. Contractor shall note that the membrane elements and R/O feed pumps were not provided with the equipment referenced in paragraph 1.02.A.1.d below and will be purchased and provided by the Owner in accordance with paragraph 1.02.A.1.d below.
      b. See "Project Manual – Reverse Osmosis Equipment Procurement" in Appendix A to this Project Manual. Assignment of Contract is included as Exhibits to Section 00520, Agreement of the Procurement Contract. While the procurement contract will be assigned to the Contractor, Brunswick Regional Water and Sewer H2GO will retain payment responsibilities to Harn R/O Systems for the duration of the Contract. Contractor shall be responsible for providing the necessary insurance coverage for inclusion of the equipment procurement assignment to their Contract. For reference the value of the Reverse Osmosis Equipment Procurement Contract is $2,314,268.
      c. Coordination with Harn R/O Systems, the Reverse Osmosis Equipment Manufacturer (ROEM), on the following major items
         1) Equipment dimensions and arrangement.
         2) Equipment installation coordination with ROEM on all pieces of ROEM equipment provided. It is anticipated the RO Treatment Trains will be delivered in several pieces and that the ROEM will be in full direction of assembly of the units at the site.
         3) Equipment start-up and performance testing of all equipment.

4) Operation and Maintenance Manuals and operator training.
5) Any other item for successful placement, testing, and connection of the equipment at the site.

d. The two (2) Reverse Osmosis skids and supporting equipment fabricated by Harn R/O Systems are held in storage. This equipment, with the exception of membrane elements and R/O feed pumps, is located at 9100 Lackey Rd NE, #6, Leland, NC 28451. Contractor shall include costs for the following in the Contract Lump Sum: Product handling at the Site including loading, transporting, unloading, uncrating, and storage; protection of products from elements and from damage; and labor, materials and equipment for installation, testing, and start-up for a complete and operable system.

e. Membrane elements and R/O Feed Pumps shall be purchased by the Owner and furnished to the Site by Harn R/O Systems. Contractor shall include costs for the following in the Contract Lump Sum: Applicable product handling at the Site including unloading, uncrating, and storage; protection of products from elements and from damage; and labor, materials and equipment for installation, testing, and start-up for a complete and operable system. The proposed Scope of Supply dated May 4, 2020 for the membrane elements, R/O feed pumps, and services to be provided by Harn R/O Systems is included as Attachment 2 to this Specification Section.

2. Well Site Work
   a. The Contractor shall supply and install two submersible well pumps at each of the five well site locations (a total of ten pumps).
   b. The Contractor shall provide all materials and perform all site work, equipment installation, piping, valves, electrical, controls, telemetry and any other work as shown on the Drawings for each of the five well site locations.
   c. A copy of Section 02526 – Water Supply Well from Contract 1, Well Construction is provided as Attachment 3 to the Specification Section for informational purposes.
3. Water Treatment Plant
   a. The work under this contract includes, but is not limited to, the furnishing or all labor, materials, tools, equipment, transportation, permits, certificates, and temporary protection necessary for, or incidental to, the execution and completion of the **site work** as indicated on the contract drawings and specified herein:
      1) Erosion control.
      2) Dewatering
      3) Clearing and Grubbing
      4) Site material removal/fill work and grading
      5) Excavation, trenching, and backfill
      6) Driveways and parking areas
      7) Concrete sidewalks and steps
      8) Chain link fences and gates
      9) Seeding and restoration
   b. The work under this contract includes, but is not limited to, the furnishing or all labor, materials, tools, equipment, transportation, permits, certificates, and temporary protection necessary for, or incidental to, the execution of

construction of the following major **new structures** as indicated on the contract drawings and specified herein:

1) Reverse Osmosis/Administrative Building
2) Carbon Dioxide System Roof
3) Calcite Contactor Facility
4) Pre-stressed Treated Water Storage Tank
5) High Service Pump Pad
6) Backwash Holding Tank
7) Metering and Chemical Injection Vaults

c. The work under this contract includes, but is not limited to, the furnishing or all labor, materials, tools, equipment, transportation, permits, certificates, and temporary protection necessary for, or incidental to, the execution of **installation** of the following major **new equipment** as indicated on the contract drawings and specified herein:

1) Raw Water and Finished Water Flow Meters
2) Scale Inhibitor Chemical Feed System
3) Cartridge Filters
4) Reverse Osmosis Equipment including RO Feed Pumps, RO Treatment Train and RO Flushing and Cleaning System. This equipment furnished under separate procurement bid with installation by Contractor.
5) Carbon Dioxide Feed System
6) Calcite Contactors
7) On-Site Sodium Hypochlorite Generation System
8) Caustic Chemical Feed System
9) Corrosion Inhibitor Chemical Feed System
10) Fluoride Chemical Feed System and FRP shelter
11) High Service Pumps (Vertical Turbine Pumps)
12) Submersible Pumps and Mixer (Backwash Tank)

d. The work under this contract includes, but is not limited to, the furnishing of all labor, materials, tools, equipment, transportation, permits, certificates, and temporary protection necessary for, or incidental to, the execution of various **new piping and valves** as indicated on the contract drawings and specified herein.

e. The work under this contract includes, but is not limited to, the furnishing of all labor, materials, tools, equipment, transportation, permits, certificates, and temporary protection necessary for, or incidental to, the furnishing and installation of various **plumbing and heating, ventilating, and air conditioning systems** as indicated on the contract drawings and specified herein.

f. The work under this contract includes, but is not limited to, the furnishing or all labor, materials, tools, equipment, transportation, permits, certificates, and temporary protection necessary for, or incidental to, the execution and completion of the following **electrical work and allied systems** as indicated on the contract drawings and specified herein:

1) Coordinate installation of new electrical service.
2) Power distribution equipment and circuitry for normal power supply.
3) Grounding system.
4) Indoor and outdoor lighting equipment and circuitry.
5) Heating and ventilating systems.

6) New motor control center, panelboards, lighting transformers, and control stations.
7) Telemetry and SCADA system

B. It is the intent of these specifications that the Owner be provided complete systems, functioning as required and meeting the requisites of all Federal, State, or local codes and regulations. The Contractor shall be responsible for compliance with the intent of the contract drawings and specifications.

1.03 WORK PERFORMED UNDER PREVIOUS CONTRACT

A. Contract 4 was originally bid on June 15, 2017 and the Contract was awarded for an Amended Scope of Work. Work performed under this previous contract, prior to Contract Termination by the Owner, generally included the following items:

1. Undercut of approximately three (3) feet of unsuitable material across the project site and backfill with suitable material. Limits of excavation include up to five (5) feet outside of the proposed plant site access road and calcite contactor facility. Unsuitable material was transported to, and suitable backfill material was received from, Sawmill Land and Sand located at 4380 Sawmill Road, Leland, NC. Contact information for Sawmill Land and Sand is slsand14@gmail.com and 910-471-2241. A copy of the soil testing reports performed by ECS Southeast, LLP are included as Attachment 4 to this specification section.
2. Provision of three (3) pump suction cans and three (3) 250 Hp motors for the Vertical Turbine High Service Pumps as specified in Section 11064. This equipment is currently stored by the Owner and shall be incorporated into the work of this Contract. Provision of the remainder of the equipment, not previously included, but required by this Section shall be as described in Section 01210 – Allowances.
3. Provision of system components for the Horizontal Calcite Contactor Vessels as identified in the Tonka Water Quotation dated 3/18/20 included in Section 01210 – Allowances and as specified in Section 13203. Equipment identified in Item B of the Quotation is currently stored by the Owner and shall be incorporated into the work of this Contract.

B. Contractor shall be responsible for scheduling and coordination of all work with the selected vertical turbine pump and calcite contactor suppliers.

1.04 WORK SEQUENCE

A. Construction Progress Schedule, as required in Section 01330, Submittal Procedures, shall indicate the anticipated items and times that the Work will interfere with normal facility operation.

B. Well construction is being completed under a separate contract performed by Skipper's Well Drilling & Pump Service, Inc. Once the wells are constructed and pumping tests completed, the final well pump selection will be made by the Engineer and the Contractor shall order the pumps. It is anticipated that well construction will be completed one well site at a time. The Contractor shall be prepared to order, deliver, and install all materials to finish all well site work at each well site location after the final Engineer approval of the submersible well pumps for that well site.

C. Based upon the previous work performed and described in Paragraph 1.03.A.1 above, it is recommended at a minimum that the upper 12 inches of the backfilled

area of the site be proof-rolled and recompacted to the project specifications prior to commencing additional earthwork at the site.

D. Settlements due to the 2 to 3 feet of new site fill shall be allowed to substantially complete prior to construction of settlement-sensitive structures. All site grading shall be completed prior to the construction of any structure.

E. Per the geotechnical report, settlement in the vicinity of the new 1 MG treated water storage tank may be expected. Preloading of the tank site was conducted in 2017 and it is recommended that the Contractor confirm with their soils testing firm if adequate compaction has been achieved relative to the anticipated settlement in the geotechnical report. Provide additional preloading of the tank site, if necessary, prior to constructing the new storage tank or adjacent foundations in order to stabilize settlement of the new structures. (Adjacent foundations include the High Service Pump Station, Backwash Storage Tank, CO2 Facility, and access drive north and east of tank.) Pre-loading shall occur early in the construction schedule to ensure adequate time for settlement stabilization.

F. Contractor is responsible for all construction activities that may interfere with normal operation of existing water distribution facilities. These activities shall be specifically noted on construction schedule. For each of these activities provide a detailed construction sequence.

G. Contractor is responsible for all scheduling and coordination of all work with the Reverse Osmosis Equipment (ROEM) Supplier Harn R/O Systems, Inc.

H. Indicate switchovers and cut-ins between new work and the existing Brunswick County water distribution system water supply on the construction schedule. Submit proposed date for switchover in writing to Engineer and Owner a minimum of seven (7) days and again 24-hours in advance of actual field work. Owner shall have the right to delay Work due to operational requirements, without additional cost to Owner.

1.05 OWNER OCCUPANCY

A. Owner will not occupy site during the period of construction.

B. Contractors shall cooperate with Owner to minimize conflict, and to facilitate Owner's operations.

1.06 CONTRACTOR USE OF SITE

A. Work is located within the Owners site and Rights-of-Way of the NC Department of Transportation. Requirements of the owners of the rights-of-way must be complied with and specifically as required in the permits attached to Section, Supplementary General Conditions.

B. Owner shall provide a staging area at the site as determined by the Owner and Contractor.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

ATTACHMENT 1
HARN R/O SYSTEMS SCOPE OF SUPPLY
DATED APRIL 17, 2017

Harn R/O SYSTEMS INC.

MEMBRANE WATER TREATMENT SYSTEMS

Brunswick Regional Water and Sewer H2GO
Reverse Osmosis Equipment Procurement

April 17, 2017

Harn R/O Systems (HRO) is pleased to present the following proposal for supplying the R/O equipment for the Brunswick Regional Water and Sewer H2GO Reverse Osmosis Membrane System Project. The scope of work includes two (2) 33/15 array 7 element reverse osmosis trains each capable of producing a nominal permeate production of 2.0 MGD @ 80% recovery as well as the ancillary components listed in the following scope of supply.

Acknowledged Addenda:

Addendum #1 – 03/31/2017
Addendum #2 – 04/07/2017

SCOPE OF SUPPLY

R/O EQUIPMENT– PER TRAIN

1. Provide one (1) 12", ductile iron, resilient seat butterfly valve fitted with a 316 stainless steel disk and stem, EPDM seat, and a 120 volt electric actuator with open/close limits to be installed upstream of the R/O high pressure feed pump.

2. Provide one (1) 4", ductile iron, resilient seat butterfly valve fitted with a 316ss disk and stem, EPDM seat, and a 120 volt electric actuator with open/close limits for isolation of the permeate flush line at the R/O train.

3. Provide one (1) high pressure R/O feed pump for each R/O train. The high pressure feed pump will be a Weir-Floway Model 14JKM 8-stage vertical turbine can pump. Pump shall have 316ss barrel, discharge head and bowl assemblies. Pump suction flange shall be 10" 150#, ANSI flange and discharge flange shall be 8", 300#, ANSI flange. Each R/O feed pump will be fitted with a 400 HP, 460 volt, 3 phase, 1800 RPM, premium efficiency WPI inverter duty ready motor complete with 120 volt space heater and motor winding thermostats. The R/O feed pump will be rated for 1,736 GPM @ 748' TDH.

4. Provide one (1) 8", 300# wafer, 316ss check valve on the discharge of the R/O high pressure feed pump.

5. Provide one (1) 8", 300# wafer, 316ss high performance butterfly valve with RTFE seat and a 120 volt electric actuator with open/close limits to be installed on the downstream side of the R/O high pressure feed pump.

310 CENTER COURT ♦ VENICE, FLORIDA 34285 ♦ (941-488-9671) ♦ FAX (941-488-9400)
Email: mainoffice@harnrosystems.com

6. Provide two (2) 8", 300# wafer, 316ss high performance butterfly valves with RTFE seats and manual gear handwheel operators on the 1st stage feed vertical manifolds to allow for isolating the 1st stage into two separate banks when cleaning.

7. Provide one (1) energy recovery device on each R/O train to transfer energy from the 2nd stage concentrate stream to the 2nd stage feed stream to boost its pressure. The energy recovery device shall be an ERI Model AT-1100. The external casing for the energy recovery device shall be duplex stainless steel.

8. Provide one (1) 4", 300# wafer, 316ss high performance butterfly valve with RTFE seat and manual lever operator on the 1st stage concentrate inlet to the energy recovery device for isolation.

9. Provide one (1) 4" 300# wafer, 316ss high performance butterfly valve with RTFE seat and manual lever operator on the 2nd stage concentrate inlet to the energy recovery device for isolation.

10. Provide one (1) 2", 300# control valve on the concentrate bypass line around the energy recovery device. Valve shall be 316ss and shall be designed to handle the full operating pressure drop without cavitation. Valve shall be fitted with a modulating, 120 volt electric actuator.

11. Provide one (1) 2", 300# wafer, 316ss high performance butterfly valve with RTFE seat and manual lever operator on the concentrate bypass line upstream of the control valve for isolation.

12. Provide one (1) 4", 150# wafer, 316ss check valve on the total concentrate line leaving the R/O train.

13. Provide one (1) R/O skid assembly for each R/O train to support pressure vessels, membrane elements, local control panels, local instruments, pressure gauges, pressure switches, high and low-pressure stainless steel piping and associated equipment. The skid assembly will be designed for a, 33/15 array with 7-element pressure vessels.

    Each train shall be designed for a nominal permeate production rate of 2.0 MGD @ 75% recovery. Frame assembly shall be constructed of Extren Series 500 fiberglass structural shapes, sanded, primed with a two-part high solids urethane primer and finished coated with a white high gloss polyurethane topcoat. Aluminum or stainless steel will be used for all fasteners and supports.

14. Provide thirty-three (33) Protec side-ported, 8" diameter fiberglass brackish water 1st stage pressure vessels for each R/O train. Pressure vessels will be sized to contain 7, 40" long, 8" diameter membrane elements. Pressure vessels will be rated for a working pressure of 450 psi and will be ASME Code designed and stamped. All side ports will be fabricated from super austenitic stainless steel and will be sized in accordance with the membrane manufacturer's recommendations.

15. Provide fifteen (15) Protec side-ported, 8" diameter fiberglass brackish water 2nd stage pressure vessels for each R/O train. Pressure vessels will be sized to contain 7, 40" long,

8" diameter membrane elements. Pressure vessels will be rated for a working pressure of 600 psi and will be ASME Code designed and stamped. All side ports shall be fabricated from super austenitic stainless steel and will be sized in accordance with the membrane manufacturer's recommendations.

16. Provide three hundred and thirty-six (336) Lanxess 8", 400 square foot membrane elements for each R/O train. Membrane elements shall be Lanxess Model B400 LE ASD. The membrane elements shall be rated for a permeate production rate of 9,200 gpd at a stabilized salt rejection of 99.5% based on standard test conditions.

    If Harn R/O is the successful bidder we are willing to supply either Hydranautics or Toray's offerings at no additional charge if further evaluation determines that supplying one of those two products in lieu of the Lanxess offering is in the best interest of the Owner.

17. Provide schedule 40, 316L stainless steel feed, interstage and concentrate pipe manifolds as specified. Pulled tees will be used on the manifolds for connection to the pressure vessels by grooved-type flexible couplings. Stainless steel piping will be passivated and and bead blasted to a uniform finish.

18. Provide schedule 5, 316" stainless steel permeate pipe manifolds as specified. Permeate piping shall be fabricated from NSF61 certified pipe and fittings as specified. However, the fabricated manifolds will not be NSF61 certified.

19. Provide 1 ¼" schedule 80 PVC pipe and fitting necessary to connect the permeate port on each pressure vessel to the 316L stainless steel permeate collection manifolds.

20. Provide one (1) 10", 150# wafer, 316ss check valve on the total permeate line leaving the R/O train.

21. Provide one (1) 8", 300# lugged, 316ss high performance butterfly valve with RTFE seat and a manual gear handwheel operator for 1st stage cleaning feed isolation.

22. Provide one (1) 8", 300# lugged, 316ss high performance butterfly valve with RTFE seat and a manual gear handwheel operator for 1st stage cleaning return isolation.

23. Provide one (1) 6", 300# lugged, 316ss high performance butterfly valve with RTFE seat and a manual lever operator for 2nd stage cleaning feed isolation.

24. Provide one (1) 6", 300# lugged, 316ss high performance butterfly valve with RTFE seat and a manual lever operator for 2nd stage cleaning return isolation.

25. Provide one (1) 10", 150# wafer, 316ss check valve on the total permeate line of each R/O train.

26. Provide instrumentation package for each R/O train to include the following:

    - One (1) permeate conductivity analyzer with sensor and 4-20 mA output
    - One (1) concentrate conductivity analyzer with sensor and 4-20 mA output

- One (1) 1st stage permeate flow magmeter with 4-20 mA output
- One (1) 2nd stage permeate flow magmeter with 4-20 mA output
- One (1) concentrate flow magmeter with 4-20 mA output
- One (1) 1st stage feed pressure transmitter with 4-20 mA output
- One (1) 1st stage concentrate pressure transmitter with 4-20 mA output
- One (1) 2nd stage feed pressure transmitter with 4-20 mA output
- One (1) 2nd stage concentrate pressure transmitter with 4-20 mA output
- One (1) total permeate pressure transmitter with 4-20 mA output
- One (1) Ashcroft feed pump low suction pressure switch
- One (1) Ashcroft feed pump high discharge pressure switch
- One (1) 4 ½" local mount, stainless steel liquid filled pressure indicator for monitor feed pump suction pressure
- One (1) 4 ½" local mount, stainless steel liquid filled pressure indicator for monitoring feed pump discharge pressure
- One (1) 5-way selector valve with 4 ½" panel mount, stainless steel, liquid filled pressure indicator for monitoring 1st stage feed, 1st stage concentrate, 2nd stage feed and 2nd stage concentrate pressures.
- One 1) 4 ½" panel mount, stainless steel, liquid filled pressure indicator for monitoring total permeate pressure.

  Instrumentation shall be manufactured by an approved supplier as listed in the specifications.

27. Provide one (1) custom fabricated fiberglass sample panel on each R/O train. Sample valves will be provided to sample feed, interstage and concentrate streams, individual permeate streams from each vessel, 1st stage permeate, 2nd stage permeate, and total permeate. Low-pressure sample lines will be 300 psi rated ¼" nylon tubing with PVC Asahi labcock valves. High pressure sample lines will be 600 psi rated ¼" black nylon tubing with Swagelok type stainless steel plug valves. Sample valves will be fitted with PVC vertical downspouts directing flow into a 6" wide x 4" deep white PVC sample trough. Sample panel will be primed and painted to match R/O skid assembly.

28. Provide one (1) 120V control panel for each R/O train. Each control panel will consist of a NEMA 4X fiberglass control cabinet integrally mounted in the R/O train instrument panels and include a PanelView 1000+ operator interface, Contrologix L71 Ethernet CPU, Contrologix I/O modules (analog and discrete), ethernet fast switch, 24VDC and 120VAC power supply, control relays for outputs, surge suppression, emergency stop pushbutton, uninterruptible power supply and miscellaneous internal components. The touch screen will be programmed to display process equipment graphics, alarm and process set point selection and manual component operation.

SCALE INHIBITOR SYSTEM

29. Provide one (1) Grundfos duplex pump scale inhibitor feed skid. Grundfos pumps shall be Model DDA FCM series mechanical diaphragm pumps as specified. Packaged chemical feed system shall be self-contained and shall include calibration columns, back pressure valves, pressure relief valves, pulsation dampeners, pipe, fittings, valves, GFI outlet, power box and wiring junction box as specified to provide a complete system.

30. Provide one (1) 300-gallon scale inhibitor storage tank. Top and side wall connections shall be provided as per the specifications.

31. Provide one (1) ultrasonic level transmitter for measuring the level in the scale inhibitor storage tank.

32. Provide one (1) variable area flowmeter for measuring scale inhibitor flow. Flow meter shall have a stainless steel body, ¼" FNPT piping connections and a 4-20 mA output signal.

R/O FLUSH SYSTEM COMPONENTS

33. Provide one (1) 8,500 gallon polyethylene flush water tank. Tank shall be fitted with a magnetic flag type level gauge with ball valve isolation at the bottom connection. Top and side wall flange connections shall be provided as per the specifications.

34. Provide one (1) ultrasonic level transmitter for measuring the level in the flush water tank.

35. Provide one (1) 6" motorized flush inlet valve. Valve shall be an Asahi Type 57 PVC butterfly valve with a Series 92 electric actuator.

36. Provide two (2) flush pumps. Pumps shall be Grundfos or Goulds 316ss vertical multistage in-line centrifugal pumps. Pumps shall be rated for a flowrate of 175 GPM @ 80' TDH. Each pump shall be fitted with a 7.5 HP, 230/460 volt, 3 phase, 3600 rpm premium efficient TEFC motor with normally closed thermostats for thermal protection.

R/O CLEANING SYSTEM COMPONENTS

37. Provide one (1) 3,500 gallon polyethylene cleaning tank. Tank shall be fitted with a magnetic flag type level gauge with ball valve isolation at the bottom connection. Top and side-wall flange connections shall be provided as per the specifications.

38. Provide one (1) 3,500 gallon polyethylene waste tank. Tank shall be fitted with a magnetic flag type level gauge with ball valve isolation at the bottom connection. Top and side-wall flange connections shall be provided as per the specifications.

39. Provide one (1) 480V, 3 phase, 82 kW flanged immersion heater to be installed in the cleaning tank. Heater shall have a 6", 150#, 304ss ANSI flange with 316ss heating elements.

40. Provide one (1) Lightnin Model 14Q2 waste tank mixer. Mixer wetted parts shall be 316ss. Mixer shall be fitted with a 2 HP, 230/460 volt, 3 phase, 1800 rpm TEFC motor.

41. Provide one (1) CIP cleaning pump. The cleaning pump will be a horizontal end suction pump with 316ss wetted components. Pump shall have a 4" 150# suction flange and a 3" 150# discharge flange. CIP pump will be rated for 840 GPM @ 160' TDH. CIP pump will be fitted with a 75 HP, 460 volt, 3 phase, 3600 RPM, premium efficienct TEFC

inverter duty ready motor complete with normally closed thermostats for thermal protection. Each CIP pump will be rated for 1,500 gpm @ 60 psi.

42. Provide one (1) FilTrek 316L stainless steel CIP cartridge filter housing. The cartridge filter housing will be sized to contain 52, 40-inch 5-micron cartridge filter elements. Cartridge filter housing shall be fabricated in accordance with applicable ASME code design for pressure vessels.

    The cartridge filter housing will be provided with 8" flanged inlet/outlet, 2" NPT drains and ½" NPT gauge and vent ports. The filter housing shall be bead-blasted inside and out. The filter housing will be rated for 4.04 gpm per 10" equivalent filter length at the specified flow rate of 840 gpm.

43. Provide two hundred and sixty (260) 5 micron, 40 inch long single open end cartridge filter elements. Cartridge material shall be FDA grade polypropylene with NSF61 approval. Cartridge filter elements provided is enough to supply two (2) sets for start-up testing and an additional three (3) spare sets as per the requirements of the specification.

44. Provide one (1) differential pressure transmitter for measuring the pressure difference between the inlet and the outlet of the cleaning cartridge filter.

MISCELLANEOUS COMPONENTS & SPARE PARTS

45. Provide one (1) manual SDI kit with 500 filter pads.

46. Provide spare parts to include the following:

    - Twenty (20) pressure vessel end cap retaining rings
    - Twenty (20) pressure vessel permeate port retaining rings
    - Twenty (20) pressure vessel feed/concentrate port seals
    - Twenty (20) pressure vessel PWT seals
    - Twenty (20) pressure vessel head seals
    - Twenty (20) pressure vessel permeate port seals
    - Forty (40) membrane interconnector o-rings
    - Forty (40) membrane brine seals
    - Ten (10) grooved coupling seals for each sized used to connect to the pressure vessels
    - Two (2) grooved coupling seals for each additional size used
    - One (1) service kit for each size valve and actuator supplied if available
    - One (1) service kit for each type of instrument supplied if available

ADDITIONAL SERVICES

47. Provide a one-year material and workmanship warranty from the date of substantial completion for all components of the system. Membrane elements to be provided with an additional four-year pro-rated performance warranty provided by membrane manufacturer.

48. Provide one (1) electronic copy of submittal documentation

49. Provide one (1) electronic copy of O&M documentation

50. Provide ten (10) days of onsite installation supervision by a Harn R/O installation technician during one (1) 2-week trip to the jobsite to supervise the installation of the membrane equipment by the Contractor as per the requirements of Specification Section 13510.3.01.

51. Provide five (5) days of onsite orifice testing by a Harn R/O senior technician and Harn R/O process engineer prior to functional test the R/O equipment prior to membrane loading as per the requirements of Specification Section 13510.3.02.

52. Provide four (4) days of onsite supervision by a Harn R/O senior technician during one (1) trip to the jobsite to supervise the installation of the membrane elements by the Contractor. Membrane installation supervision shall be provided as per the requirement of Specification Section 13510.3.03.

53. Provide three (3) days of onsite start-up testing of the R/O equipment by a Harn R/O senior technician and Harn R/O process engineer after the membrane elements have been loaded. Start-up testing shall be provided to meet the requirements of Specification Section 13510-3.04.

54. Provide five (5) days of onsite performance testing by a Harn R/O senior technician and Harn R/O process engineer after completion of the start-up testing of the R/O equipment as per Specification Section 13510-3.05.

55. Provide water quality testing for the feed, permeate and concentrate streams during the performance testing as per Specification section 13510-3.05. The number of samples shall be limited to five (5) feed water samples, ten (10) permeate samples and ten (10) concentrate samples. Constituents that are tested for shall be limited to those listed in Specification Section 13510-1.03.A.

56. Provide two (2) days of operator hands-on and classroom training by a Harn R/O senior technician and Harn R/O process engineer as per the requirements of Specification Section 13540-2.05.

57. Provide two (2) days of membrane cleaning assistance by a Harn R/O senior technician within one-year of start-up as per the requirements of Specification Section 13540-3.06.

58. Provide one (1) day of additional training by a Harn R/O senior technician within one-year of start-up as per the requirements of Specification Section 13540-3.07.

310 CENTER COURT ♦ VENICE, FLORIDA 34285 ♦ (941-488-9671) ♦ FAX (941-488-9400)
Email: mainoffice@harnrosystems.com

EXCEPTIONS AND CLARIFICATIONS

- Shipment and insurance from HRO facility to the job site is ***included***.
- 6.75% Sales Tax is ***included***.
- Performance and Payment Bond is ***included***.
- Installation of the above equipment is ***excluded***.
- Contractor to provide onsite installation of the R/O equipment while Harn R/O technician is on-site for installation supervision. Contractor is responsible for providing adequate labor to install the equipment within the two week of on-site installation included in our scope of supply.
- Spare parts are limited to those specifically included in the above scope of supply. Any additional spare parts are ***excluded***.
- VFD's are ***excluded***.
- Limits of all piping connections will be as detailed in the Engineer's design drawings provided as part of the bid package. Contractor shall be responsible for providing all necessary fittings and hardware to connect to our termination points.
- Flush System and CIP System components shall be shipped loose to the jobsite for installation by the contractor. All interconnecting piping valves, fittings, etc. not specifically detailed in our above scope of supply are ***excluded*** and will be furnished and installed by the Contractor.
- All interconnecting Flush System and CIP System piping from the Flush System and the CIP System to the R/O skids is ***excluded*** and will be furnished and installed by the Contractor.
- Scale Inhibitor System components shall be shipped loose to the jobsite for installation by the Contractor. All interconnecting piping, valves, fittings, etc. not specifically detailed in our above scope of supply are ***excluded*** and will be furnished and installed by the Contractor.
- All interconnecting connecting chemical feed piping, valves, and accessories from the Scale Inhibitor System to the R/O skids is ***excluded*** and will be furnished and installed by the Contractor.
- Anchor bolts are ***excluded.***
- Grout pads necessary to install the equipment are ***excluded*** and will be furnished and installed by the contractor.

- A Harn R/O technician will only be on-site during regular business hours from 8 AM – 5 PM, Monday – Friday. A service technician is available by phone 24/7 if an issue were to occur with the R/O equipment when a technician is not on-site. Contractor or Owner is responsible for providing additional qualified staffing as necessary for any operation of equipment that is required to occur outside of these specified time periods.
- On-site service days are limited to those described in the above scope of supply. Any additional on-site time requested by the contractor shall be billed at a per diem rate of $850/day plus expenses for each technician.
- Membrane installation is ***excluded*** and will be provided by the Contractor under direct supervision of a Harn R/O technician. Contractor will be responsible for providing a minimum of four men to install the membrane elements. Contractor shall be responsible for providing all necessary tools, scaffolding and additional materials that are needed to install the membrane elements. Contractor shall be responsible for providing for the disposal of the packaging from the membrane elements.
- Water, power, chemicals, bacteriological testing, hydrostatic testing and any water quality sampling or laboratory analysis not specifically included in the above scope of supply is ***excluded*** and will be provided by the Contractor or Owner as needed.
- Power, control wiring and conduit from the skid mounted control panels to the instrumentation mounted on the R/O train instrument panels is ***included***.
- Power, control wiring and conduit from the skid mounted control panels to the valves and instrumentation mounted at the R/O feed pumps is ***excluded*** and will be provide and installed by the Contractor.
- Power, control wiring and conduit to the skid mounted control panels is ***excluded*** and will be provided by the Contractor.
- Power, control wiring and conduit outside the limits of HRO provided panels and skids are ***excluded***.
- SCADA system is ***excluded*** and will be provided and installed by others.
- Factory pressure testing of the R/O trains is ***excluded***. Individual stainless steel pipe manifolds will be pressure tested to 1.5x operating pressure prior to shipment to the jobsite. Pressure testing will be witnessed by one of our PE's on staff.
- See attached pump/motor proposal for vendor exceptions.
- Membrane manufacturer's proposed warranty has been included as part of our bid.

FOR THE SUM OF: .....See Bid Form

ESTIMATED SCHEDULE:

- **Submittals: 8-10 weeks after receipt of Notice to Proceed.**
- **Delivery: As required to meet the Contractors installation schedule or a minimum of 20-24 weeks following submittal approval, whichever is later.**

PAYMENT TERMS:

Monthly draws based on an approved schedule of values and percent of completion for work in process at both Harn R/O Systems, Inc. manufacturing facility and on site with 10% retainage to be reduced to 5% upon completion of 50% of the work. Proposal is valid for 60 days, after that time proposal may be withdrawn or price escalations may apply.

ATTACHMENT 2
HARN R/O SYSTEMS SCOPE OF SUPPLY
DATED MAY 4, 2020

Harn R/O SYSTEMS INC.

MEMBRANE WATER TREATMENT SYSTEMS

May 4, 2020

The Wooten Company
Attn: Charles Davis
120 North Boylan Avenue
Raleigh, NC 27603

Re: R/O Equipment Procurement – Brunswick Regional Water and Sewer H2GO

Mr. Davis,

Harn R/O Systems is pleased to present the following Change Order revision to our Contract that is required for the re-implementation and completion of this project. I have detailed below the engineering, materials and labor that Harn will provide in order to complete this project. The scope outlined in the proposal below shall supersede all requirements of the original project specifications and shall constitute all of the services Harn R/O Systems shall be responsible for providing.

1. Provide two (2) high pressure R/O feed pumps. The high pressure feed pump will be a Weir-Floway Model 14JKM 8-stage vertical turbine can pump. Pumps shall have 316ss barrel, discharge head and bowl assemblies. Pump suction flange shall be 10" 150#, ANSI flange and discharge flange shall be 8", 300#, ANSI flange. Each R/O feed pump will be fitted with a 400 HP, 460 volt, 3 phase, 1800 RPM, premium efficiency WPI inverter duty ready motor complete with 120 volt space heater and motor winding thermostats. The R/O feed pumps to be as previously submitted and approved for this project. New submittal documents shall be provided by the manufacturer.

2. Provide six hundred and seventy-two (672) Lanxess 8", 400 square foot membrane elements, three hundred and thirty (336) for each R/O train. Membrane elements shall be Lanxess Model B400 LE ASD. The membrane elements shall be rated for a permeate production rate of 9,200 gpd at a stabilized salt rejection of 99.5% based on standard test conditions. Membrane elements and membrane element warranty to be as previously submitted and approved for this project.

3. Provide one (1) electronic copy of O&M documentation.

4. Provide up to ten (10) days of onsite installation supervision by a Harn R/O installation technician during one (1) 2-week trip to the jobsite to supervise the installation of the membrane equipment, currently stored off-site, by the Contractor as per the requirements of Specification Section 13510.3.01. Contractor shall be responsible for transportation of all stored equipment to the jobsite.

5. Provide up to five (5) days of onsite orifice testing by a Harn R/O senior technician and/or Harn R/O process engineer to functional test the R/O equipment prior to membrane loading as per the requirements of Specification Section 13510.3.02.

6. Provide up to four (4) days of onsite supervision by a Harn R/O senior technician during one (1) trip to the jobsite to supervise the installation of the membrane elements by the Contractor. Membrane installation supervision shall be provided as per the requirement of Specification Section 13510.3.03.

310 CENTER COURT ♦ VENICE, FLORIDA 34285 ♦ (941-488-9671) ♦ FAX (941-488-9400)
Email: mainoffice@harnrosystems.com

7. Provide up to three (3) days of onsite start-up testing of the R/O equipment by a Harn R/O senior technician and/or Harn R/O process engineer during one (1) trip to the jobsite after the membrane elements have been loaded. Start-up testing shall be provided to meet the requirements of Specification Section 13510-3.04.

8. Provide up to five (5) days of onsite performance testing by a Harn R/O senior technician and/or Harn R/O process engineer during one (1) trip to the jobsite after completion of the start-up testing of the R/O equipment as per Specification Section 13510-3.05.

9. Provide water quality testing for the combined feed water stream as well as the permeate and concentrate streams from each R/O train during the performance testing as per Specification section 13510-3.05. The total number of samples taken shall be limited to five (5) combined feed water samples, ten (10) permeate samples (five per train), and ten (10) concentrate samples (five per train). Constituents that are tested for shall be limited to those listed in Specification Section 13510-1.03.A.

10. Provide two (2) days of operator hands-on and classroom training by a Harn R/O senior technician and/or Harn R/O process engineer during one (1) trip to the jobsite as per the requirements of Specification Section 13540-2.05.

11. Provide two (2) days of membrane cleaning assistance by a Harn R/O senior technician during one (1) trip to the jobsite within one-year of start-up as per the requirements of Specification Section 13540-3.06.

12. Provide one (1) day of additional training by a Harn R/O senior technician within one-year of start-up as per the requirements of Specification Section 13540-3.07.

EXCEPTIONS AND CLARIFICATIONS

- Shipment of the membrane elements and the feed pumps to the job site is ***included***. Owner or Contractor shall be responsible for unloading equipment upon receipt of delivery and for providing proper off-site storage if they are unable to store the equipment at the jobsite when notified that it is ready to be shipped. If equipment is stored off-site Owner or Contractor shall be responsible for subsequent transport of equipment back to the jobsite.
- 6.75% Sales Tax is ***included***.
- The value of the existing Performance and Payment bond shall be modified to reflect the change in contract value once change order has been approved.
- Equipment warranty shall be limited to a 1-year manufacturer's warranty provided for the R/O feed pumps and a 3-year performance warranty provided by the membrane manufacturer that was previously submitted and approved. No additional warranty shall be provided on the equipment currently being kept in storage by the Owner.
- Contractor to provide onsite installation of the R/O feed pumps and additional equipment currently in storage while Harn R/O technician is on-site for installation supervision. Contractor is responsible for providing adequate labor to install the equipment within the two weeks of on-

site installation included in our scope of supply. Any additional time required will be billed at the per diem rate detailed below.

- R/O Feed Pump VFD's are ***excluded***.
- All anchor bolts and grout pads necessary to install the equipment are ***excluded*** and will be furnished and installed by the contractor.
- Contractor shall be responsible for providing all necessary interconnecting piping. Harn shall provide no additional components beyond what has already been delivered to the Owner and what is detailed in this scope of supply.
- Contractor shall be responsible for providing all necessary power, control wiring and conduit needed to provide a fully operational system.
- Membrane installation is ***excluded*** and will be provided by the Contractor under direct supervision of a Harn R/O technician. Contractor will be responsible for providing a minimum of four men to install the membrane elements. Contractor shall be responsible for providing all necessary tools, scaffolding and additional materials that are needed to install the membrane elements. Contractor shall be responsible for providing for the disposal of the packaging from the membrane elements.
- A Harn R/O technician will only be on-site during regular business hours from 8 AM – 5 PM, Monday – Friday. A service technician is available by phone 24/7 if an issue were to occur with the R/O equipment when a technician is not on-site. Contractor or Owner is responsible for providing additional qualified staffing as necessary for any operation of equipment that is required to occur outside of these specified time periods.
- On-site service days are limited to those described in the above scope of supply. Any additional on-site time requested by the contractor shall be billed at a per diem rate of $1,200/day plus expenses for each technician.
- Water, power, chemicals, bacteriological testing, hydrostatic testing and any water quality sampling or laboratory analysis not specifically included in the above scope of supply is ***excluded*** and will be provided by the Contractor or Owner as needed.
- Contractor shall be responsible for providing any temporary piping or other provisions required to dispose of all water used during testing of the R/O equipment, membrane storage solution and off-spec permeate produced prior to placing the R/O trains into service.
- SCADA system is ***excluded*** and will be provided and installed by others.
- All previous versions of this scope of supply are no longer valid.

ESTIMATED SCHEDULE:

- Submittals: Feed pump submittals to be provided within 8-10 weeks. No additional submittal documentation to be provided.
- Feed Pump Delivery: Estimated delivery is 30-36 weeks once pumps have been released for fabrication.
- Membrane Element Delivery: Estimated delivery is 1st Quarter 2021. Owner to provide Contractor's project schedule to Harn once one is available so that we can notify the membrane manufacturer of any necessary changes to their delivery schedule.
- On-site Services: A minimum of 1-month notice to be provided for all Harn field service visits listed above.

PAYMENT TERMS:

Monthly draws based on previously approved schedule of values and percent of completion for work in process at the equipment manufacturer's facility and at the job site. Proposal is valid for 30 days, after that time proposal may be withdrawn or price escalations may apply.

ATTACHMENT 3
CONTRACT 1 – WELL CONSTRUCTION
SECTION 02526 -WATER SUPPLY WELL

SECTION 02526

WATER SUPPLY WELL - GRAVEL PACKED

PART 1 GENERAL

1.01 SCOPE

A. Provide labor, materials and equipment required to construct the gravel packed, deep water supply wells as indicated on the Drawings and specified herein. The Work shall include, but not be limited to, the following:
   1. Well Site 2
      a. Well 2 PD (PWS code 02P)
      b. Well 2 BC (PWS Code 02B)
   2. Well Site 3
      a. Well 3 PD (PWS code 03P)
      b. Well 3 BC (PWS code 03B)
   3. Well Site 4
      a. Well 4 PD (PWS code 04P)
      b. Well 4 BC (PWS code 04B)
   4. Well Site 5
      a. Well 5 PD (PWS code 05P)
      b. Well 5 BC (PWS code 05B)
   5. Testing.
   6. Well disinfection.
   7. Site clean up.

B. Bid shall be based on the quantities and settings as specified herein. Adjustment in contract price and time for completion shall be made in accordance with the General Conditions of these specifications.

C. Well will be constructed on the property of the Owner. Well site property corners have been staked. Provide required surveying for the exact location of the well on the site as indicated on the Drawings.

D. Specifications provide a general description of the work and do not cover the details and variations that may occur during well construction. It is intended that the Contractor provide a complete well whether or not all work is specifically detailed.

1.02 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. American Water Works Association (AWWA) Standards
      a. A100 Water Wells
   2. North Carolina Administrative Code, Title 15A (NCAC)
      a. 2C, Well Construction Standards
      b. 27, Well Contractor Certification Rules
      c. 18C, Water Supplies

3. Ground Water and Wells - Second edition published by Johnson Division, St. Paul, Minnesota 55112.

1.03 DESCRIPTION

A. General: The eight wells listed in paragraph 1.01.A shall be constructed under this contract. Wells with the "PD" designation will be shallow wells drawing water from the Lower Peedee Aquifer. The expected chloride content for PD wells is between 2,000 ppm to 2,500 ppm. The expected yield is 600 gpm based upon nearby test well data. Wells with the "BC" designation will be deep wells drawing water from the Black Creek Aquifer. The expected chloride content for BC wells is between 4,500 ppm to 4,750 ppm. The yield is expected to be 900 gpm.

The water will be pumped to a Reverse Osmosis Plant for treatment.

During the development and construction of each well, waste (excess) water will be piped to a temporary holding pit where the wastewater will be clarified to remove settleable solids. From the temporary pit, wastewater will be pumped to the designated discharge point shown on the drawings. Coordinate accordingly. Mud and turbid water must first discharge into the temporary mud pit prior to entering the designated discharge point (i.e. only non-turbid water shall be discharged into basin or ditch). Contractor shall install measures to prevent erosion at the discharge site.

The size and location of the mud pit shall be submitted during shop drawing review. The mud pit may be bypassed if the quality of the wastewater is suitable for direct discharge to the designated discharge point as determined by the Engineer.

B. Well 2 PD (02P)
   1. Pilot hole shall be 395 feet deep and a minimum of 4 inches in diameter.
   2. Production well construction shall consist of the following:
      a. Total Depth: 365 feet.
      b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
      c. Inner Casing: 290 feet of 12 inches diameter casing (0.25 inch Sch 20 type 316 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.
      d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.
   3. Minimum production capacity: 600 gpm
   4. Min Casing Thickness:
      a. Outer Casing 22 inch dia., 0.375 inch Steel
      b. Inner Casing 12 inch dia., 0.25 inch Sch 20 Stainless Steel

C. Well 2 BC (02B)
   1. Pilot hole shall be 565 feet deep and a minimum of 4 inches in diameter.
   2. Production well construction shall consist of the following:
      a. Total Depth: 535 feet.
      b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
      c. Inner Casing: 460 feet of 12 inches diameter casing (0.375 inch Sch 40 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.

d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.

3. Minimum production capacity: 900 gpm
4. Min Casing Thickness:
   a. Outer Casing 22 inch dia. 0.375 inch Steel
   b. Inner Casing 12 inch dia., 0.375 inch Sch 40 Stainless Steel

D. Well 3 PD (03P)
1. Pilot hole shall be 375 feet deep and a minimum of 4 inches in diameter.
2. Production well construction shall consist of the following:
   a. Total Depth: 345 feet.
   b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
   c. Inner Casing: 270 feet of 12 inches diameter casing (0.25 inch Sch 20 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.
   d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.
3. Minimum production capacity: 600 gpm
4. Min Casing Thickness:
   a. Outer Casing 22 inch dia., 0.375 inch Steel
   b. Inner Casing 12 inch dia., 0.25 inch Sch 20 Stainless Steel

E. Well 3 BC (03B)
1. Pilot hole shall be 540 feet deep and a minimum of 4 inches in diameter.
2. Production well construction shall consist of the following:
   a. Total Depth: 510 feet.
   b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
   c. Inner Casing: 435 feet of 12 inches diameter casing (0.375 inch Sch 40 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.
   d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.
3. Minimum production capacity: 900 gpm
4. Min Casing Thickness:
   a. Outer Casing 22 inch dia. 0.375 inch Steel
   b. Inner Casing 12 inch dia., 0.375 inch Sch 40 Stainless Steel

F. Well 4 PD (04P)
1. Pilot hole shall be 395 feet deep and a minimum of 4 inches in diameter.
2. Production well construction shall consist of the following:
   a. Total Depth: 365 feet.
   b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
   c. Inner Casing: 290 feet of 12 inches diameter casing (0.25 inch Sch 20 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.

d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.

3. Minimum production capacity: 600 gpm
4. Min Casing Thickness:
   a. Outer Casing 22 inch dia., 0.375 inch Steel
   b. Inner Casing 12 inch dia., 0.25 inch Sch 20 Stainless Steel

G. Well 4 BC (04B)
1. Pilot hole shall be 570 feet deep and a minimum of 4 inches in diameter.
2. Production well construction shall consist of the following:
   a. Total Depth: 540 feet.
   b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
   c. Inner Casing: 465 feet of 12 inches diameter casing (0.375 inch Sch 40 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.
   d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.
3. Minimum production capacity: 900 gpm
4. Min Casing Thickness:
   a. Outer Casing 22 inch dia. 0.375 inch Steel
   b. Inner Casing 12 inch dia., 0.375 inch Sch 40 Stainless Steel

H. Well 5 PD (05P)
1. Pilot hole shall be 390 feet deep and a minimum of 4 inches in diameter.
2. Production well construction shall consist of the following:
   a. Total Depth: 360 feet.
   b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
   c. Inner Casing: 285 feet of 12 inches diameter casing (0.25 inch Sch 20 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.
   d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.
3. Minimum production capacity: 600 gpm
4. Min Casing Thickness:
   a. Outer Casing 22 inch dia., 0.375 inch Steel
   b. Inner Casing 12 inch dia., 0.25 inch Sch 20 Stainless Steel

I. Well 5 BC (05B)
1. Pilot hole shall be 560 feet deep and a minimum of 4 inches in diameter.
2. Production well construction shall consist of the following:
   a. Total Depth: 530 feet.
   b. Outer Casing: 100 feet of 22 inch diameter steel casing, installed concentrically in a 30 inch diameter bore hole and cemented in place.
   c. Inner Casing: 455 feet of 12 inches diameter casing (0.375 inch Sch 40 stainless), installed concentrically in the 22 inch diameter outer casing and a minimum 20.8 inch diameter bore hole.

d. Screens: 75 feet of 12 inch diameter, continuous slot vee-wire type 316 stainless steel (12-P, max depth 600 feet, OD 12.8", ID 11.9", collapse PSI of 290), installed concentrically in a minimum 20.8 inch diameter bore hole.

3. Minimum production capacity: 900 gpm
4. Min Casing Thickness:
   a. Outer Casing 22 inch dia. 0.375 inch Steel
   b. Inner Casing 12 inch dia., 0.375 inch Sch 40 Stainless Steel

J. Submit the following in accordance with Section, Submittal Procedures:
1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met. Submit for each of the following materials:
   a. Outer Casing Material
   b. Inner Casing Material
2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
   a. Grout (type, additives, weight and volume)
   b. Screen (material, recommended aperture and supporting calculations)
   c. Gravel Pack (Mineral Content and Sieve Analysis)
3. Samples
   a. Drill Cuttings (two sets bagged)
4. Test and Field Reports: Submit for the following:
   a. Driller's Log
   b. Resistivity and Spontaneous Potential Logs
   c. Gamma Log
   d. Sieve Analyses of the Water Bearing Formations (every 10 feet)
   e. 24-Hour drawdown test.
   f. As Built Drawings
   g. Water Quality Analyses
   h. Water Well Completion Report, NCDENR Format
   i. Development Plan (Additives, and Methods)
   j. Weekly Progress Reports in the form of Daily Drillers Log.

1.04 QUALITY ASSURANCE

A. Quality assurance shall be as required in Section, Quality Control and the following requirements.

B. Construction shall be in accordance with AWWA A100, 15A NCAC 2C, and as specified herein.

C. Qualifications
1. Properly certified by the State of North Carolina in accordance with NCAC, Title 15A, Chapter 27, Well Contractor Certification Rules.
2. Pump installer shall be properly registered with the State of North Carolina in accordance with NCAC, Title 15A, 2C, .0103
3. Provide an experienced superintendent thoroughly knowledgeable in well drilling operations and capable of maintaining proper logs and daily reports.

D. Sand Free: Well shall be guaranteed to be reasonably sand free at all times. Reasonable sand freeness shall be defined as follows.
1. When pumping at rated capacity without surging – less than 5 ppm of sand per gallon of water when sampled by a Rossum Sand Tester.

2. When surging well from 50% to 150% of rated capacity - not more than four particles of sand per gallon of water.

E. Samples shall be taken from the open end of discharge pipe by holding container at the bottom of the discharge stream. If well produces sand in excess of the above stated amounts, Contractor may resume development work but shall be entitled to no additional compensation for additional work. If Contractor is unable to comply with this requirement, Purchaser has the right to reject the installation with no obligation on either side.

F. Efficiency
   1. The Contractor shall guarantee that the completed production well shall have a 24-hour well efficiency of at least 75%. The 24-hour well efficiency shall be determined by dividing, (a) the actual specific capacity achieved after pumping 24 hours at a pre-selected constant capacity (determined from the Preliminary Aquifer Pumping Test and as approved by Engineer) by (b) the theoretical specific capacity obtainable from the transmissivity of the aquifer as determined by evaluation of the pumping test data by Engineer. (This method is from Groundwater and Wells, 2nd edition, P554 through 559, by Fletcher Driscoll, 1986).
   2. The theoretical 24-hour specific capacity in GPM per foot of drawdown is defined as i) the transmissivity in gallons per day per foot determined from the residual drawdown plot divided by ii) 2000.
   3. Report test data, calculate the transmissivity (T) of the aquifer and well efficiency, and turn over copies of original work papers to the engineer for review prior to demobilization from the site.
   4. Should the 24-hour well efficiency be less than seventy-five percent (75%), the Contractor shall be required to continue development of the well and retest the well upon completion. No additional payment shall be made for additional development or retesting.
   5. Should the contractor not be able to obtain the required seventy-five percent (75%) efficiency, the owner may reject the work and require the contractor to vacate the site, in which case the owner shall not owe any monies for work done. Previously paid monies shall be refunded by the Contractor to the owner and the Contractor may salvage material and must abandon the well.

G. Plumbness and Alignment: If the Engineer has reason to believe that the well is out of plumb or alignment, the contractor shall, at no additional cost to the Owner, perform testing to demonstrate that the well meets AWWA A100 standards for plumbness and alignment. Testing shall be performed in accordance with AWWA A100 Appendix D, Plumbness and Alignment – Procedure for Testing.

1.05 ACCEPTANCE CRITERIA:

A. After the development of the well, notify the Engineer that the work is complete. Samples shall be taken as required under Part 1.05.B to determine if the well is sand free. If the well is not sand free continue development.

B. Well water shall be free of drilling induced turbidity (<5 NTU).

C. Gravel pack shall be stabilized.

D. As a result of the drawdown tests the Engineer has determined that the well meets the efficiency criteria set forth in Article 1.05.C.

E. Well is sand free at the completion of the 24-hour drawdown test as required under Article 1.05.B.

1.06 GUARANTEE DURING WARRANTY PERIOD

A. If at any time during the one year period following acceptance of the project, the Owner shall test the well, and shall show that the production efficiency is less than the guaranteed minimum, the Owner shall send written notice to the contractor. Upon receipt of such notice, the Contractor shall proceed promptly to do such things as will again bring the well efficiency up to the guaranteed efficiency, or failing in such attempt, the contractor shall be required to refund to the Owner the proportionate amount of the contract price that the well has diminished in efficiency.

B. If at any time during the year period following project acceptance the well is found not to be sand free, the contractor shall return to the site and redevelop or otherwise correct the sand pumping at no additional cost to the Owner.

1.07 ABANDONMENT CLAUSE

A. In the event the well produces less than the specified capacity, or the well produces excess sand, the well will not be accepted nor any payment made for it until such conditions are corrected by the Contractor. If such conditions are uncorrectable, the Contractor may recover such material as he may elect and the hole shall be abandoned in accordance with Title 15: North Carolina Administrative Code Sub Chapter 2C; Section 0.0113 Abandonment of Wells. The Contractor shall receive no compensation for any well so abandoned.

PART 2 PRODUCTS

2.01 OUTER CASING

A. Well casings shall be new and unused black steel pipe conforming to ASTM - A53, Grade A seamless or electric resistance welded of the diameter and wall thickness designated.

B. Casing joints shall be field welded with a full penetration. Welds shall develop a minimum of 100 percent of the pipe thickness.

C. Centralizers shall be of the same material as the casing.

2.02 INNER CASING

A. Inner casings shall be ASTM A312 type 316 stainless steel with a wall thickness as described in Sections 1.03.B and 1.03.C.

B. Casing joints shall be field welded with full penetration. Welds shall develop a minimum of 100 percent of the pipe thickness.

C. Centralizers shall be of the same material as the casing.

2.03 WATER LEVEL MEASUREMENT PIPE

A. Water level measurement pipe shall be 1-1/4-inch diameter schedule 40 type 316 stainless steel pipe with screw joint couplings. Cap top with threaded cap.

B. Tack weld to casing at 20 foot centers.

C. For all wells, the bottom of the water level measurement pipe shall be constructed into the inner casing at a depth no deeper than 10 feet above the screen depth.

2.04 SCREENS

A. Well screens shall be the continuous slot design, fabricated of special shaped, cold drawn or cold rolled wire or bars. Outer winding of wire shall be V-shaped and welded to the internal longitudinal bars. Screen sections shall be of type 316 stainless steel.

B. Screen openings shall be designed the proper width to permit the well with gravel pack to produce a sand free water. Screen opening size will be determined once grain-size analyses of formation samples are received.

C. Joints connecting screen sections shall be butt-type couplings of the same material as the screen, or the screen sections may be butt welded as recommended by the manufacturer.

D. Centralizers shall be type 316 stainless steel.

E. Screens shall have sufficient strength to withstand the forces applied during and after installation.

2.05 CEMENT GROUT

A. Cement grout shall be a mixture of Portland Cement, Type I, ASTM C150 and not more than 6 gallons of water per bag (1 cubic foot) of cement. The use of bentonite (up to 2% by weight of cement) to reduce shrinkage and other admixtures to increase fluidity must be approved by the Engineer.

B. Water used shall be fresh, clean and potable.

2.06 GRAVEL PACK MATERIAL

A. Gravel shall be clean, well rounded grains that are smooth and uniform. Material shall be mostly siliceous with a limit of 5% by weight of calcareous material.

B. Material shall be screened and washed and have a maximum uniformity coefficient of 2.5.

C. Grading of the gravel pack material shall be selected by the Engineer and based on the analysis of the formation samples.

D. Submit analysis and calculations supporting gravel pack selection.

2.07 DRILLING FLUIDS

A. Drilling fluids shall be a sodium bentonite drilling clay commercially processed. No organic based fluids shall be allowed.

B. Use potable water.

C. After grouting operation clean mud of cement contamination by the replacement of drilling fluid and mixing fresh mud.

2.08 ELECTRIC TAPE

A. Provide a new electric tape type water level measuring device for use during testing. Provide a minimum of 300 feet of cable.

B. Device shall be Solinst® Model 101 P7, or equal. Turn over to Owner at end of construction.

2.09 TEST PUMP AND EQUIPMENT

A. Test pump shall be a vertical turbine type. Use pump and power source capable of producing 150 percent of the well design at an orifice discharge. Control pump rate through a throttling valve at rates of 50 percent of the well capacity.

B. Equipment shall be reliable for the test period. Reimburse Owner for additional inspection cost that may be incurred as a result of equipment failure.

C. Equip gas or diesel engines with industrial rated mufflers or better.

D. Install circular orifice meter and control valve to meter and control discharge rates.

PART 3 EXECUTION

3.01 CERTIFICATION

A. During well construction activities a certified well contractor shall be on site and carry a valid certification card and picture ID.

3.02 DRILLING

A. Perform drilling using the conventional rotary drilling method or reverse rotary drilling. A mud rotary drill rig shall be utilized. Condition of rig shall be sufficient to complete the project without breakdowns due to negligence. Use a drill collar to insure drilling a straight hole.

B. Mud pump and mud shall be sufficient to insure that the hole does not cave in. A temporary surface casing may be used to insure stability. Construct mud pit a minimum of six feet from proposed well head foundation.

C. Temporary Capping. A well which is completed for a period prior to being placed in service, or is left uncompleted due to a recess or delay in construction, shall be capped with a water-tight welded or threaded cap or equipped with some other type of "vandal-proof" cover and project a minimum of 12 inches from the surrounding grade.

3.03 PILOT HOLE PHASE

A. Drill test boring at the site of the finished well to the depth and diameter specified.

B. During the drilling maintain an accurate log to indicate the elevation of each change in the geologic formations, description of formation, and unusual fluid losses.

C. Drill a bore hole to specified depth and collect samples of drill cuttings. Take samples of sediments at 10-foot depth intervals and at significant changes in sediments throughout entire depth of the well. The Contractor shall conduct grain size analyses provided by a certified geotechnical laboratory for up to 5 samples from the LPDA and up to 6 samples from the BCA (11 samples total) using standard sieve analysis with hydrometer to determine gradation, effective size and uniformity coefficient of sand sample in water bearing aquifers. These analyses will be used to select gravel and screen sizes. Samples shall be taken in accordance with Ground Water and Wells, Second Edition. Carefully preserve two sets of samples at site in sample bags properly labeled for identification of sample depth and job name. The Contractor shall retain samples until delivery instructions are received from the NC Department of Environment and Natural Resources or for a period of at least 60 days after submission of the well record form (GW-1) that indicates that said samples are available. Prepare driller's log utilizing samples thus obtained. Perform Geophysical Logs as described below.

D. On completion of the test hole boring the contractor shall provide the following geophysical logs. Vertical scale of 1"=20'. Perform geophysical log testing to include:

Natural gamma.

Self Potential (SP).

Single point resistance.

16" – 64" Normal resistivity

E. Use same "zero point" elevation for each log, and "zero point" shall correspond to the land surface of each site.

F. Verify accuracy of depth counter prior to logging. This should include extending 100 feet of cable on the ground and comparing the depth counter with a steel tape measure. Measurement error of the depth counter shall not exceed 0.25 feet/100 feet. Clean cable after verification test and before running geophysical log on the borehole.

3.04 OUTER CASING BORE HOLE CONSTRUCTION

A. Drill a 30" diameter hole to accommodate the outer casing to an approximate depth of 100 feet.

3.05 OUTER CASING INSTALLATION

A. Top of outer casing shall be at least 12 inches above final ground elevation. Install casing from the top of the pump base to the top of the water bearing sand.

B. Center casing in the hole to provide a 4-inch annular space between the casing and the bore hole. Place centering guides around the pipe at a minimum of 120 degrees and no greater than fifty feet apart to insure adequate clearance.

C. The Contractor will be required to test each new well for plumbness and alignment while installing casing. If required, the Contractor shall perform test as described in American Water Works Association Standard ANSI/AWWA A100. The plumbness and alignment must be satisfactory for the successful installation and operation of the permanent pumping equipment as determined by Engineer. Maximum Variation From Plumb: In accordance with AWWA A100.

D. Butt weld joints as work progresses.

3.06 GROUTING CASINGS

A. After outer casing has been installed, centered and plumbed, the four (4) inch annular space between the walls of the drilled hole and the outside of the casing shall be filled with neat cement grout under pressure from bottom to top, using a Bradenhead. Mix grout at the site. Mixing and pumping shall be a continuous operation until the grout has filled the entire annular space as evidenced by its overflowing at the surface. Mixture shall weigh approximately fifteen pounds per gallon and at no time during the cementing operation shall the weight fall below fourteen pounds per gallon.

B. After inner casing and screen have been installed, centered and plumbed, and gravel pack emplaced around screen, the four (4) inch annular space between the walls of the drilled hole and the outside of the casing shall be filled with neat cement grout emplaced using a tremie pipe. Mix grout at the site. Mixing and pumping shall be a continuous operation until the grout has filled the entire annular space as

evidenced by its overflowing at the surface. Mixture shall weigh approximately fifteen pounds per gallon and at no time during the cementing operation shall the weight fall below fourteen pounds per gallon.

C. The Contractor is cautioned that he must have sufficient pumping and mixing equipment, together with separate standby equipment, as well as a sufficient supply of cement at the site before this operation is begun as the cementing, once started, shall be a continuous operation until the grout overflows at the surface.

D. Allow grout to set for 72 hours prior to proceeding with next operation.

E. The Contractor shall guarantee the effectiveness of the cement seal around both casings and that there will be no leakage around the casings anywhere along its entire length.

3.07 INNER CASING AND SCREEN

A. After the grout has set for the outer casing, drill a bore hole for the inner casing and screen to a depth required. The Engineer will determine the depth of casing and screen, and screen size based on grain-size analyses of formation samples.

B. Properly weld, place, and lower screen and inner casing into the well. Screen placement shall be ± 6 inches of the proposed placement.

C. Center casing and screen in the hole by use of centralizers. Space centralizers, as a minimum, 120 degrees apart at not more than 50 feet vertical centers.

D. Cap bottom of casing.

E. Weld 1-1/4-inch water level measurement pipe to the outside of the inner casing. Bottom shall terminate through the wall of the inner casing. Top shall be capped 12 inches above ground level.

3.08 GRAVEL PACK

A. After the screen and inner casing assembly has been installed, centered and plumbed, a gravel filter shall be constructed around the screen by pumping special washed and screened filter gravel to the bottom of the well through a separate and temporary tremie pipe, building the filter from the bottom of the well upward to a point 10 to 20 feet above the top of the screen interval. The Engineer will determine the gravel pack size and material based on grain-size analyses of formation samples.

B. Place gravel pack in a uniform and continuous manner to minimize the possibility of hydraulic segregation and bridging.

C. One-half pound of HTH per cubic yard of gravel shall be mixed and placed with the gravel.

3.09 DEVELOPING THE WELL

A. Development of the well shall remove native silts and clays, drilling mud and fine sands from the aquifer and gravel pack to ensure the maximum specific capacity will be obtained from the completed well.

B. Well may be developed by bailing, surging, jetting, over pumping or other means as approved by the Engineer.

C. The wells shall be considered properly developed when water samples, collected during the pumping test, contain no more than 5 milliliters per liter of settleable solids, nor more than 5 NTUs of turbidity as suspended solids, and no more than 5

parts per million (PPM) sand as measured with a Rossum Sand Content Tester (verify specification of Rossum Sand Tester with Engineer). "Settleable solids" means the volume of solid particles in a well-mixed one liter sample that will settle out of suspension, in the bottom of an Imhoff Cone, after one hour. Contractor shall provide testing at no expense to Owner and to provide all testing equipment.

D. Additional development by air-lift pumping will be performed until the criteria cited above are met. The bottom of the air pipe shall extend no deeper than the top of the screen during well development.

E. If development standards listed in item (e) above cannot be met, the Contractor shall propose and employ alternate development methods (to be approved by the Engineer) to include surging, chemical treatment, or other methods, until the standards are met

3.10 24-HOUR TEST

A. Well test shall be witnessed by the Engineer. Provide 7 days notice to the Engineer prior to starting the test. Allow a minimum of twenty-four hours for well to stabilize after completion of development and prior to beginning test.

B. A step-drawdown test for each well will be performed. The step test will include 2-hour stepped pumping rates at 75%, 100%, and 125% of the design flow rate for each well. A well recovery period of 2 hours will be provided after the test. For the purposes of the step-drawdown pumping tests, the 100% withdrawal rate for all Lower Pee Dee wells (##P designation) is 600 gpm and the 100% withdrawal rate for all Black Creek wells (##B designation) is 900 gpm. This pumping test data will be used to determine the pumping rate to be utilized for the final constant rate aquifer pumping test. At the end of each of the three pumping steps, analyze water for settleable solids, suspended solids, and sand content as described herein. Upon completion of the test, allow a minimum of twenty-four hours of well recovery time before proceeding with further testing.

C. A constant-rate drawdown test for each well will be performed. After recording the static water level in the observation well and the production well, begin pumping at the highest sustainable pumping rate determined from the step-drawdown test (as approved by the Engineer). The Contractor shall be responsible for operating and maintaining the pumping and measurement equipment during the test. The pump shall be equipped with sufficient throttling devices to reduce the discharge rate to approximately 25 percent of the maximum capacity of the pump. The pump discharge shall be set at a constant rate that can be maintained throughout the testing period. Pumping time shall continue for 24 hours without interruption and shall be continued for a period of at least four hours after the pumping water level stabilizes (ceases to decline more than 3 inches in a four hour period), or until the Contractor is advised by Engineer to discontinue pumping. Pump well continuously for a period of 24 hours and extended if necessary to such time as hydraulic conditions reach stabilization. Pumping rate shall be determined by the Engineer and is expected to be the design yield. The pumping rate will be constant for the duration of the test. A well recovery period of 12 hours will be provided after the test.

D. During all tests and recovery periods, take water level measurements to the nearest 1 inch at the interval required by the Engineer.

E. Flow during each test will be measured using an in-line flow meter or orifice weir. The in-line flow meter shall have a calibration recorded within the past year. The

orifice weir shall be consistent in design to that shown on Figure 16.1 of "Groundwater and Wells", Second Edition by Fletcher Driscoll, 1986. The diameter of the orifice shall be less than 80% of the inside diameter of the discharge pipe. Submit calibration data and specifications for flow meters and orifice weirs to Engineer prior to tests. There shall be adequate back pressure on the control valve to ensure that a constant flow rate can be achieved at the minimum design flow rate for each well. The metering device shall have accuracy within plus or minus three percent.

F. Provide temporary piping and ditching required to remove water from the site during testing to prevent any downstream flooding.

3.11 WATER ANALYSIS

A. At the end of the 24-hour test period, samples of water shall be collected.. A complete physical and chemical analysis shall be run by a certified laboratory for New Well Analyses. Submit laboratory results in triplicate to the Engineer.

B. A laboratory certified for the required testing by the State of North Carolina shall perform testing.

C. In addition to the requirements of 15A NCAC 18C .1500, the water analysis shall include the following:
   1. Aluminum (EPA 200.7)
   2. Strontium (EPA 200.7)
   3. Silica as SiO2 (EPA 200.7)
   4. Ammonia (EPA 350.1)
   5. Total Phosphorus (EPA 365.1)
   6. Bicarbonate Alkalinity (EPA 310.1)
   7. Hydrogen sulfide (field test)
   8. Salinity (EPA 2520)
   9. MtBE (EPA 602)
   10. Naphthalene (EPA 625)

3.12 DISINFECTION

A. Disinfect drilling fluid, equipment, and well in accordance with Section, Disinfection of Potable Water System. Disinfect the well in accordance with AWWA Standard for Disinfection of Wells (ANSI/AWWA C654-87). Contractor shall obtain a bacteriological sample after flushing the well and deliver to approved laboratory for testing. Test results shall be forwarded directly to the Engineer from the testing laboratory. If the bacteriological test is positive, the contractor shall repeat the disinfection process and resample the well for further bacteriological testing until a negative bacterial result is obtained. The additional disinfection and bacteriological testing shall be performed by the Contractor at no additional cost to the Owner.

3.13 CLEAN UP

A. Remove mud from the pit and backfill pit to provide drainage.

B. Provide fill around the well casing to provide positive drainage away from the casing.

C. Seed and mulch denuded areas.

END OF SECTION

ATTACHMENT 4
ECS SOUTHEAST SOIL TESTING REPORTS

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 6, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**
ECS Job # **22:25949**

Permits:
Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X	Field Reports
X	For your use
X	As requested

ENCL:

This is an automated generated report when Soils lab tests were completed for the current project's below listed lab tests:

Sawmill Pit / S-1 (Standard Proctor)

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

COMPACTION TEST REPORT

Curve No.: S-1

Project No.: 25949 **Date:** 11/6/17

Project: H2GO Reverse Osmosis WTP - Contract 4

Client: State Utility Contractors, Inc.

Source of Sample: Sawmill Pit **Depth:** 0.00-0.00

Sample Number: S-1

Remarks:

MATERIAL DESCRIPTION

Description: Orangish Brown, Silty, Fine to Medium Sand, Some Clay

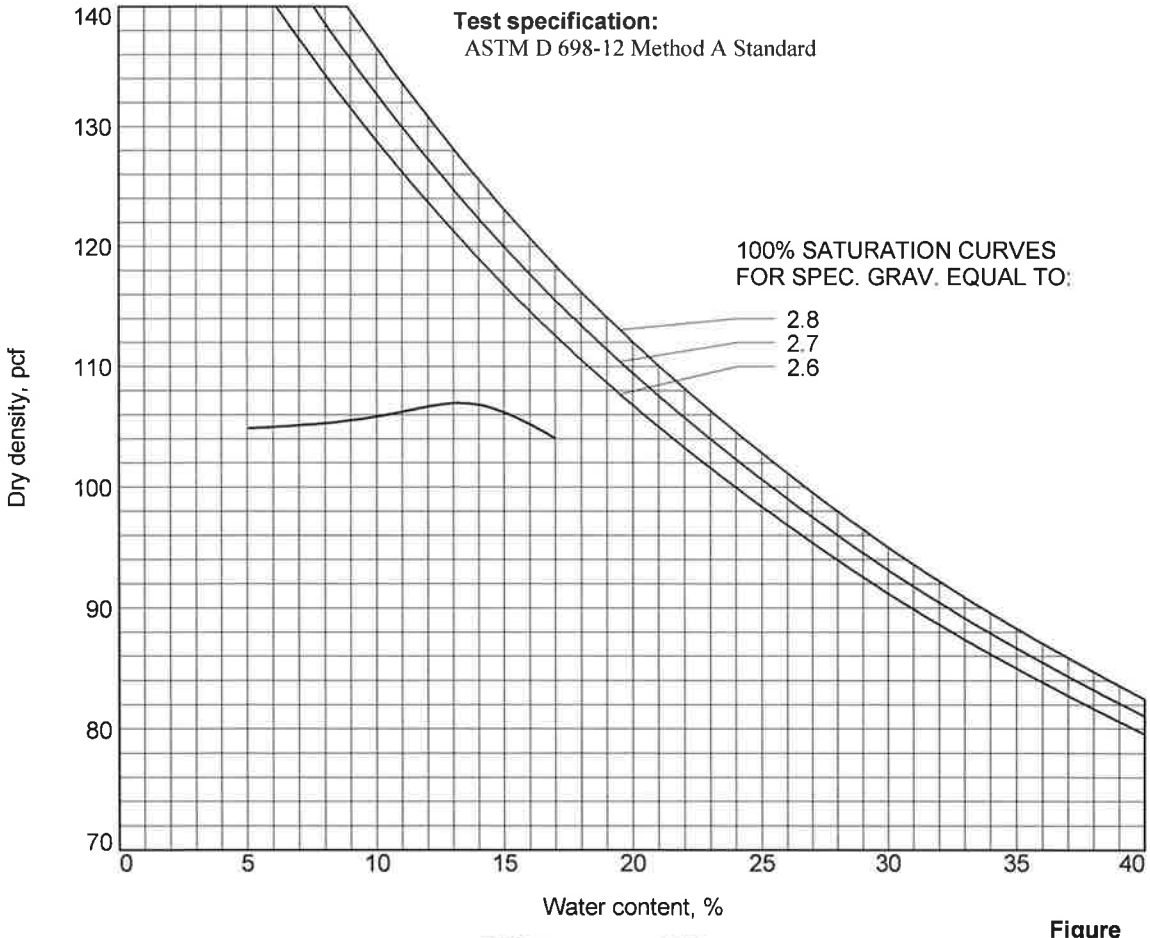
Classifications - **USCS:** **AASHTO:**

Nat. Moist. = **Sp.G. =** 2.60

Liquid Limit = **Plasticity Index =**

% < No.200 =

TEST RESULTS
Maximum dry density = 107.0 pcf
Optimum moisture = 13.2 %



Figure

ECS Southeast, LLP

Tested By: EG **Checked By:** KEL

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 3, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

__X__ Field Reports
__X__ For your use
__X__ As requested

ENCL:

Field Report # 1 11/02/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**1**
Day & Date	**Thursday 11/02/2017**
Weather	**74°/ Sunny**
On-Site Time	**5.25**
Lab Time	**0.50**
Travel Time*	**0.75**
Total	**6.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **26**

Chargeable Items

Time of Arrival **09:45A** Departure **03:00P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to observe the 3 foot undercut of foundation soils and to check the compaction of soils used for backfill. Please see the attached sketch for the approximate density test locations.

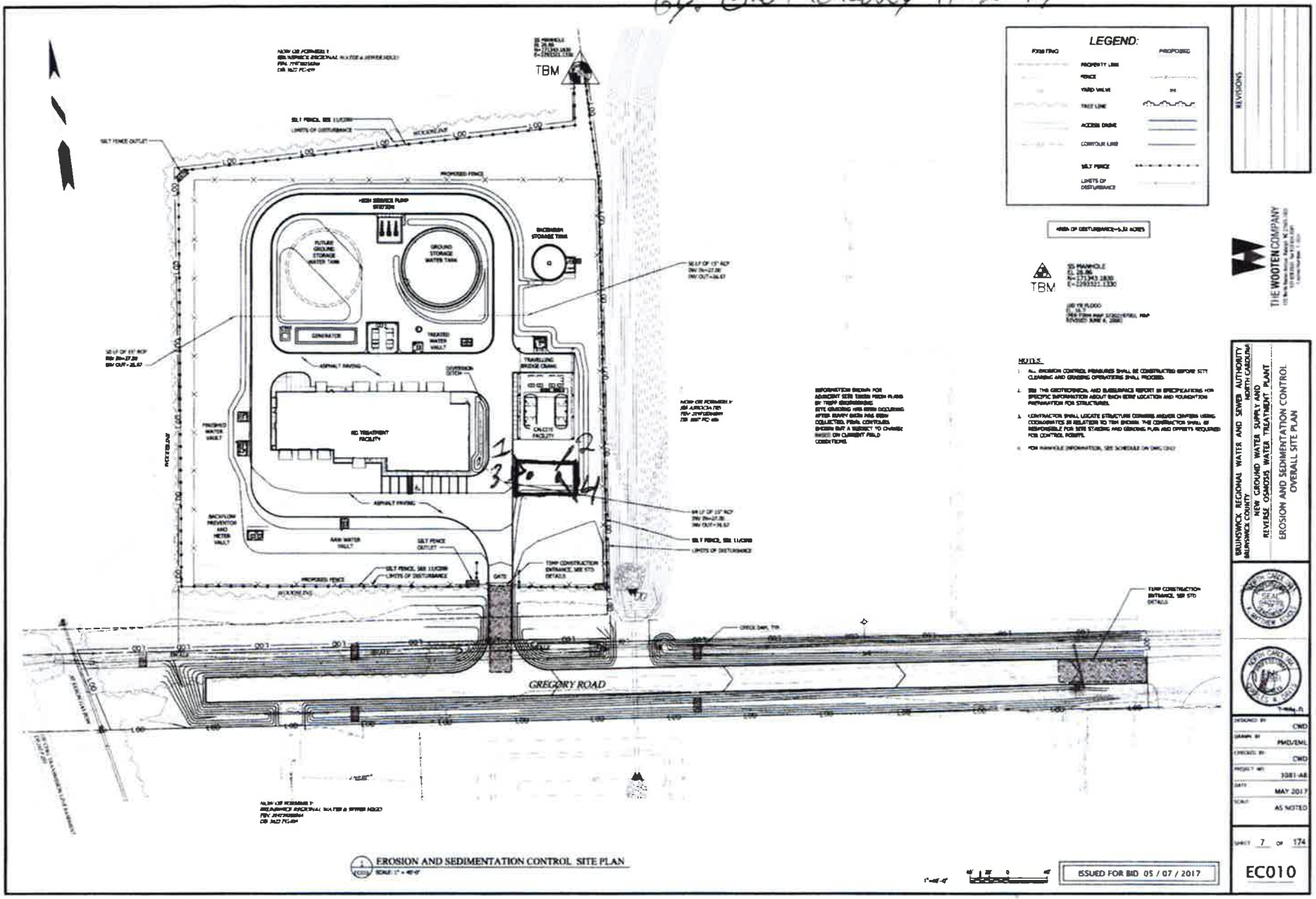
Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

Although tests for -1 feet passed, there was visible pumping of soil so the superintendent elected to stop backfill until soil could dry out. A representative sample of the soil was also taken back to the laboratory for standard Proctor (ASTM D 698) testing.

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

H2GO Plant #25949
Undercut + Backfill w/ Density Tests
By: Glen Bradley 11-2-17



REVISIONS

THE WOOTEN COMPANY

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY, NORTH CAROLINA
NEW GROUND WATER SUPPLY AND REVERSE OSMOSIS WATER TREATMENT PLANT
EROSION AND SEDIMENTATION CONTROL
OVERALL SITE PLAN

DESIGNED BY	CWD
DRAWN BY	PMD/EML
CHECKED BY	CWD
PROJECT NO	3381-AB
DATE	MAY 2017
SCALE	AS NOTED

SHEET 7 OF 174

EC010

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/02/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3241
Model	3440	Moisture Std	880
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Yellowish Brown Silty, FM Sand	Standard Proctor Method (ASTM D-698)	106.90	14.10

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
1		DT	6	pad	-2	S-1	0.00	106.90	14.10	124.6	107.3	16.2	100	P	
2		DT	6	pad	-2	S-1	0.00	106.90	14.10	122.6	104.9	16.8	98.1	P	
3		DT	6	pad	-1	S-1	0.00	106.90	14.10	122.5	104.8	16.9	98.0	P	
4		DT	6	pad	-1	S-1	0.00	106.90	14.10	123.9	106.3	16.5	99.4	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 6, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 2 11/03/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**2**
Day & Date	**Friday 11/03/2017**
Weather	**76°/ Sunny**
On-Site Time	**4.00**
Lab Time	**0.50**
Travel Time*	**0.50**
Total	**5.00**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **23**

Chargeable Items

Time of Arrival **08:30A** Departure **12:30P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to observe the undercut of the pad by 3 feet and to check the compaction of soils for building pad. Please see the attached sketch for the approximate density test locations.

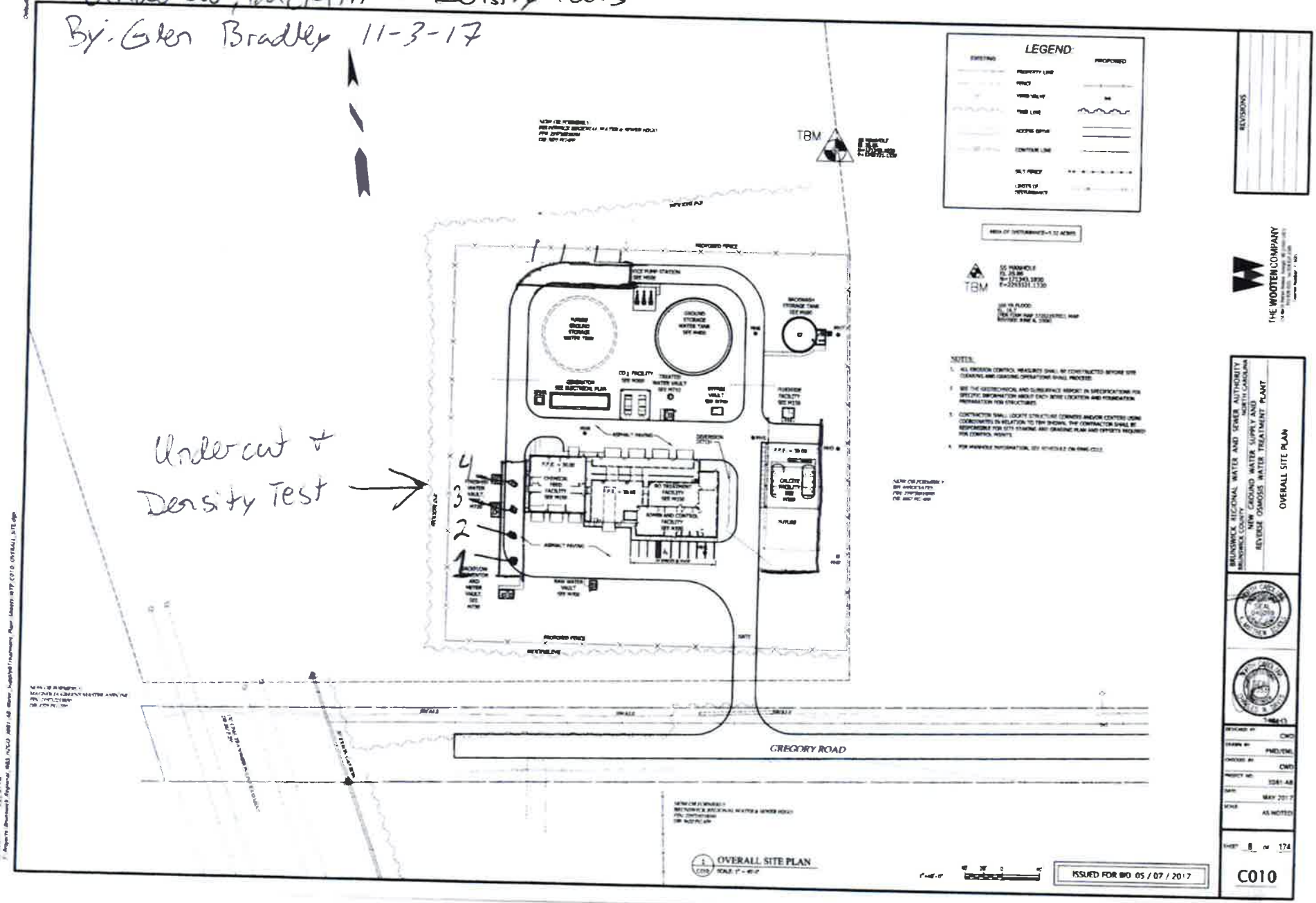
Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25949

~~Undercut, backfill~~ & Density Tests

By: Glen Bradley 11-3-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/03/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 10			
Make	Troxler	Density Std	2043
Model	3440	Moisture Std	550
Ser. No.	722		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	**Yellowish Brown Silty FM sand**	**Standard Proctor Method (ASTM D-698)**	**106.90**	**14.10**

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
1		DT	6	Building pad	-2	S-1	0.00	106.90	14.10	126.0	110.0	14.5	103	P	
2		DT	6	Building pad	-2	S-1	0.00	106.90	14.10	123.6	107.1	15.3	100	P	
3		DT	6	Building pad	-2	S-1	0.00	106.90	14.10	122.4	109.1	12.2	102	P	
4		DT	6	Building pad	-2	S-1	0.00	106.90	14.10	122.5	108.5	12.9	102	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 7, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**
ECS Job # **22:25949**

Permits:
Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X	Field Reports
X	For your use
X	As requested

ENCL:

Field Report # 3 11/06/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**3**
Day & Date	**Monday 11/06/2017**
Weather	**70°/ Sunny**
On-Site Time	**5.50**
Lab Time	**0.50**
Travel Time*	**0.50**
Total	**6.50**
Re Obs. Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **17**

Chargeable Items

Time of Arrival **09:45A** Departure **03:15P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

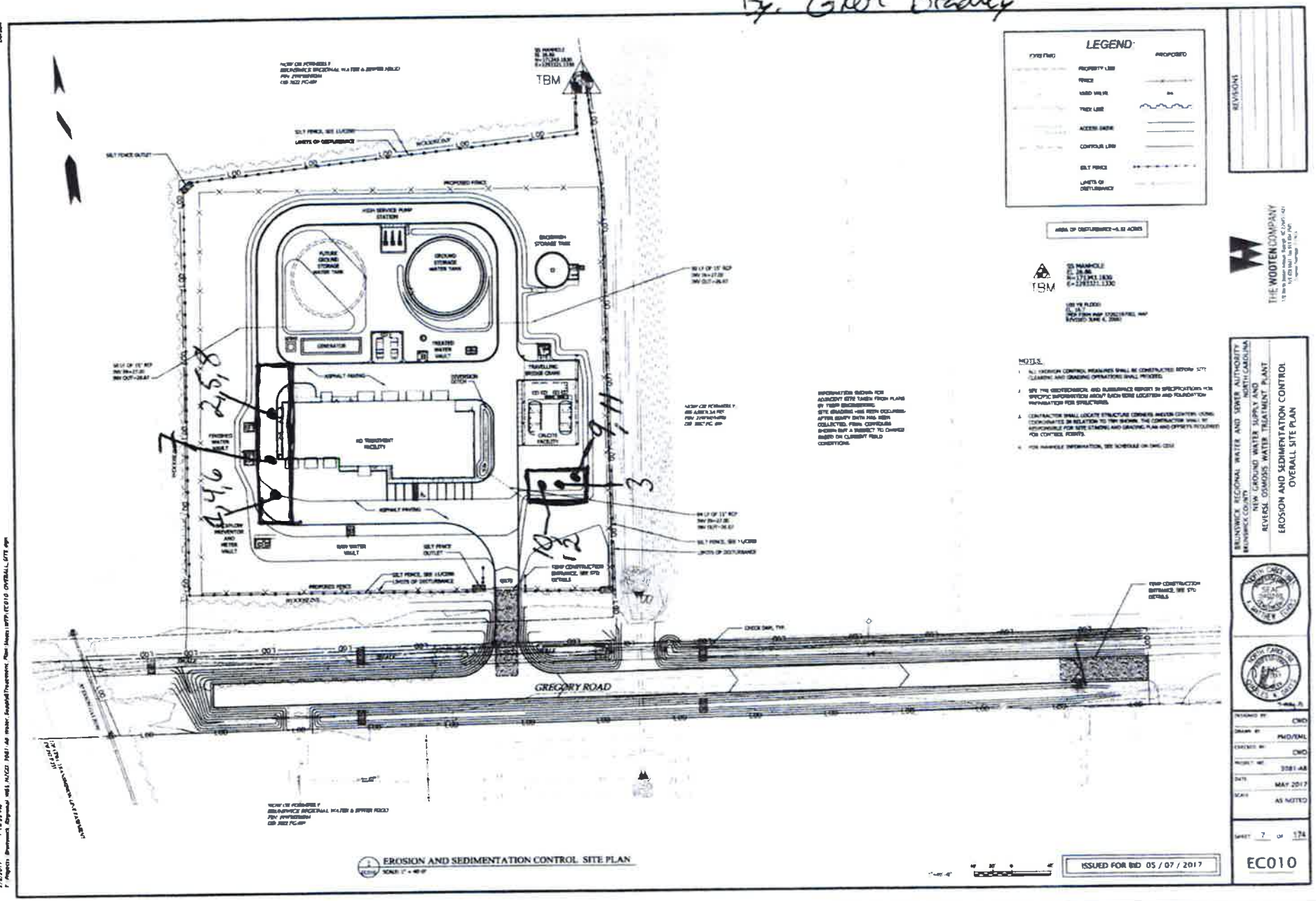
The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25749
Density Test Locations
By: Glen Bradley



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/06/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 10			
Make	Troxler	Density Std	2058
Model	3440	Moisture Std	555
Ser. No.	722		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Yellowish Brown Silty FM Sand	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	pad	-1'8"	S-1	0.00	107.00	13.20	117.2	105.7	10.9	98.8	P	115x25
2		DT	6	pad	-1'8"	S-1	0.00	107.00	13.20	117.0	105.8	10.7	98.9	P	115x25
3		DT	6	pad	-1'8"	S-1	0.00	107.00	13.20	117.4	106.0	10.8	99.1	P	65x30
4		DT	6	pad	-10"	S-1	0.00	107.00	13.20	118.3	104.5	13.2	97.7	P	115x25
5		DT	6	pad	-10"	S-1	0.00	107.00	13.20	115.9	104.2	11.3	97.4	P	115x25
6		DT	6	pad	0	S-1	0.00	107.00	13.20	120.0	107.8	11.4	101	P	
7		DT	6	pad	0	S-1	0.00	107.00	13.20	122.5	110.1	11.2	103	P	
8		DT	6	pad	0	S-1	0.00	107.00	13.20	125.3	110.4	13.4	103	P	
9		DT	6	pad	-10"	S-1	0.00	107.00	13.20	116.3	103.5	12.4	96.7	P	65x30
10		DT	6	pad	-10"	S-1	0.00	107.00	13.20	116.1	104.1	11.4	97.3	P	65x30
11		DT	6	pad	0	S-1	0.00	107.00	13.20	117.2	106.7	9.8	99.7	P	
12		DT	6	pad	0	S-1	0.00	107.00	13.20	119.8	106.9	12.1	99.9	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 8, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 4 11/07/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**4**
Day & Date	**Tuesday 11/07/2017**
Weather	**73°/ Sunny**
On-Site Time	**6.00**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**7.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **10:30A** Departure **04:30P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the backfill of the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at location's 8-12.

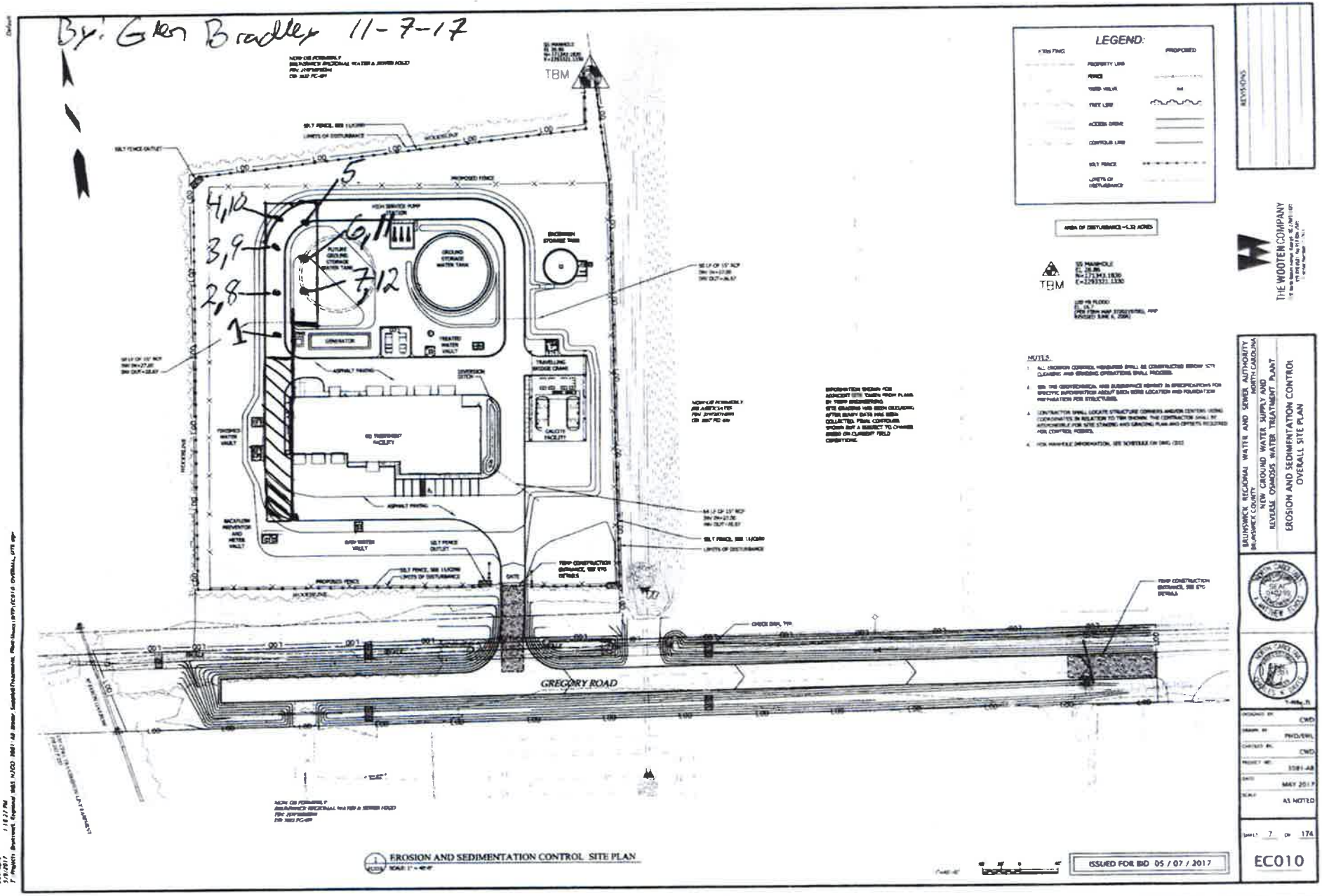
Locations 8-12 failed due to soil being unstable and having a high moisture content.

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25949
Density Test Locations

By: Glen Bradley 11-7-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/07/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3250
Model	3440	Moisture Std	891
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	site pad	-2'6"	S-1	0.00	107.00	13.20	122.8	108.7	13.0	102	P	
2		DT	6	site pad	-2'6"	S-1	0.00	107.00	13.20	119.8	107.3	11.7	100	P	
3		DT	6	site pad	-2'6"	S-1	0.00	107.00	13.20	127.7	109.8	16.3	103	P	
4		DT	6	site pad	-2'6"	S-1	0.00	107.00	13.20	124.8	107.5	16.2	101	P	
5		DT	6	site pad	-2'6"	S-1	0.00	107.00	13.20	125.2	107.2	16.8	100	P	
6		DT	6	site pad	-2'6"	S-1	0.00	107.00	13.20	125.4	108.7	15.3	102	P	
7		DT	6	site pad	-2'6"	S-1	0.00	107.00	13.20	125.7	107.8	16.6	101	P	
8		DT	6	site pad	1'8"	S-1	0.00	107.00	13.20	127.8	109.0	17.4	102	F	Unstable due to high moisture
9		DT	6	site pad	1'8"	S-1	0.00	107.00	13.20	125.3	107.3	16.9	100	F	Unstable due to high moisture
10		DT	6	site pad	1'8"	S-1	0.00	107.00	13.20	128.4	109.3	17.5	102	F	Unstable due to high moisture
11		DT	6	site pad	1'8"	S-1	0.00	107.00	13.20	128.0	108.8	17.7	102	F	Unstable due to high moisture
12		DT	6	site pad	1'8"	S-1	0.00	107.00	13.20	128.5	109.9	17.1	103	F	Unstable due to high moisture

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 9, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 5 11/08/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**5**
Day & Date	**Wednesday 11/08/2017**
Weather	**54°/ Cloudy**
On-Site Time	**6.75**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**8.25**
Re Obs. Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **10:30A** Departure **05:15P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at locations 1-4.

Test locations 1-4 failed due to a high percent of moisture making for visibly unstable conditions.

The project superintendent was notified of the test results.

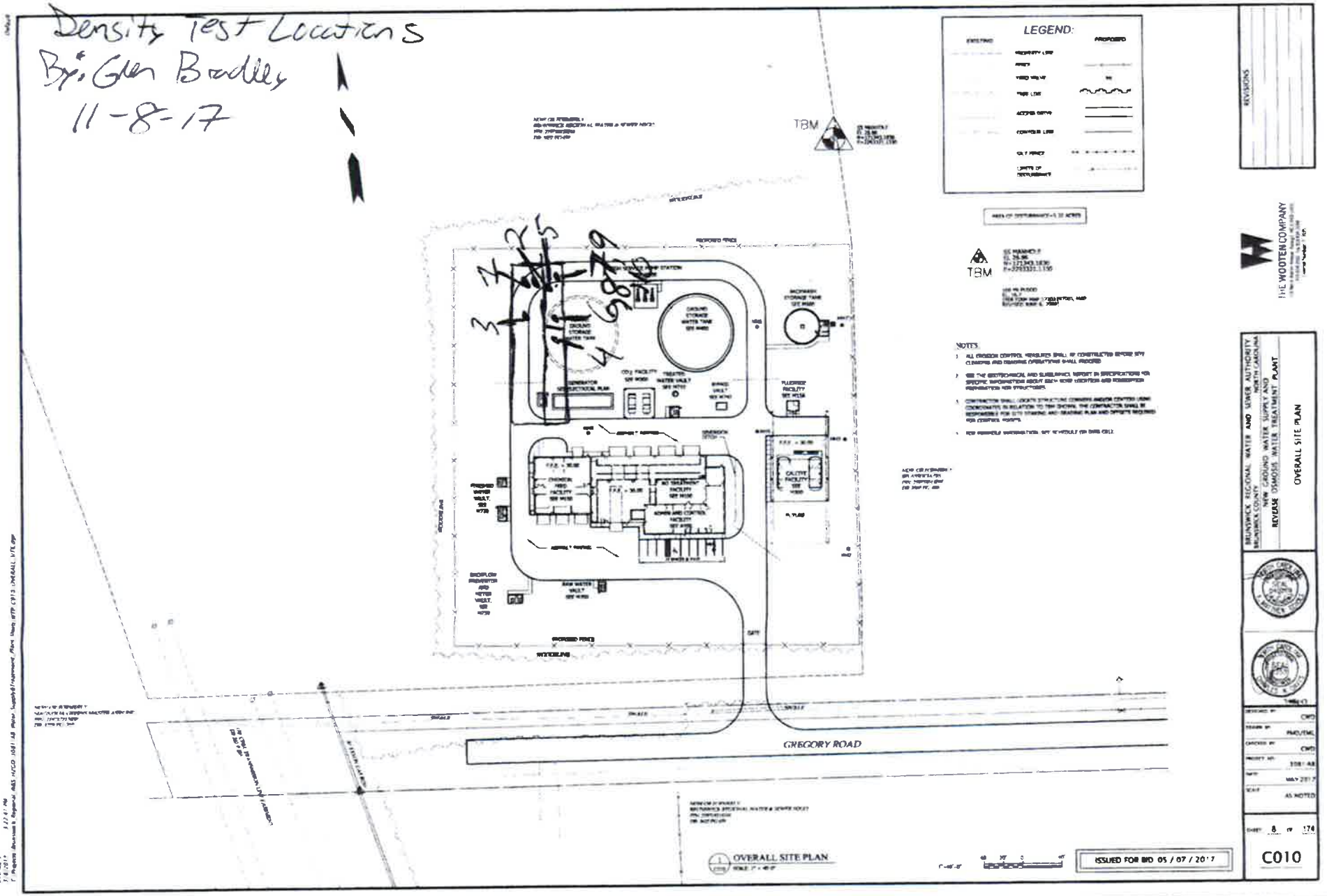
By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant ~~#25949~~

Density Test Locations

By: Glen Bradley

11-8-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/08/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3254
Model	3440	Moisture Std	862
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	building site pad	-1'8"	S-1	0.00	107.00	13.20	123.8	105.3	17.6	98.4	F	Unstable soil due to high moisture
2		DT	6	building site pad	-1'8"	S-1	0.00	107.00	13.20	125.9	107.2	17.4	100	F	Unstable soil due to high moisture
3		DT	6	building site pad	-1'8"	S-1	0.00	107.00	13.20	126.7	107.9	17.4	101	F	Unstable soil due to high moisture
4		DT	6	building site pad	-2'6"	S-1	0.00	107.00	13.20	127.5	107.5	18.6	101	F	Unstable soil due to high moisture
5		DT	6	building site pad	-2'6"	S-1	0.00	107.00	13.20	113.7	101.7	11.8	95.0	P	
6		DT	6	building site pad	-2'6"	S-1	0.00	107.00	13.20	113.2	104.3	8.5	97.5	P	
7		DT	6	building site pad	-1'8"	S-1	0.00	107.00	13.20	118.2	107.9	9.5	101	P	
8		DT	6	building site pad	-1'8"	S-1	0.00	107.00	13.20	117.9	108.5	8.6	101	P	
9		DT	6	building site pad	-10"	S-1	0.00	107.00	13.20	116.2	106.6	8.9	99.6	P	
10		DT	6	building site pad	-10"	S-1	0.00	107.00	13.20	120.9	110.3	9.6	103	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 15, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**
ECS Job # **22:25949**

Permits:
Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X	Field Reports
X	For your use
X	As requested

ENCL:

Field Report # 6 11/13/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

William S. Cromartie
Construction Materials Dept. Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**6**
Day & Date	**Monday 11/13/2017**
Weather	**53°/ Cloudy**
On-Site Time	**6.50**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**8.00**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **09:45A** Departure **04:15P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

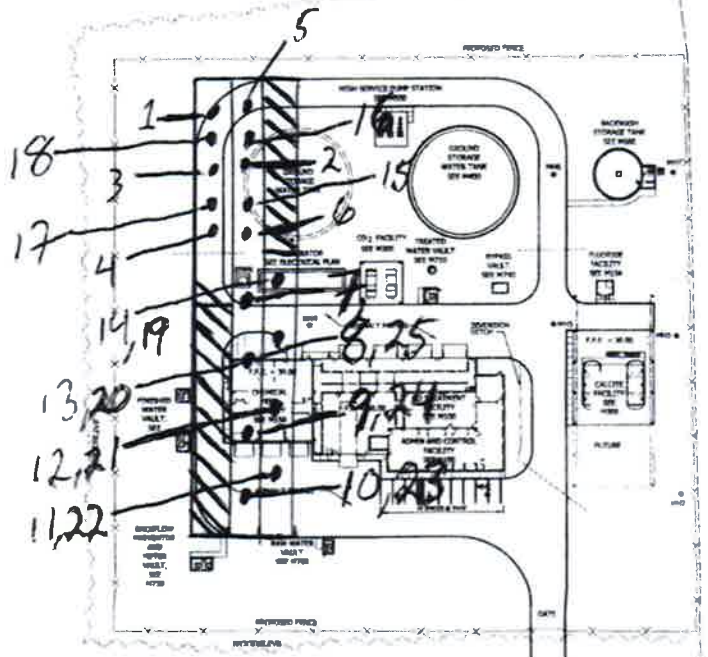
Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at location #15, 17 and 18.

The moisture content of the soils at test locations #15, 17 and 18 was observed to be above the optimal level. ECS recommended allowing the area to dry or replacing the soils with a drier material.

The project superintendent was notified of the test results.

H260 Treatment Plant #25949

Density Test Locations
By: Glen Bradley
11-13-17



LEGEND:

NOTES:

GREGORY ROAD

OVERALL SITE PLAN

ISSUED FOR BID 05 / 07 / 2017

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY, NORTH CAROLINA
NEW GROUND WATER SUPPLY AND
REVERSE OSMOSIS WATER TREATMENT PLANT

OVERALL SITE PLAN

THE WOOTEN COMPANY

REVISIONS

DESIGNED BY: CWO
DRAWN BY: PWD/TML
CHECKED BY: CWO
PROJECT NO: 3081.AB
DATE: MAY 2017
SCALE: AS NOTED
SHEET 8 OF 174
C010

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/13/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3238
Model		Moisture Std	871
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-1'8'	S-1	0.00	107.00	13.20	123.9	109.2	13.5	102	P	
2		DT	6	Building site pad	-1'8'	S-1	0.00	107.00	13.20	124.3	110.4	12.6	103	P	
3		DT	6	Building site pad	-1'8'	S-1	0.00	107.00	13.20	121.1	109.4	10.7	102	P	
4		DT	6	Building site pad	-1'8'	S-1	0.00	107.00	13.20	125.3	111.1	12.8	104	P	
5		DT	6	Building site pad	-1'8'	S-1	0.00	107.00	13.20	123.4	110.8	11.3	104	P	
6		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	125.3	109.3	14.7	102	P	
7		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	126.6	110.4	14.7	103	P	
8		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	113.7	104.9	8.5	98.0	P	
9		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	119.6	108.1	10.6	101	P	
10		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.8	104.8	11.5	97.9	P	
11		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	114.9	103.6	10.9	96.8	P	
12		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.8	106.1	10.2	99.2	P	
13		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.9	106.4	13.7	99.4	P	
14		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	119.7	105.7	13.2	98.8	P	
15		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	117.2	100.7	16.4	94.1	F	Unstable soil due to high

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/13/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3238
Model		Moisture Std	871
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
															moisture
16		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.2	106.5	13.8	99.5	P	
17		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.9	100.5	20.3	93.9	F	Unstable soil due to high moisture
18		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	117.1	100.0	17.1	93.5	F	Unstable soil due to high moisture
19		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	115.6	104.6	10.5	97.8	P	
20		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	118.4	106.5	11.1	99.5	P	
21		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	118.7	106.2	11.7	99.3	P	
22		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	116.6	104.8	11.3	97.9	P	
23		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	120.4	106.9	12.6	99.9	P	
24		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	121.2	108.3	11.9	101	P	
25		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	118.2	105.4	12.1	98.5	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 15, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 7 11/14/2017

Winslow Goins

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

William S. Cromartie
Construction Materials Dept. Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**7**
Day & Date	**Tuesday 11/14/2017**
Weather	**57°/ Sunny**
On-Site Time	**5.25**
Lab Time	**0.50**
Travel Time*	**0.75**
Total	**6.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **16**

Chargeable Items

Time of Arrival **09:45A** Departure **03:00P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at location #3 and 4.

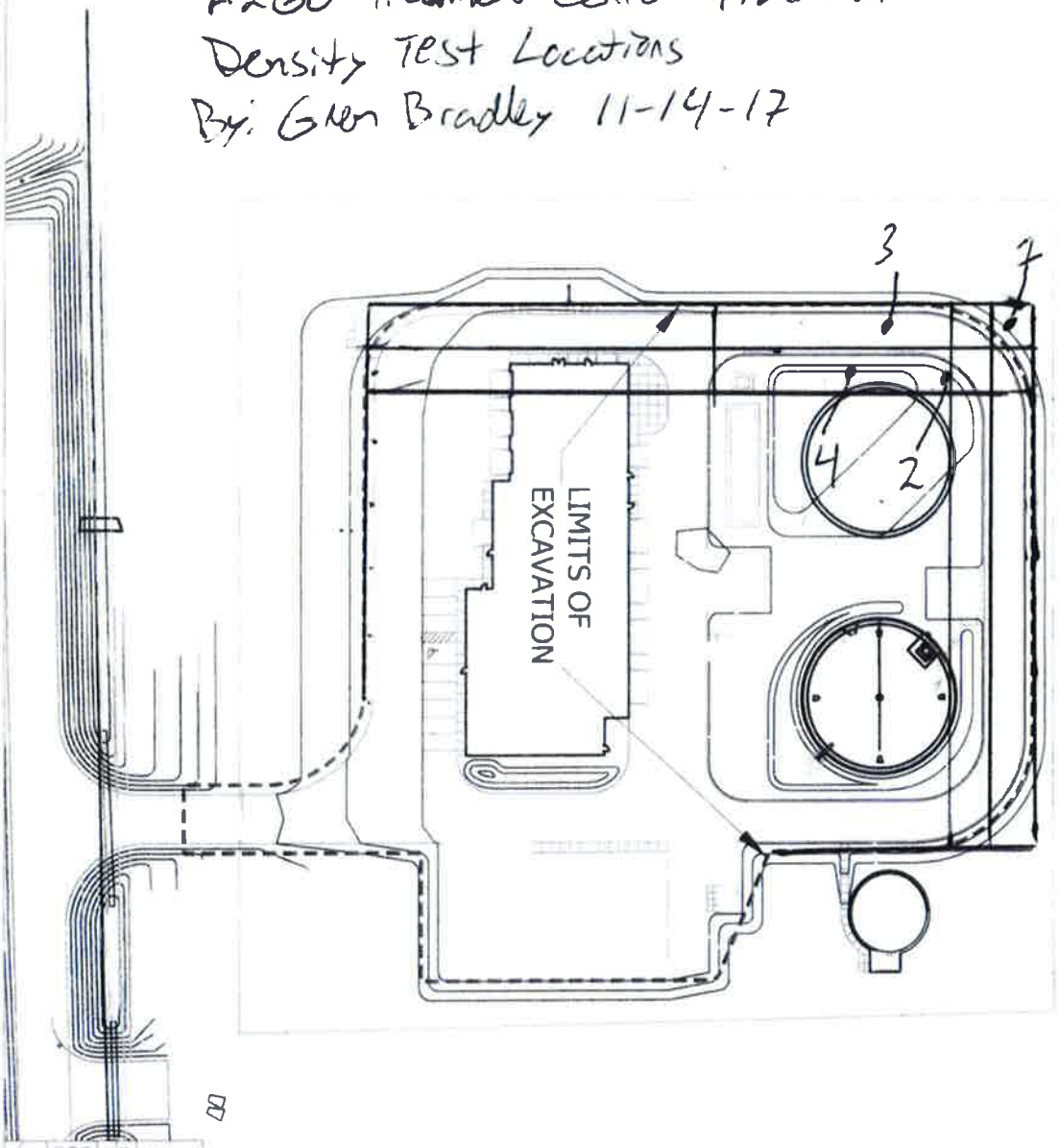
The moisture content of the soils at test locations #3 and 4 was observed to be above the optimal level. ECS recommended allowing the area to dry or replacing the soils with a drier material.

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

ECS SOUTHEAST, LLP
Geotechnical • Construction Materials • Environmental • Facilities
"Setting the Standard for Service"
NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H260 Treatment Center #25949
Density Test Locations
By: Glen Bradley 11-14-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/14/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3270
Model		Moisture Std	858
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	118.8	106.0	12.0	99.1	P	
2		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	120.0	107.9	11.2	101	P	
3		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	120.0	100.9	18.8	94.3	F	High moisture and unstable conditions
4		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	119.6	100.8	18.7	94.2	F	High moisture and unstable conditions

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 15, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 8 11/15/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Will McKinnon
Field Services Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**8**
Day & Date	**Wednesday 11/15/2017**
Weather	**50°/ Sunny**
On-Site Time	**6.75**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**8.25**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **32**

Chargeable Items

Time of Arrival **08:45A** Departure **03:30P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

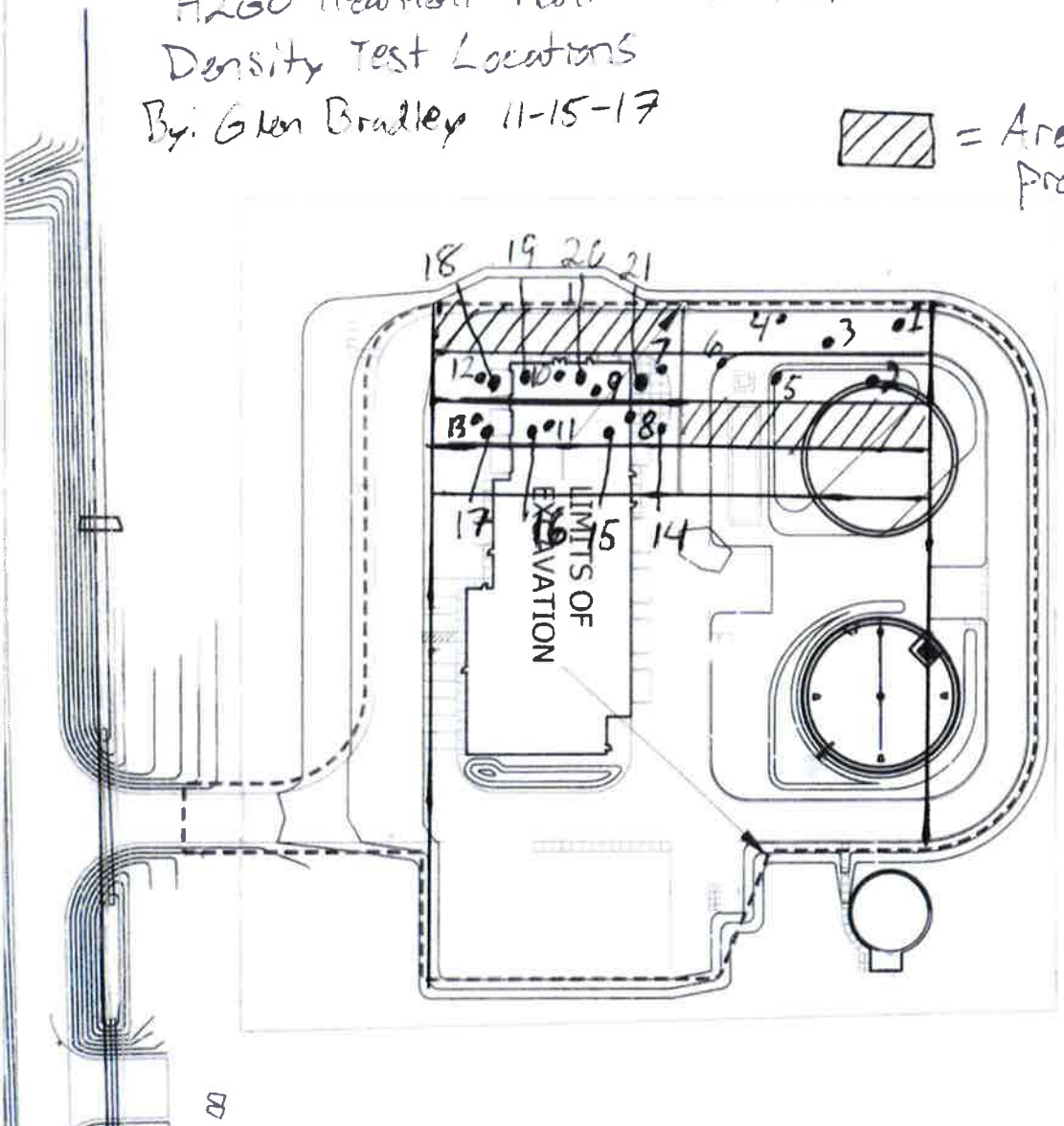
Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-15-17

= Area Tested + filled previously



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/15/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 10			
Make		Density Std	3243
Model		Moisture Std	864
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	118.7	106.4	11.5	99.4	P	
2		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	120.8	109.3	10.5	102	P	
3		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	122.7	105.2	16.7	98.3	P	
4		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.7	106.6	8.6	99.6	P	
5		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.0	109.0	11.0	102	P	
6		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.9	106.9	14.0	99.9	P	
7		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	122.0	107.0	13.8	100	P	
8		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	124.1	110.1	12.7	103	P	
9		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	123.4	107.9	14.3	101	P	
10		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	123.6	109.3	13.0	102	P	
11		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	126.0	110.2	14.4	103	P	
12		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	124.2	108.6	14.4	102	P	
13		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	122.8	106.0	15.8	99.1	P	
14		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.2	106.5	9.1	99.5	P	
15		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	114.3	105.6	8.2	98.7	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/15/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 10			
Make		Density Std	3243
Model		Moisture Std	864
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	115.9	107.8	7.5	101	P	
17		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	118.8	109.2	8.8	102	P	
18		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	114.6	103.6	10.6	96.8	P	
19		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.1	105.7	9.9	98.8	P	
20		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	119.6	107.3	11.5	100	P	
21		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	121.5	106.9	13.7	99.9	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 20, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 9 11/16/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

William S. Cromartie
Construction Materials Dept. Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**9**
Day & Date	**Thursday 11/16/2017**
Weather	**65°/ Sunny**
On-Site Time	**6.25**
Lab Time	**0.50**
Travel Time*	**0.50**
Total	**7.25**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **15**

Chargeable Items

Time of Arrival **09:45A** Departure **04:00P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

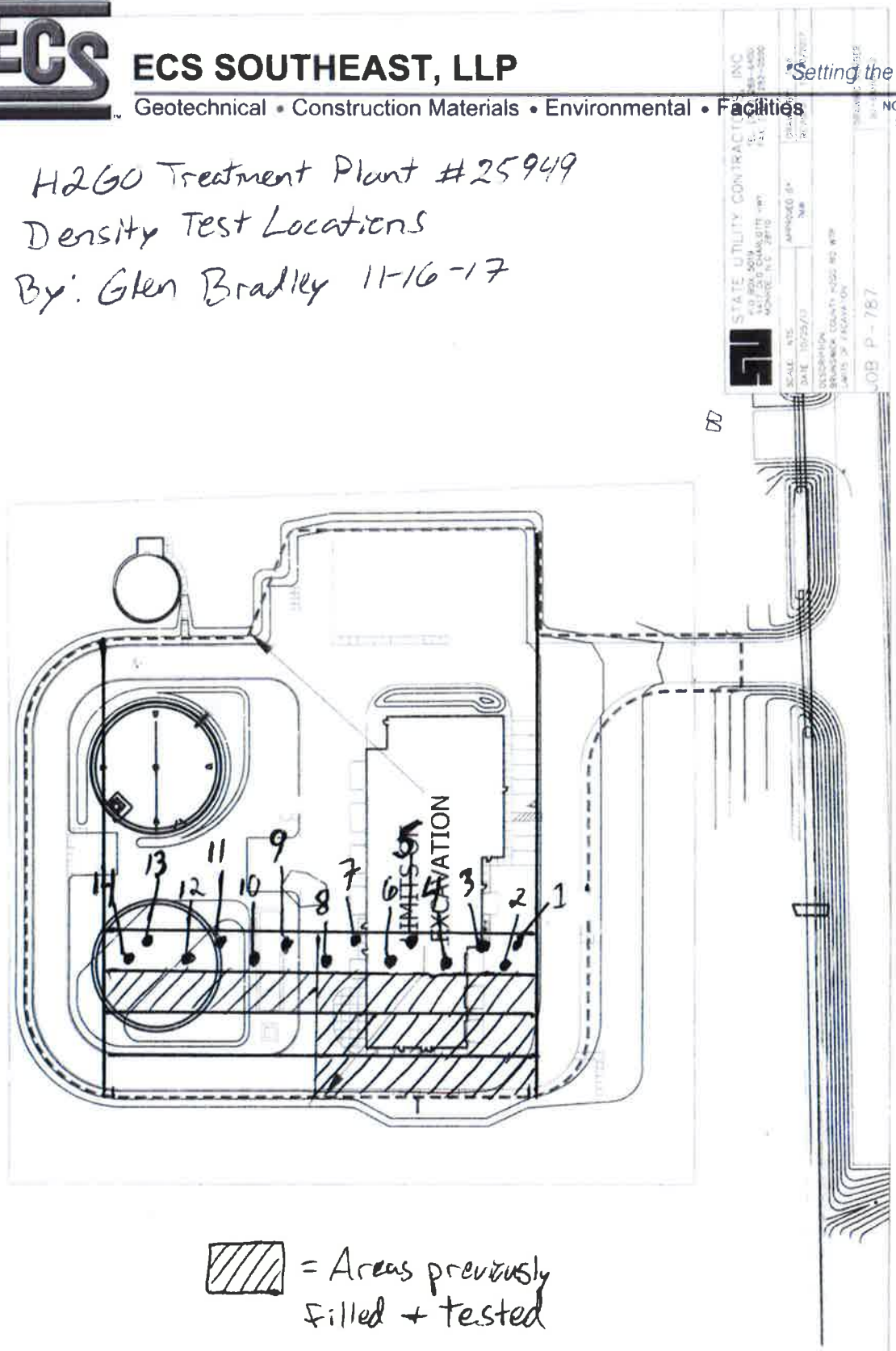
The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at locations #19-24.

The soils a test areas #19-24 contained moisture levels above the optimal level. ECS recommends that the areas be allowed to dry.

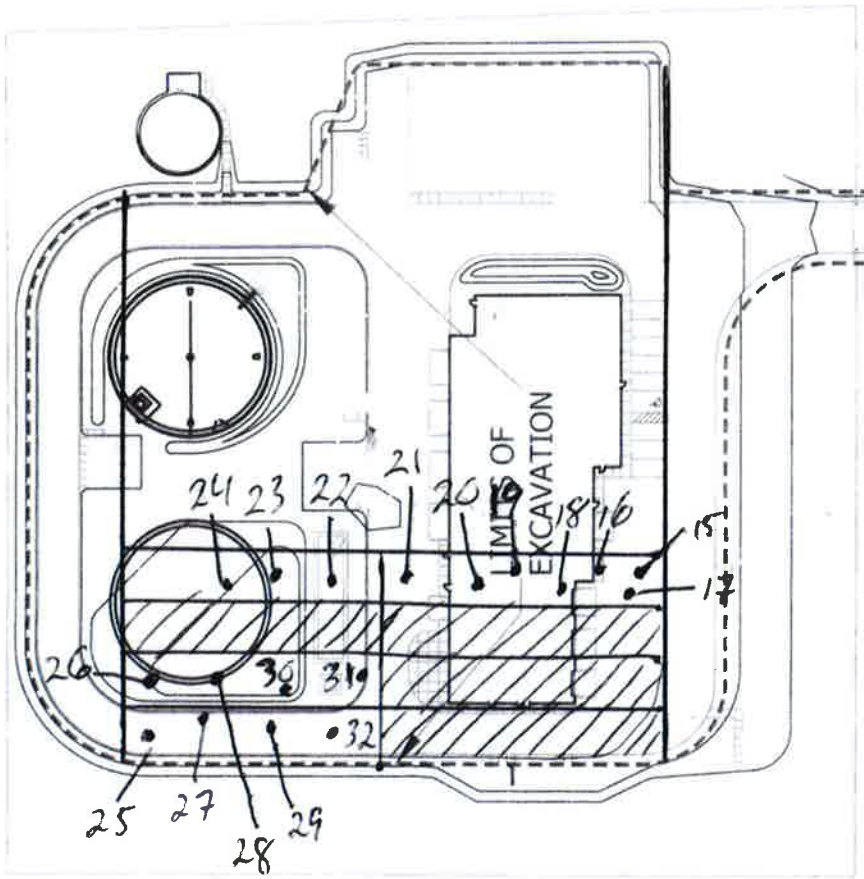
The project superintendent was notified of the test results.

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-16-17



= Areas previously filled + tested

H260 Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-16-17



= Areas previously filled & tested

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/16/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3242
Model		Moisture Std	836
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	112.1	103.1	8.7	96.4	P	
2		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	124.1	110.9	11.9	104	P	
3		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	117.3	102.8	14.1	96.1	P	
4		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	125.7	109.5	14.8	102	P	
5		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.7	104.6	13.5	97.8	P	
6		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	117.8	103.0	14.4	96.3	P	
7		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.4	103.5	16.3	96.7	P	
8		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.6	106.0	14.7	99.1	P	
9		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.6	102.3	15.9	95.6	P	
10		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	119.5	103.0	16.1	96.3	P	
11		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.8	105.2	15.7	98.3	P	
12		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.8	103.4	14.9	96.6	P	
13		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.9	103.2	15.3	96.4	P	
14		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.6	101.8	16.5	95.1	P	
15		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	119.8	103.2	16.1	96.4	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/16/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3242
Model		Moisture Std	836
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	122.8	105.9	15.9	99.0	P	
17		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	122.3	106.3	15.0	99.3	P	
18		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	117.1	103.1	13.6	96.4	P	
19		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	121.8	102.3	19.1	95.6	F	Unstable due to high moisture
20		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	121.6	101.5	19.8	94.9	F	Unstable due to high moisture
21		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	122.3	102.7	19.2	96.0	F	Unstable due to high moisture
22		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	120.9	101.1	19.5	94.5	F	Unstable due to high moisture
23		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	120.8	102.3	18.0	95.6	F	Unstable due to high moisture
24		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	122.8	103.1	19.1	96.4	F	Unstable due to high moisture
25		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	118.3	102.8	15.1	96.1	P	
26		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	121.2	105.6	14.8	98.7	P	
27		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	120.4	103.3	16.6	96.5	P	
28		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.8	104.7	11.5	97.9	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/16/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3242
Model		Moisture Std	836
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
29		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	118.3	102.8	15.1	96.1	P	
30		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	117.9	104.6	12.7	97.8	P	
31		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.9	103.5	13.0	96.7	P	
32		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	118.4	102.7	15.3	96.0	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 20, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 10 11/17/2017

Winslow Goins

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

William S. Cromartie
Construction Materials Dept. Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**10**
Day & Date	**Friday 11/17/2017**
Weather	**59°/ Sunny**
On-Site Time	**6.50**
Lab Time	**0.50**
Travel Time*	**0.75**
Total	**7.75**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **17**

Chargeable Items

Time of Arrival **09:45A** Departure **04:15P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

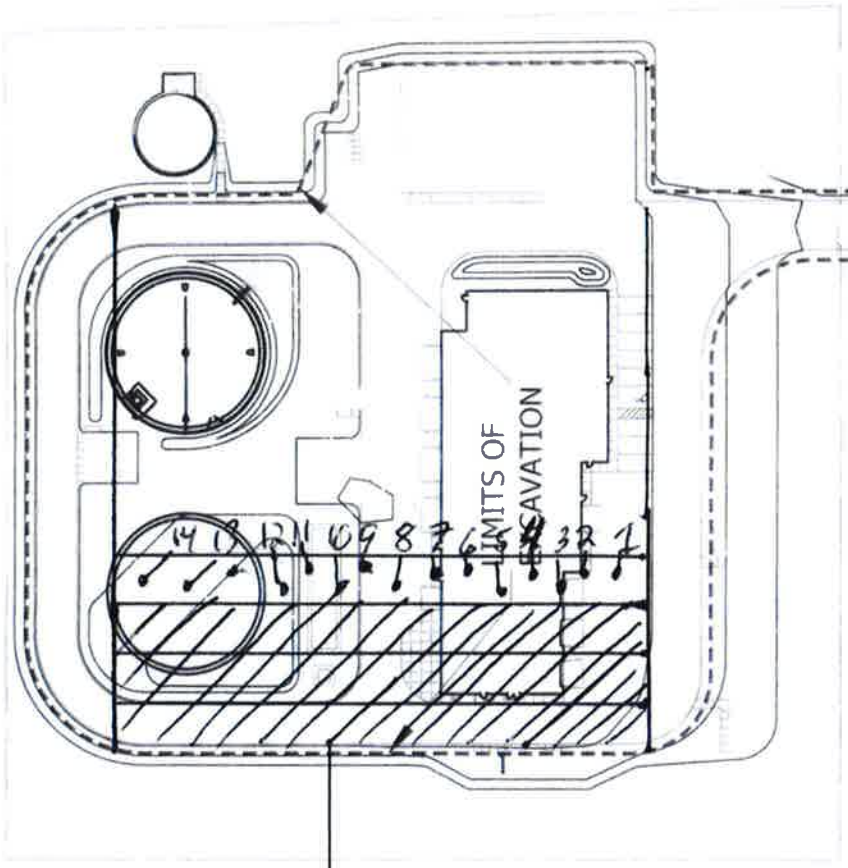
ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-17-17



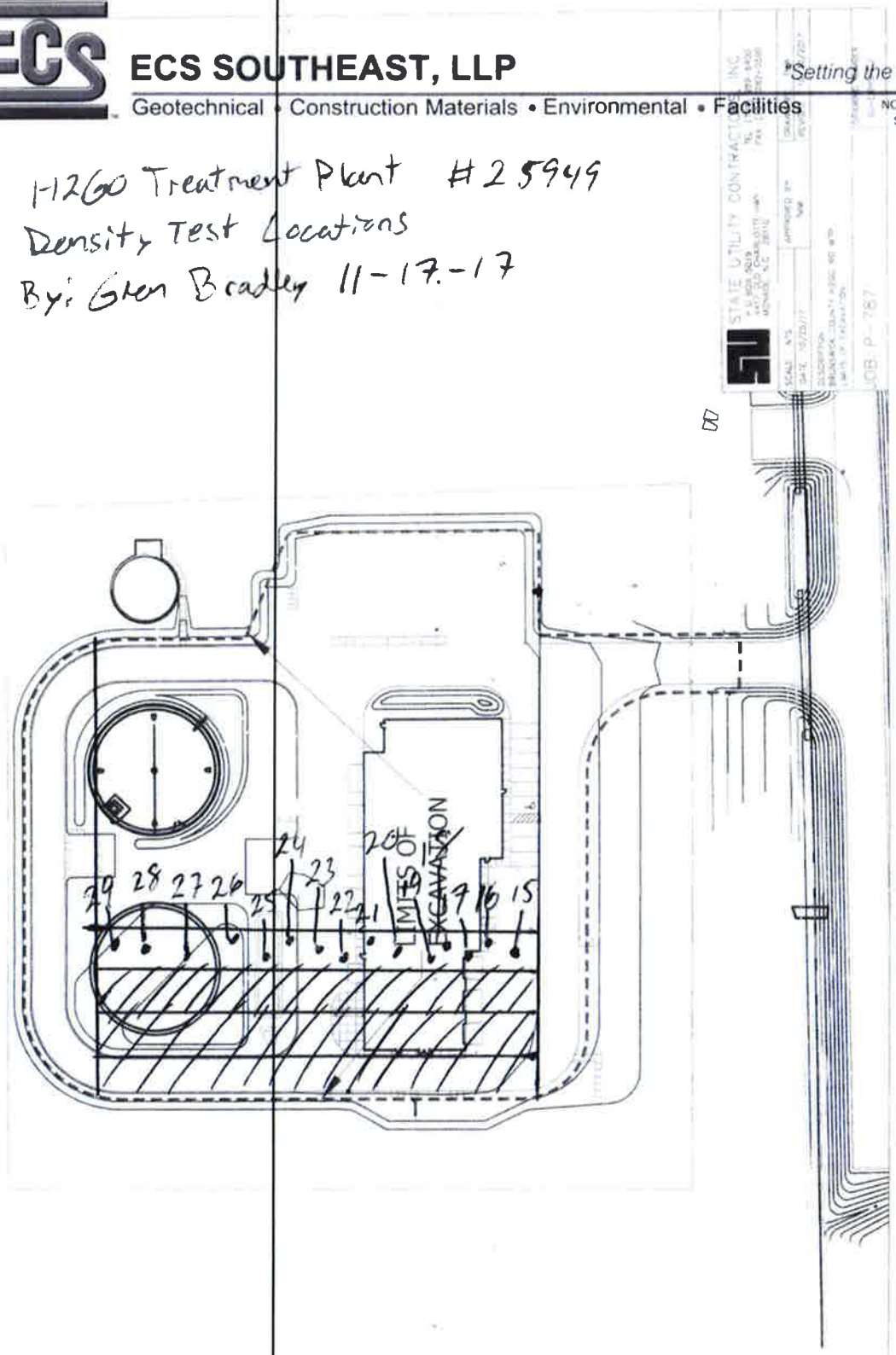
= Areas Previously filled + Tested

6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

ECS SOUTHEAST, LLP
Geotechnical • Construction Materials • Environmental • Facilities
"Setting the Standard for Service"
NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

I-1260 Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-17-17



6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com
ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/17/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3266
Model		Moisture Std	783
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	116.5	102.0	14.2	95.3	P	
2		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	120.2	102.8	17.0	96.1	P	
3		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	118.4	104.6	13.3	97.8	P	
4		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	121.4	104.2	16.5	97.4	P	
5		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	117.7	103.0	14.3	96.3	P	
6		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	121.0	103.1	17.4	96.4	P	
7		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	119.1	102.0	16.7	95.3	P	
8		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	120.3	102.9	16.9	96.2	P	
9		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	122.5	105.0	16.6	98.1	P	
10		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	121.5	103.6	17.3	96.8	P	
11		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	121.7	104.5	16.5	97.7	P	
12		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	121.1	104.1	16.3	97.3	P	
13		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	119.1	103.1	15.6	96.4	P	
14		DT	6	Building site pad	-1'8	S-1	0.00	107.00	13.20	121.7	103.9	17.2	97.1	P	
15		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	113.6	103.6	9.7	96.8	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/17/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 11			
Make		Density Std	3266
Model		Moisture Std	783
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	113.6	102.7	10.6	96.0	P	
17		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.0	102.1	13.6	95.4	P	
18		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	117.5	108.7	8.1	102	P	
19		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	118.8	107.9	10.1	101	P	
20		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.0	105.7	8.8	98.8	P	
21		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	117.8	106.7	10.4	99.7	P	
22		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	120.1	103.5	16.1	96.7	P	
23		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.2	105.7	9.0	98.8	P	
24		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	114.0	105.1	8.5	98.2	P	
25		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.1	107.2	8.3	100	P	
26		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.2	104.8	10.9	97.9	P	
27		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.0	105.1	9.5	98.2	P	
28		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	112.9	102.3	10.4	95.6	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 21, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

__X__ Field Reports
__X__ For your use
__X__ As requested

ENCL:

Field Report # 11 11/20/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**11**
Day & Date	**Monday 11/20/2017**
Weather	**49°/ Sunny**
On-Site Time	**5.50**
Lab Time	**0.50**
Travel Time*	**0.75**
Total	**6.75**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **17**

Chargeable Items

Time of Arrival **10:00A** Departure **03:30P**

* Travel time and mileage will be billed in accordance with the contract.

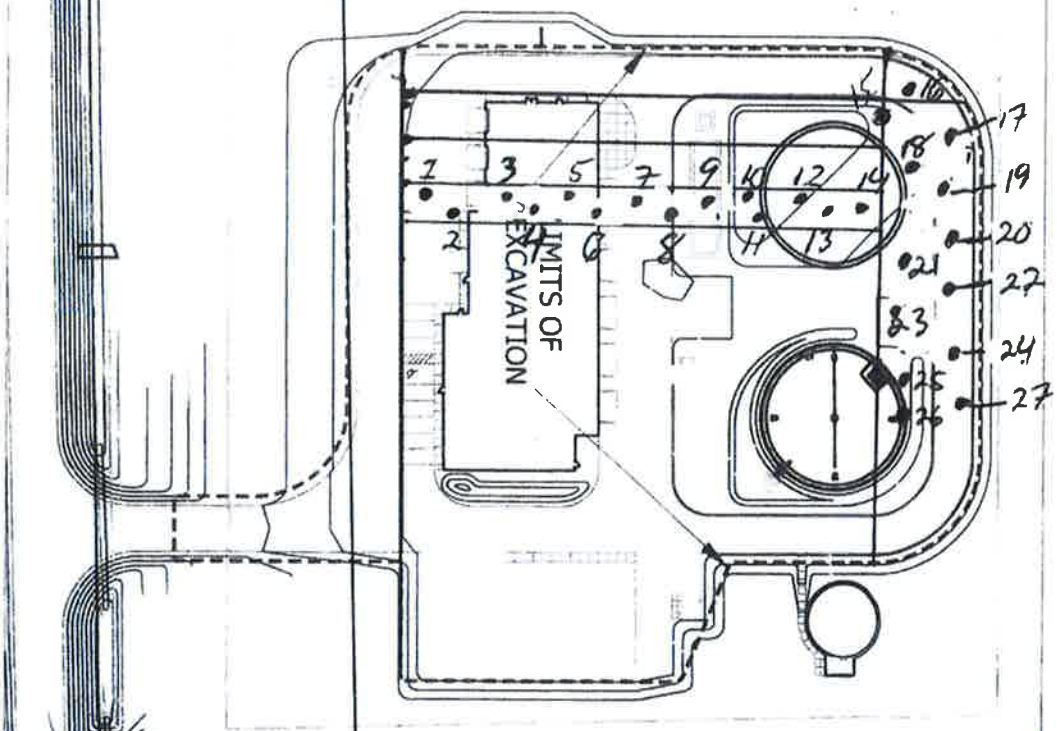
Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

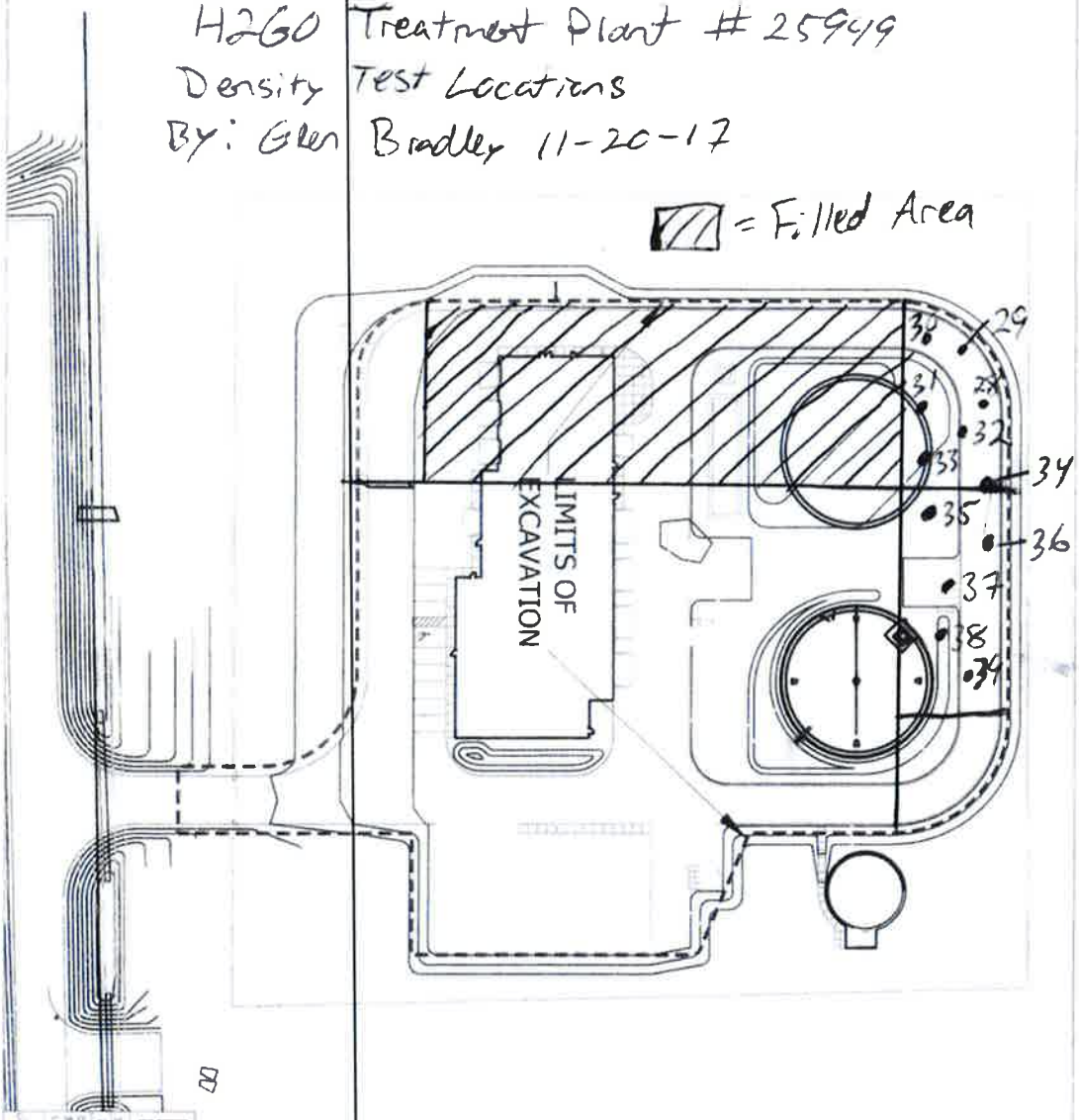
Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-20-17



H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-20-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/20/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3269
Model	3440	Moisture Std	870
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	114.2	103.8	10.1	97.0	P	
2		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	110.9	102.3	8.5	95.6	P	
3		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	113.6	104.5	8.7	97.7	P	
4		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	113.1	105.7	7.0	98.8	P	
5		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	111.1	103.5	7.3	96.7	P	
6		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	113.2	106.3	6.6	99.3	P	
7		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	119.1	106.7	11.6	99.7	P	
8		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	113.6	105.7	7.4	98.8	P	
9		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.4	103.8	12.1	97.0	P	
10		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	112.1	103.4	8.4	96.6	P	
11		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	117.0	106.8	9.6	99.8	P	
12		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	110.7	104.8	5.7	97.9	P	
13		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	111.2	104.3	6.6	97.5	P	
14		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	121.9	113.4	7.5	106	P	
15		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	109.9	102.8	6.9	96.1	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/20/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3269
Model	3440	Moisture Std	870
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	113.2	102.2	10.8	95.5	P	
17		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.3	103.5	12.3	96.7	P	
18		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	117.6	103.8	13.3	97.0	P	
19		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.9	105.6	10.7	98.7	P	
20		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.4	102.9	13.3	96.2	P	
21		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.4	102.9	13.3	96.2	P	
22		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	114.9	103.7	10.8	96.9	P	
23		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.6	103.3	12.8	96.5	P	
24		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.0	104.5	12.9	97.7	P	
25		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	114.8	102.7	11.8	96.0	P	
26		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	117.3	103.9	12.9	97.1	P	
27		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.3	103.2	12.8	96.4	P	
28		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	119.2	104.2	14.4	97.4	P	
29		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	120.9	105.0	15.2	98.1	P	
30		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	118.0	106.1	11.2	99.2	P	
31		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	121.6	104.3	16.6	97.5	P	
32		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	118.8	104.1	14.1	97.3	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/20/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3269
Model	3440	Moisture Std	870
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
33		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	116.6	102.7	13.6	96.0	P	
34		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	121.8	106.0	14.9	99.1	P	
35		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	118.7	104.7	13.4	97.9	P	
36		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	117.2	102.6	14.2	95.9	P	
37		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	116.2	102.8	13.1	96.1	P	
38		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	117.9	105.8	11.5	98.9	P	
39		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	117.8	102.6	14.8	95.9	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 22, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 12 11/21/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**12**
Day & Date	**Tuesday 11/21/2017**
Weather	**66°/ Sunny**
On-Site Time	**4.75**
Lab Time	**0.50**
Travel Time*	**1.50**
Total	**6.75**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **44**

Chargeable Items

Times of	Arrival	Departure
	10:00A	**10:15A**
	11:15A	**03:45P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method ASTM D-698.

By **Glen M Bradley, — Field Technician** 1800

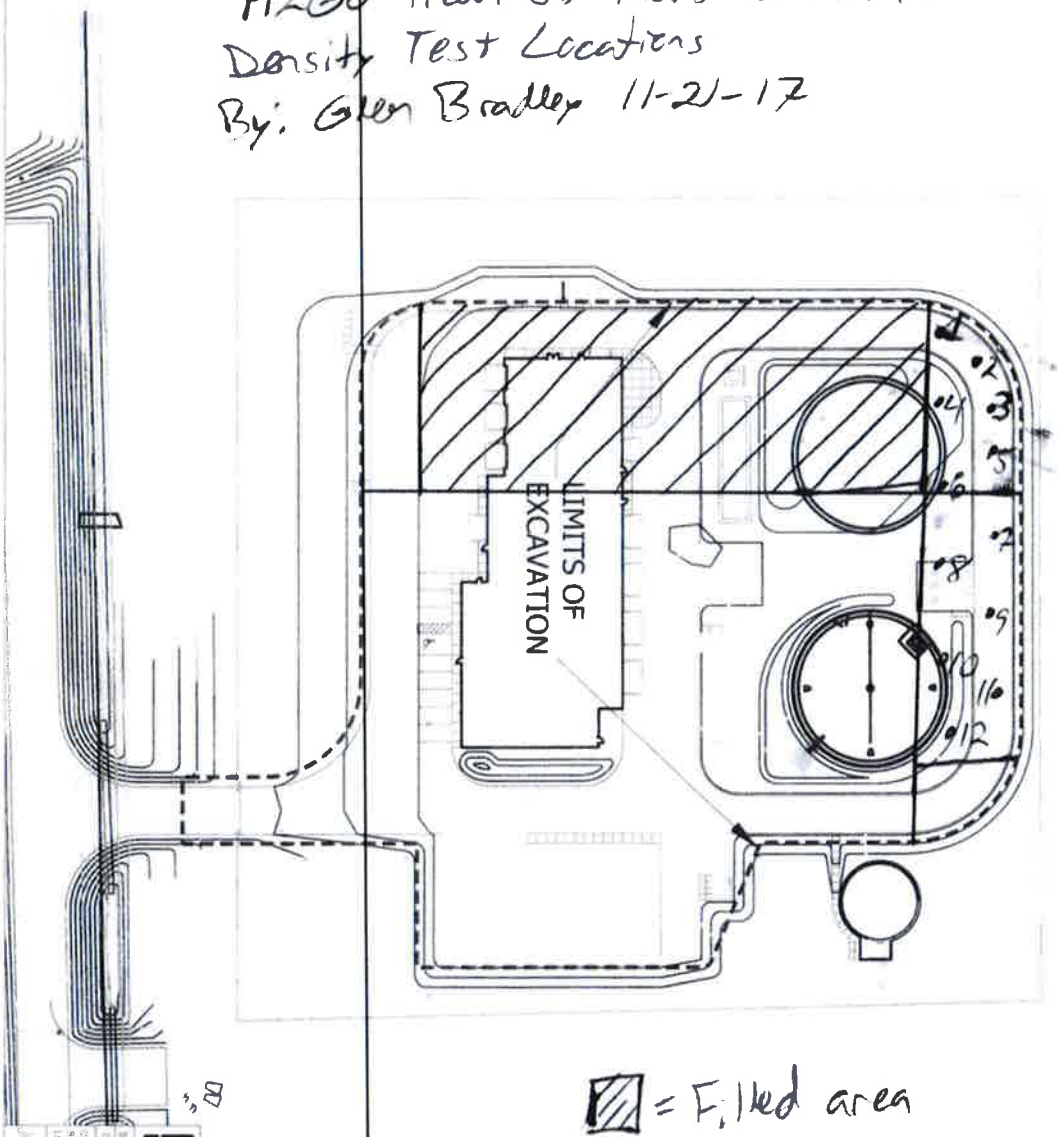
ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-21-17

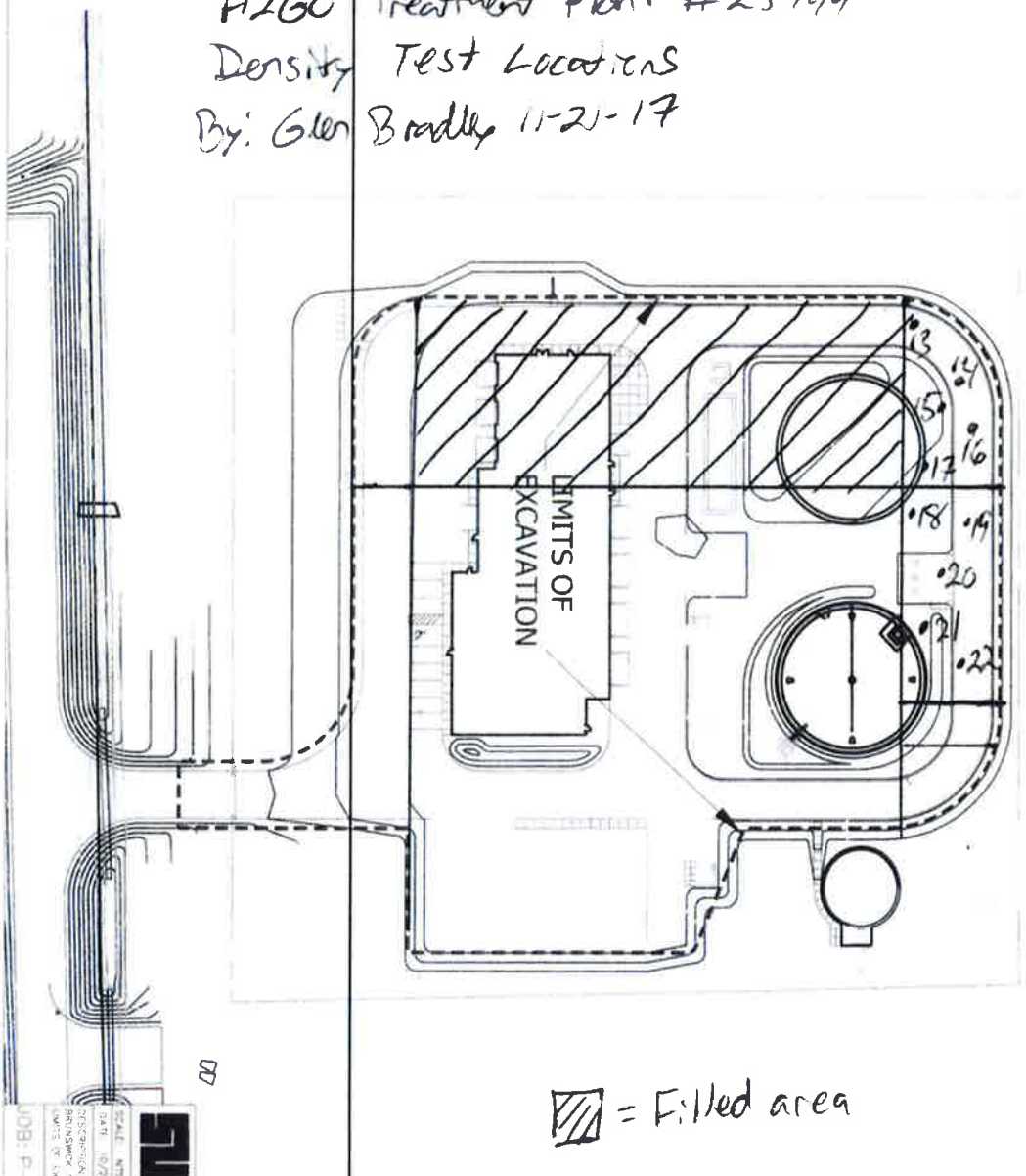


= Filled area

6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

H2GO Treatment Plant #25919
Density Test Locations
By: Glen Bradley 11-21-17



= Filled area

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/21/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3200
Model	3440	Moisture Std	836
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	115.5	102.7	12.6	96.0	P	
2		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	115.5	103.0	12.3	96.3	P	
3		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	117.6	102.8	14.4	96.1	P	
4		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	115.2	102.5	12.4	95.8	P	
5		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	116.6	103.2	13.0	96.4	P	
6		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	117.9	102.9	14.6	96.2	P	
7		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	115.5	102.9	12.4	96.2	P	
8		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	116.8	102.1	14.4	95.4	P	
9		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	118.2	104.6	13.0	97.8	P	
10		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	117.6	102.7	14.5	96.0	P	
11		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	119.7	104.7	14.4	97.9	P	
12		DT	6	Build site pad	-10"	S-1	0.00	107.00	13.20	116.6	102.1	14.2	95.4	P	
13		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	117.0	105.0	11.5	98.1	P	
14		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	116.5	104.0	12.0	97.2	P	
15		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	117.4	104.1	12.7	97.3	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/21/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3200
Model	3440	Moisture Std	836
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	118.9	104.2	14.1	97.4	P	
17		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	116.2	102.2	13.6	95.5	P	
18		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	117.6	102.6	14.7	95.9	P	
19		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	115.8	102.1	13.4	95.4	P	
20		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	116.5	102.7	13.4	96.0	P	
21		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	116.4	102.9	13.3	96.2	P	
22		DT	6	Build site pad	0	S-1	0.00	107.00	13.20	117.2	102.3	14.6	95.6	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 25, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 13 11/22/2017

Winslow Goins

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**13**
Day & Date	**Wednesday 11/22/2017**
Weather	**62°/ Cloudy**
On-Site Time	**2.00**
Lab Time	**0.50**
Travel Time*	**0.75**
Total	**3.25**
Re Obs. Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **24**

Chargeable Items

Time of Arrival **09:45A** Departure **11:45A**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested to perform density tests. Upon arriving on site the undersigned was notified by the superintendent that the testing was cancelled for this date due to one of the grading workers becoming ill half way through the day.

By **Glen M Bradley, — Field Technician** 1800

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 28, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**
ECS Job # **22:25949**

Permits:
Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X	Field Reports
X	For your use
X	As requested

ENCL:
Field Report # 14 11/27/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**14**
Day & Date	**Monday 11/27/2017**
Weather	**55°/ Sunny**
On-Site Time	**5.00**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**6.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **10:00A** Departure **03:00P**

* Travel time and mileage will be billed in accordance with the contract.

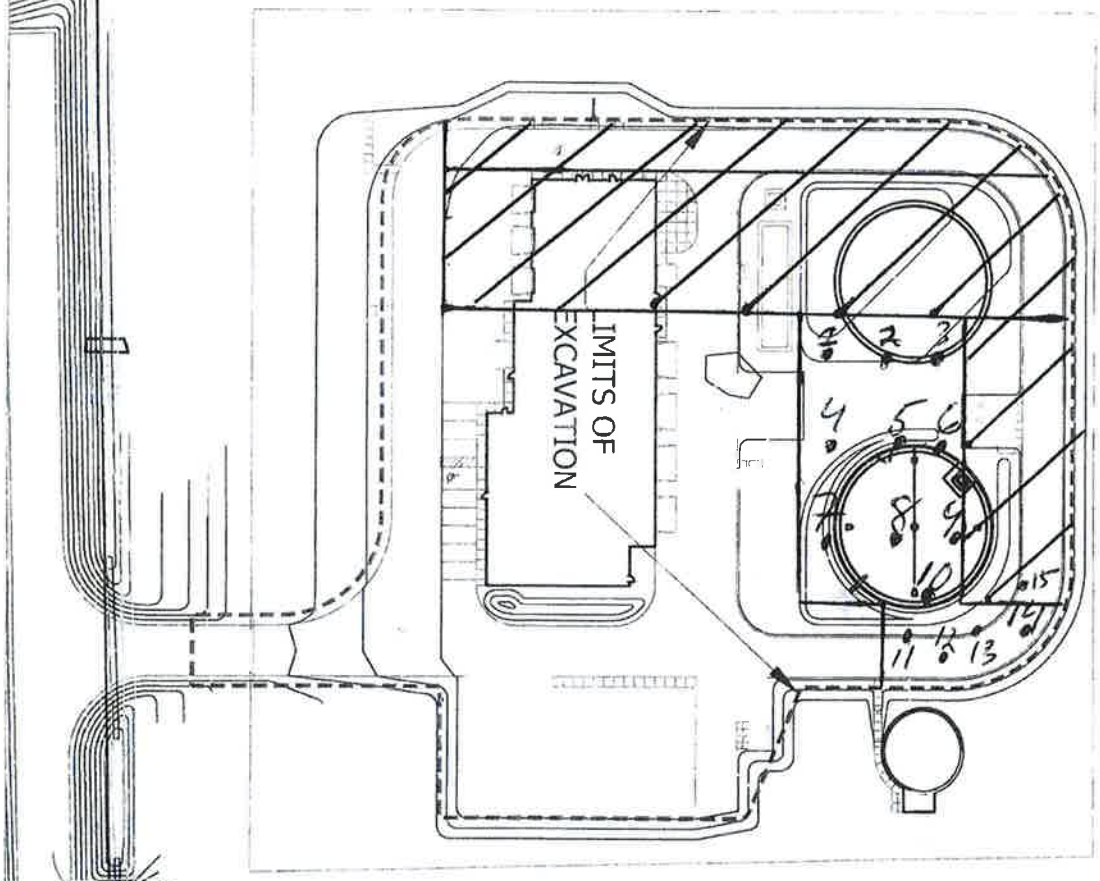
Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

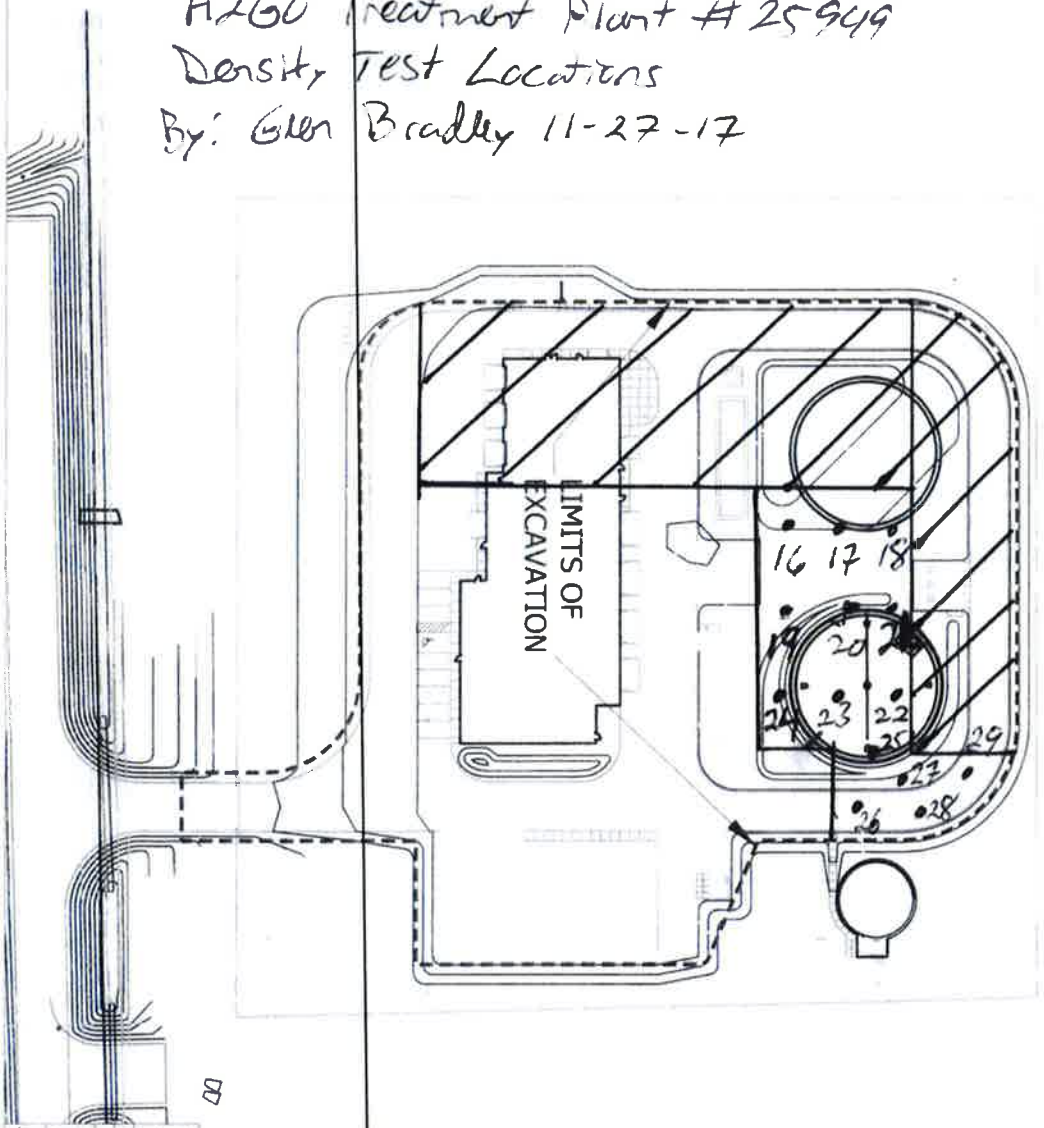
By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-27-17



JOB: P-787

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 11-27-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/27/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3260
Model	3440	Moisture Std	863
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	110.5	102.8	7.4	96.1	P	
2		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	112.7	104.6	7.7	97.8	P	
3		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	110.3	102.7	7.5	96.0	P	
4		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	112.5	104.5	7.7	97.7	P	
5		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	110.3	102.8	7.3	96.1	P	
6		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	113.0	102.9	9.8	96.2	P	
7		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	113.5	103.0	10.2	96.3	P	
8		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	115.4	105.7	9.2	98.8	P	
9		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	116.1	106.3	9.3	99.3	P	
10		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	114.1	106.3	7.3	99.3	P	
11		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	110.3	102.1	8.0	95.4	P	
12		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	110.6	102.1	8.5	95.4	P	
13		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	111.0	102.8	7.9	96.1	P	
14		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	113.1	104.1	8.6	97.3	P	
15		DT	6	Building site pad	-2'6	S-1	0.00	107.00	13.20	108.5	102.0	6.4	95.3	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/27/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3260
Model	3440	Moisture Std	863
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	114.8	103.5	10.9	96.7	P	
17		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	117.2	105.9	10.7	99.0	P	
18		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	112.1	101.9	10.2	95.2	P	
19		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.3	102.7	10.3	96.0	P	
20		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	111.8	101.7	9.8	95.0	P	
21		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	114.4	104.9	9.1	98.0	P	
22		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	114.0	102.5	11.2	95.8	P	
23		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.5	102.6	10.7	95.9	P	
24		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.8	102.9	10.6	96.2	P	
25		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.8	102.9	10.5	96.2	P	
26		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.2	102.5	10.5	95.8	P	
27		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	112.1	102.6	9.4	95.9	P	
28		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.5	102.8	10.6	96.1	P	
29		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	112.5	102.4	9.9	95.7	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 29, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

__X__ Field Reports
__X__ For your use
__X__ As requested

ENCL:

Field Report # 15 11/28/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**15**
Day & Date	**Tuesday 11/28/2017**
Weather	**68°/ Sunny**
On-Site Time	**6.50**
Lab Time	**0.50**
Travel Time*	**0.50**
Total	**7.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **20**

Chargeable Items

Time of Arrival **10:30A** Departure **05:00P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

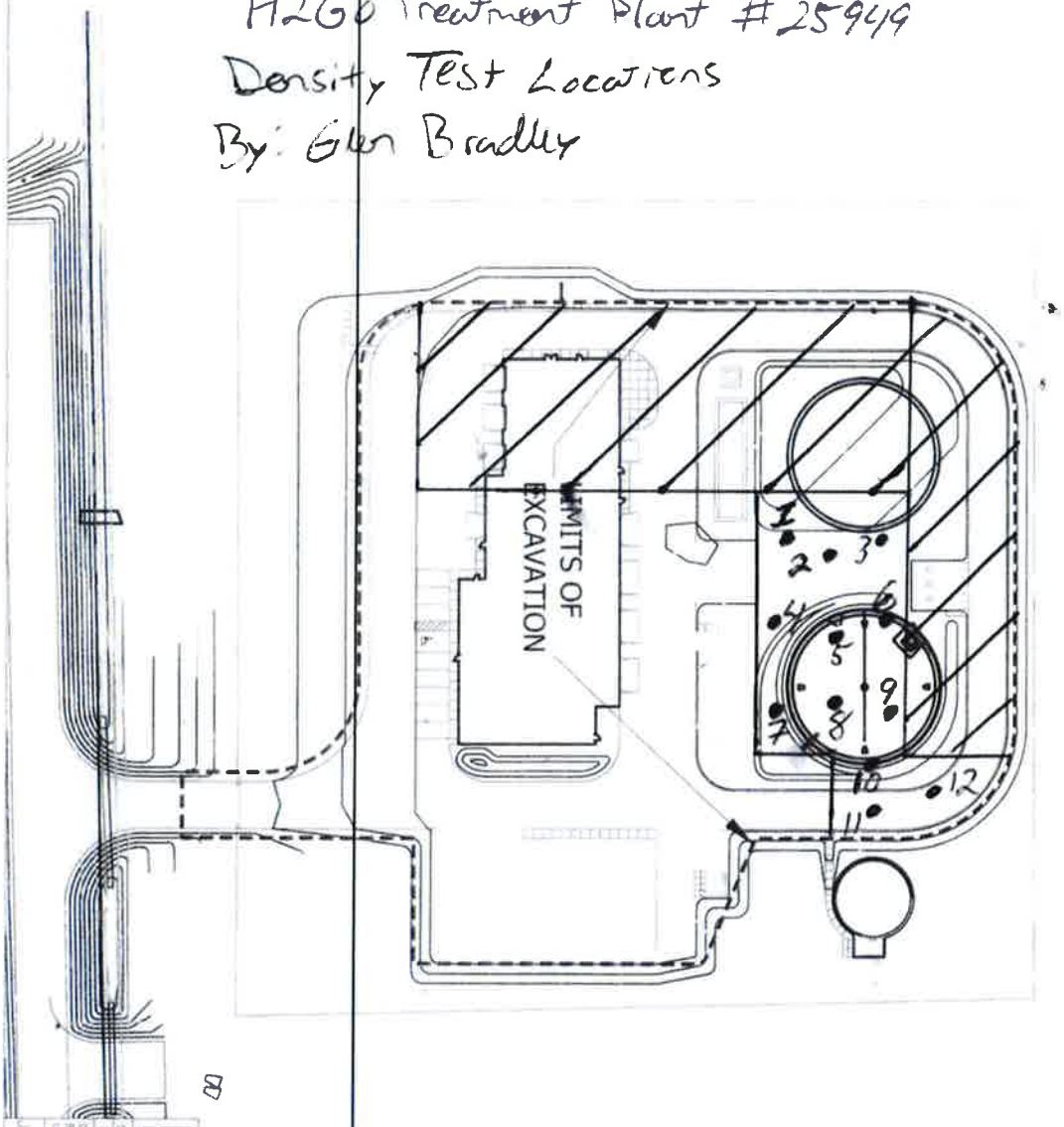
ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley



6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

ECS SOUTHEAST, LLP

"Setting the Standard for Service"

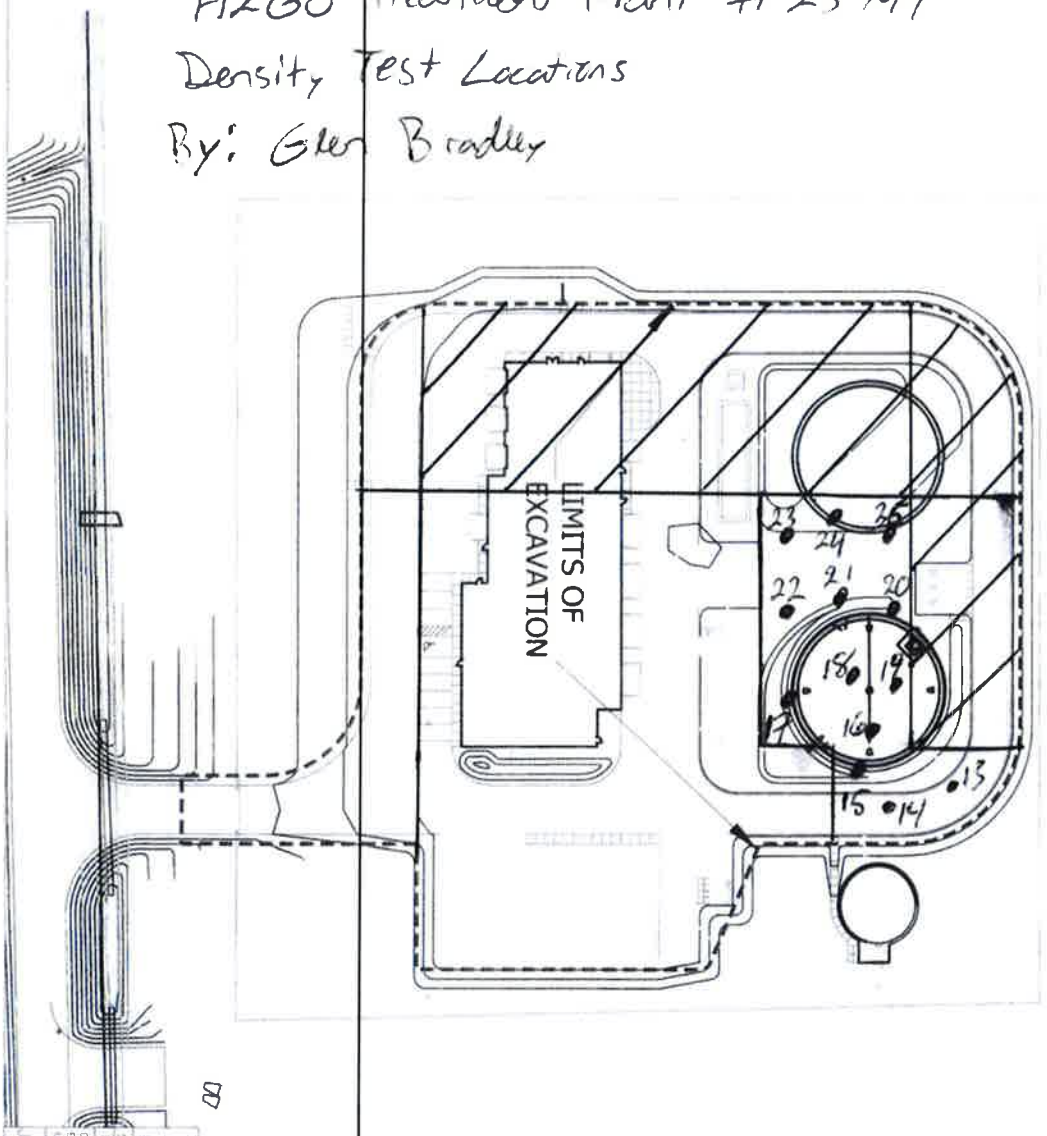
Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H260 Treatment Plant # 25919

Density Test Locations

By: Glen Bradley



6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/28/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3284
Model	3440	Moisture Std	860
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	114.0	104.2	9.4	97.4	P	
2		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	112.0	102.4	9.4	95.7	P	
3		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.6	104.8	10.2	97.9	P	
4		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	110.7	102.1	8.6	95.4	P	
5		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.3	105.1	9.7	98.2	P	
6		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	112.8	102.2	10.4	95.5	P	
7		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	117.0	102.7	13.9	96.0	P	
8		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	117.0	103.9	12.6	97.1	P	
9		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	120.1	106.5	12.7	99.5	P	
10		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	113.4	102.5	10.6	95.8	P	
11		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.4	103.3	17.5	96.5	P	
12		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	119.3	104.3	14.4	97.5	P	
13		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	121.4	102.6	18.3	95.9	P	
14		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	119.7	104.6	14.5	97.8	P	
15		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.1	104.3	11.3	97.5	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/28/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3284
Model	3440	Moisture Std	860
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	113.9	104.2	9.3	97.4	P	
17		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	113.9	103.5	10.0	96.7	P	
18		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	121.1	106.7	13.5	99.7	P	
19		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	120.2	108.3	11.1	101	P	
20		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	118.7	106.4	11.5	99.4	P	
21		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	120.9	103.2	17.2	96.4	P	
22		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	119.7	103.8	15.3	97.0	P	
23		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	120.3	105.5	14.1	98.6	P	
24		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	119.4	105.7	13.0	98.8	P	
25		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	118.2	103.2	14.5	96.4	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

November 30, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 16 11/29/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**16**
Day & Date	**Wednesday 11/29/2017**
Weather	**65°/ Sunny**
On-Site Time	**6.75**
Lab Time	**0.50**
Travel Time*	**0.50**
Total	**7.75**
Re Obs. Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **15**

Chargeable Items

Time of Arrival **10:00A** Departure **04:45P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

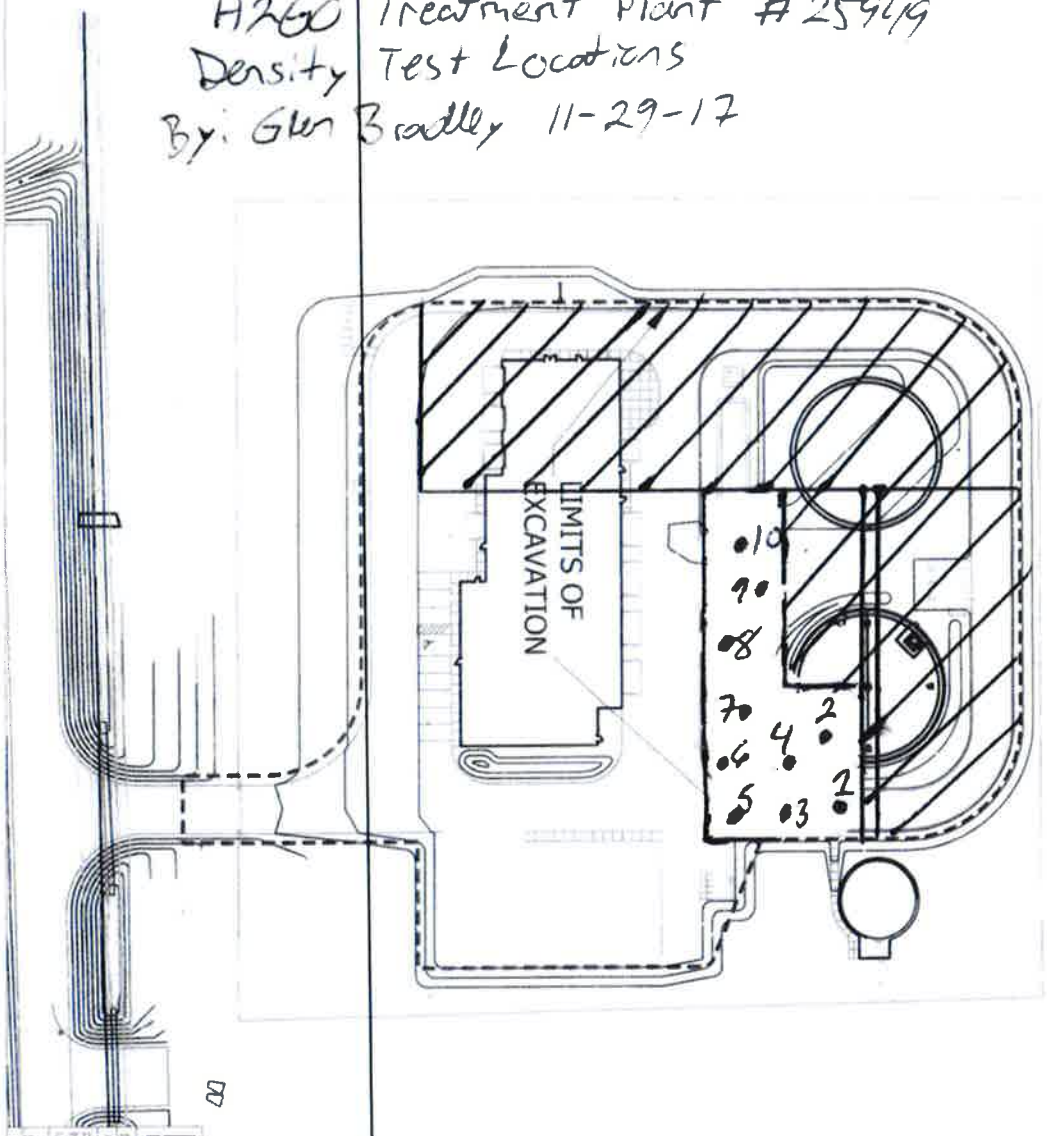
ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H260 Treatment Plant #2594/9
Density Test Locations
By: Glen Bradley 11-29-17



6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

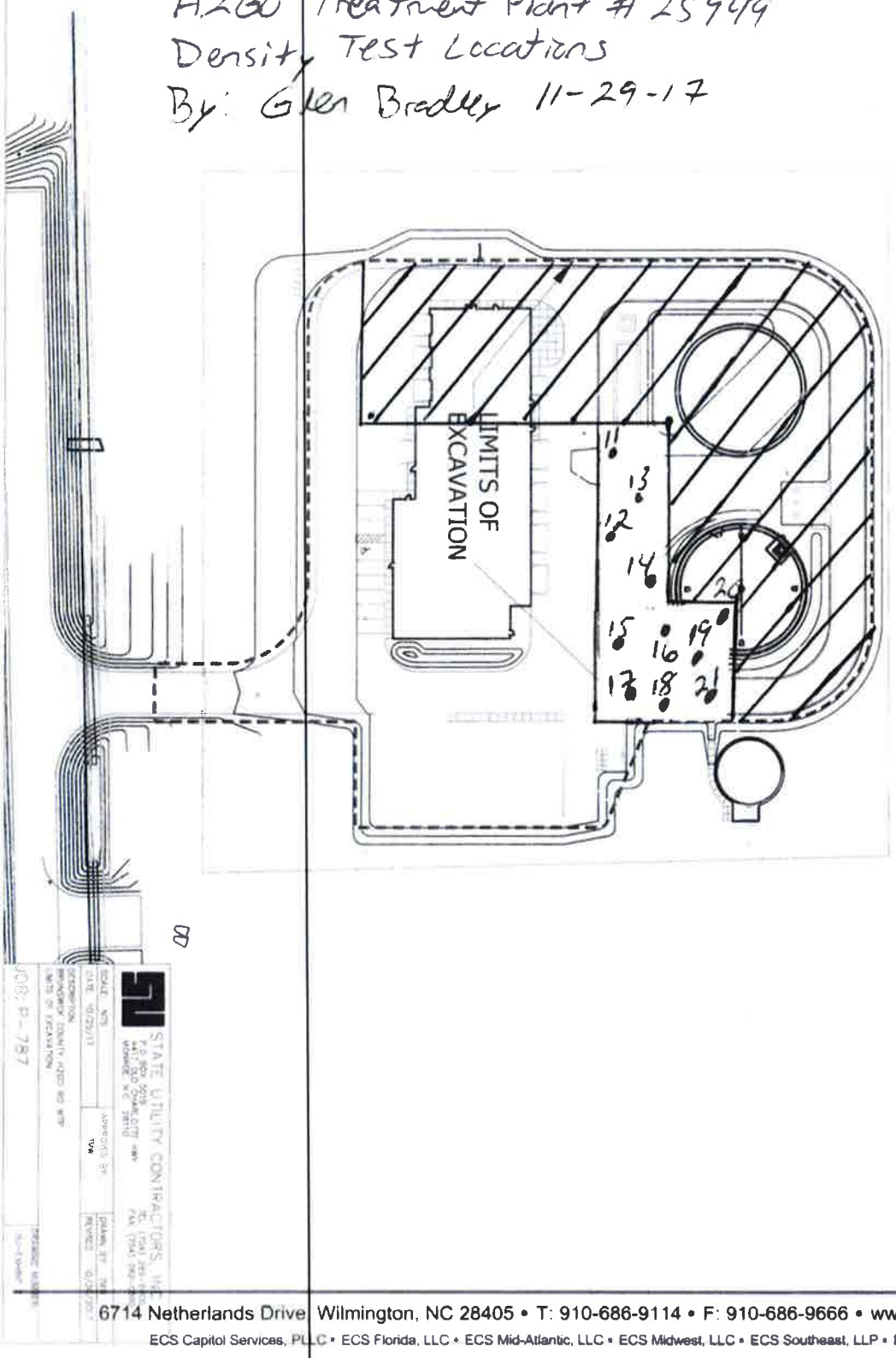
ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H2GO Treatment Plant # 25949
Density Test Locations
By: Glen Bradley 11-29-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/29/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3279
Model	3440	Moisture Std	860
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.8	103.1	15.2	96.4	P	
2		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	114.8	102.9	11.6	96.2	P	
3		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.9	102.1	14.6	95.4	P	
4		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	116.7	103.6	12.6	96.8	P	
5		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	122.4	108.0	13.2	101	P	
6		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	119.2	106.6	11.8	99.6	P	
7		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.9	105.2	13.0	98.3	P	
8		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.7	107.6	12.2	101	P	
9		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	119.2	106.8	11.5	99.8	P	
10		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.2	108.7	11.4	102	P	
11		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	115.3	103.5	11.4	96.7	P	
12		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	120.5	105.3	14.4	98.4	P	
13		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	118.5	105.4	12.5	98.5	P	
14		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	119.8	106.4	12.6	99.4	P	
15		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	125.2	105.5	18.7	98.6	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/29/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3279
Model	3440	Moisture Std	860
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	116.8	104.0	12.3	97.2	P	
17		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	120.9	103.6	16.8	96.8	P	
18		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	117.6	104.8	12.2	97.9	P	
19		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	117.9	105.6	11.6	98.7	P	
20		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	117.5	105.2	11.6	98.3	P	
21		DT	6	Building site pad	1'8"	S-1	0.00	107.00	13.20	117.6	104.2	12.8	97.4	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 1, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

__X__ Field Reports
__X__ For your use
__X__ As requested

ENCL:

Field Report # 17 11/30/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	22:25949
Report No.	17
Day & Date	Thursday 11/30/2017
Weather	71°/ Sunny
On-Site Time	5.00
Lab Time	0.50
Travel Time*	0.50
Total	6.00
Re Obs. Time	0.00

Project	H2GO Reverse Osmosis WTP - Contract 4
Location	Belville, NC
Client	State Utility Contractors, Inc. - Todd Wasson, P.E.
Contractor	State Utility Contractors, Inc. - Accounts Payable

Remarks

Trip Charges* Tolls/Parking* Mileage* 15 Time of Arrival 10:00A Departure 03:00P

Chargeable Items

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

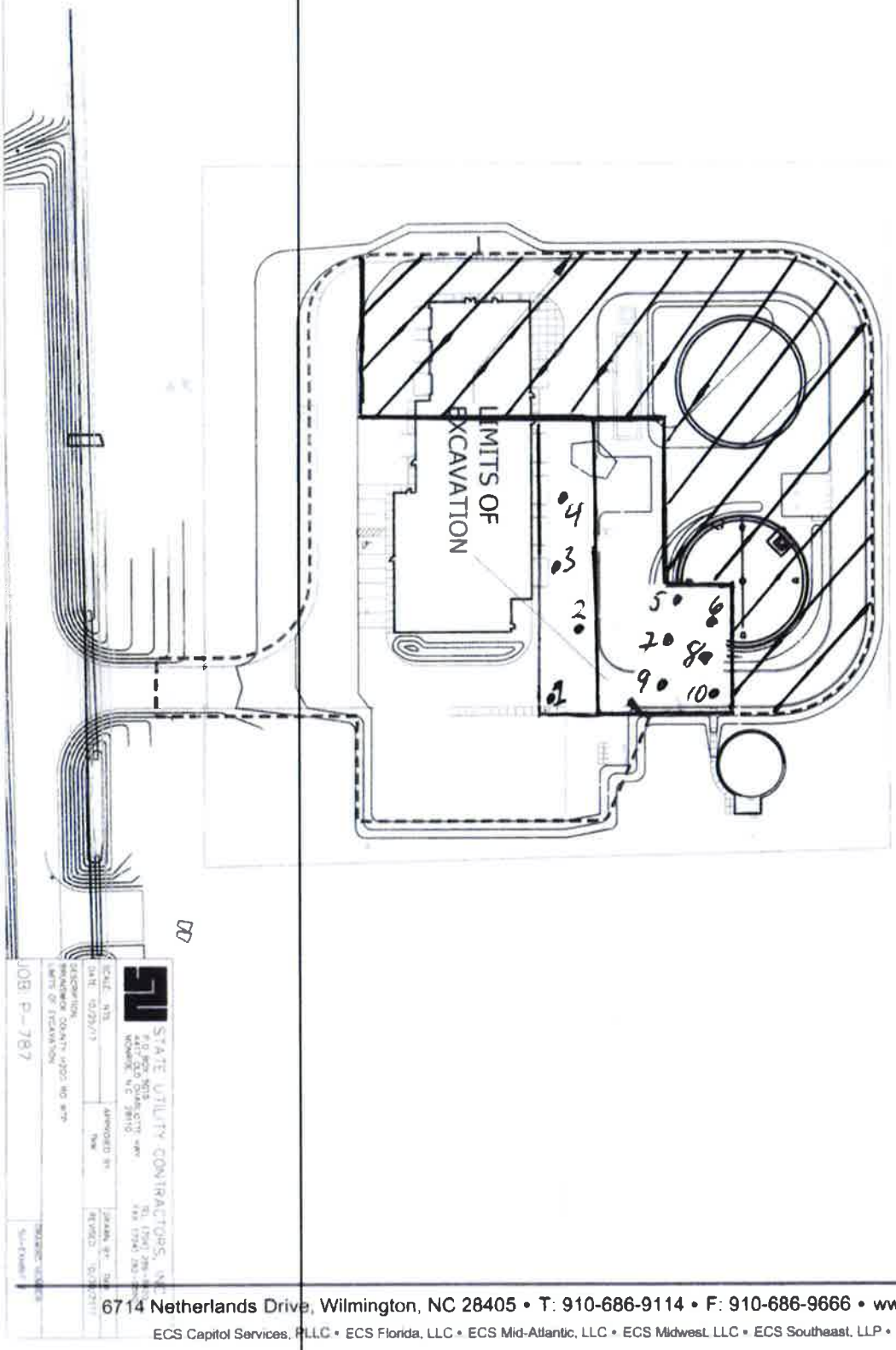
The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at locations # 1-4.

Locations # 1-4 had a percent moisture content that was too high to achieve compaction and was visibly unstable.

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800


LIMITS OF EXCAVATION
1
2
3
4
5
6
7
8
9
10
JOB P-787

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 11/30/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3281
Model	3440	Moisture Std	877
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.1	100.2	19.9	93.6	F	Moisture too high and visibly unstable
2		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.3	101.3	19.8	94.7	F	Moisture too high and visibly unstable
3		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.8	100.6	20.1	94.0	F	Moisture too high and visibly unstable
4		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.5	99.9	20.6	93.4	F	Moisture too high and visibly unstable
5		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.5	105.1	15.6	98.2	P	
6		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	114.9	102.4	12.2	95.7	P	
7		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	122.1	109.6	11.4	102	P	
8		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.8	102.3	14.2	95.6	P	
9		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.6	103.6	11.6	96.8	P	
10		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.0	102.8	11.9	96.1	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 4, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X	Field Reports
X	For your use
X	As requested

ENCL:

Field Report # 18 12/01/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**18**
Day & Date	**Friday 12/01/2017**
Weather	**70°/ Sunny**
On-Site Time	**6.00**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**7.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **09:45A** Departure **03:45P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

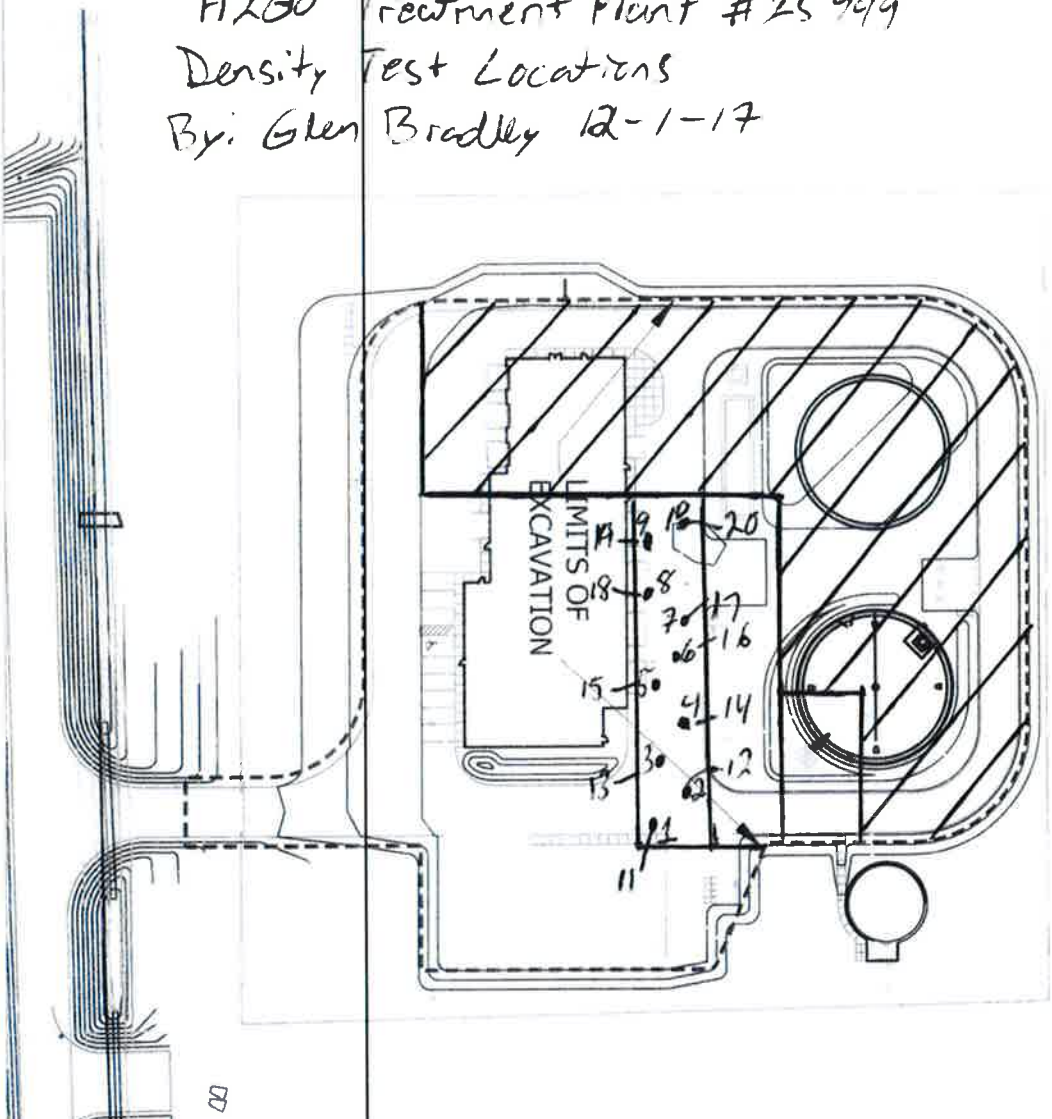
ECS SOUTHEAST, LLP

Geotechnical • Construction Materials • Environmental • Facilities

"Setting the Standard for Service"

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 12-1-17



6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/01/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3190
Model	3440	Moisture Std	866
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	122.3	107.7	13.5	101	P	
2		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.5	102.6	18.5	95.9	P	
3		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	125.0	108.7	15.0	102	P	
4		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.0	102.1	18.6	95.4	P	
5		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	121.6	104.8	16.0	97.9	P	
6		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	122.6	105.1	16.6	98.2	P	
7		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	118.7	102.1	16.3	95.4	P	
8		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	123.9	107.4	15.4	100	P	
9		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.4	103.8	16.0	97.0	P	
10		DT	6	Building site pad	-2'6"	S-1	0.00	107.00	13.20	120.9	105.5	14.6	98.6	P	
11		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.4	102.2	11.0	95.5	P	
12		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	114.0	103.7	9.9	96.9	P	
13		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.5	102.6	10.7	95.9	P	
14		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	123.6	106.5	16.0	99.5	P	
15		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	112.5	102.2	10.0	95.5	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/01/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3190
Model	3440	Moisture Std	866
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	119.8	105.1	13.9	98.2	P	
17		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	115.4	104.3	10.6	97.5	P	
18		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	114.2	102.5	11.5	95.8	P	
19		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	122.8	107.4	14.3	100	P	
20		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	121.2	107.9	12.3	101	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 5, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**
ECS Job # **22:25949**

Permits:
Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X	Field Reports
X	For your use
X	As requested

ENCL:

Field Report # 19 12/04/2017

Winslow Goins

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**19**
Day & Date	**Monday 12/04/2017**
Weather	**62°/ Sunny**
On-Site Time	**6.25**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**7.75**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **10:00A** Departure **04:15P**

* Travel time and mileage will be billed in accordance with the contract.

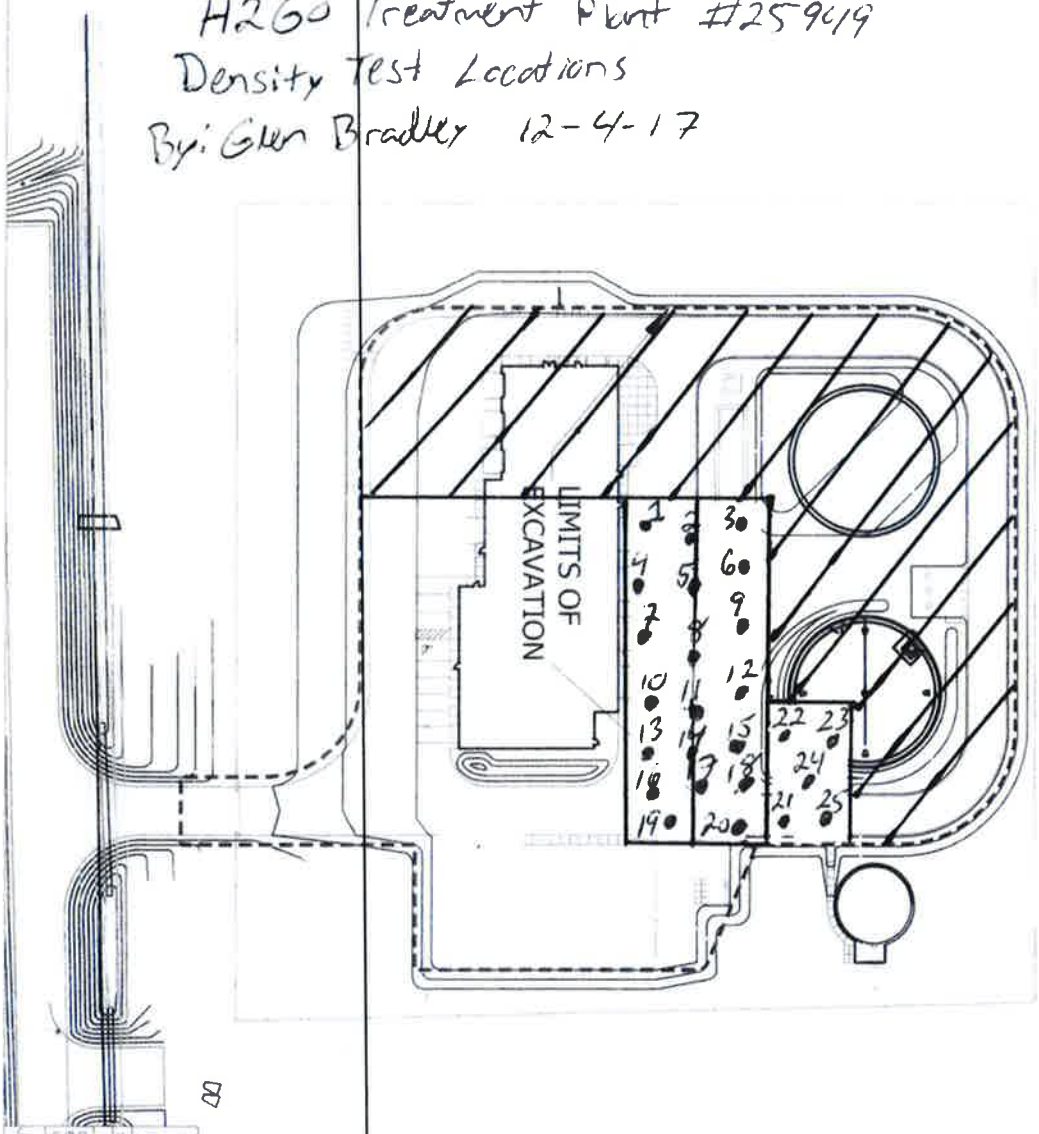
Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method ASTM D-698.

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25919
Density Test Locations
By: Glen Bradley 12-4-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/04/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3221
Model	3440	Moisture Std	871
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	112.6	102.3	9.9	95.6	P	
2		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	111.8	102.5	9.1	95.8	P	
3		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	110.4	104.7	5.4	97.9	P	
4		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	111.7	105.0	6.4	98.1	P	
5		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.1	104.7	10.9	97.9	P	
6		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	112.6	102.5	9.8	95.8	P	
7		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	112.5	105.0	7.1	98.1	P	
8		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.7	106.2	9.9	99.3	P	
9		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	111.8	103.7	7.8	96.9	P	
10		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	111.0	104.6	6.2	97.8	P	
11		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	122.7	107.5	14.1	101	P	
12		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.2	103.0	11.8	96.3	P	
13		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.3	108.5	11.7	101	P	
14		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	118.5	104.4	13.6	97.6	P	
15		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	110.7	102.7	7.8	96.0	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/04/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3221
Model	3440	Moisture Std	871
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	111.3	102.3	8.9	95.6	P	
17		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	119.9	104.9	14.3	98.0	P	
18		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.0	106.6	13.5	99.6	P	
19		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.8	104.8	10.4	97.9	P	
20		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.0	104.0	10.5	97.2	P	
21		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	123.3	106.8	15.4	99.8	P	
22		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	115.3	102.5	12.3	95.8	P	
23		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	113.7	104.3	9.0	97.5	P	
24		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	120.2	104.4	15.1	97.6	P	
25		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	120.9	104.6	15.5	97.8	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 6, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**
ECS Job # **22:25949**

Permits:
Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X	Field Reports
X	For your use
X	As requested

ENCL:

Field Report # 20 12/05/2017

Winslow E. Goins
Principal Engineer

Darrell J. Henderson
Project Engineer

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**20**
Day & Date	**Tuesday 12/05/2017**
Weather	**62°/ Rain**
On-Site Time	**8.00**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**9.50**
Re Obs. Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **08:45A** Departure **04:45P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

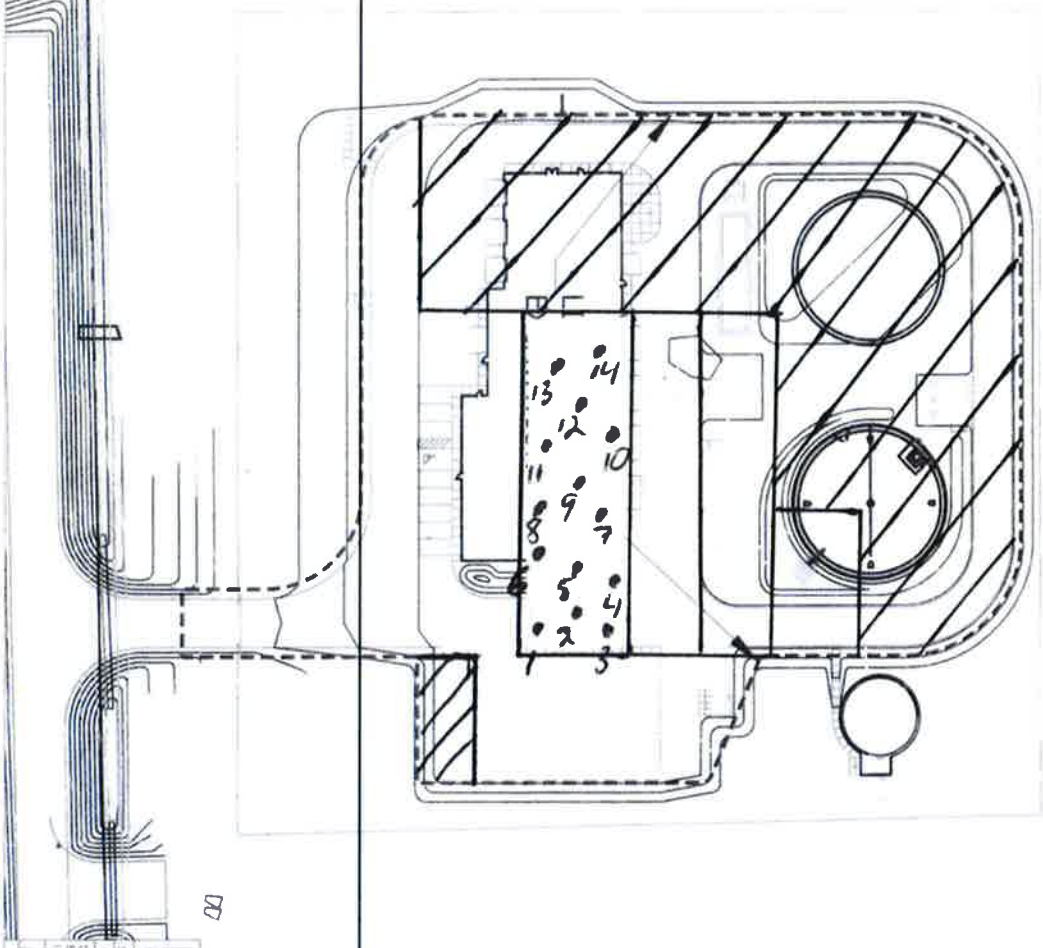
The undersigned arrived on site, as requested, to check the compaction of soils for building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley** 1800

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 12-5-17



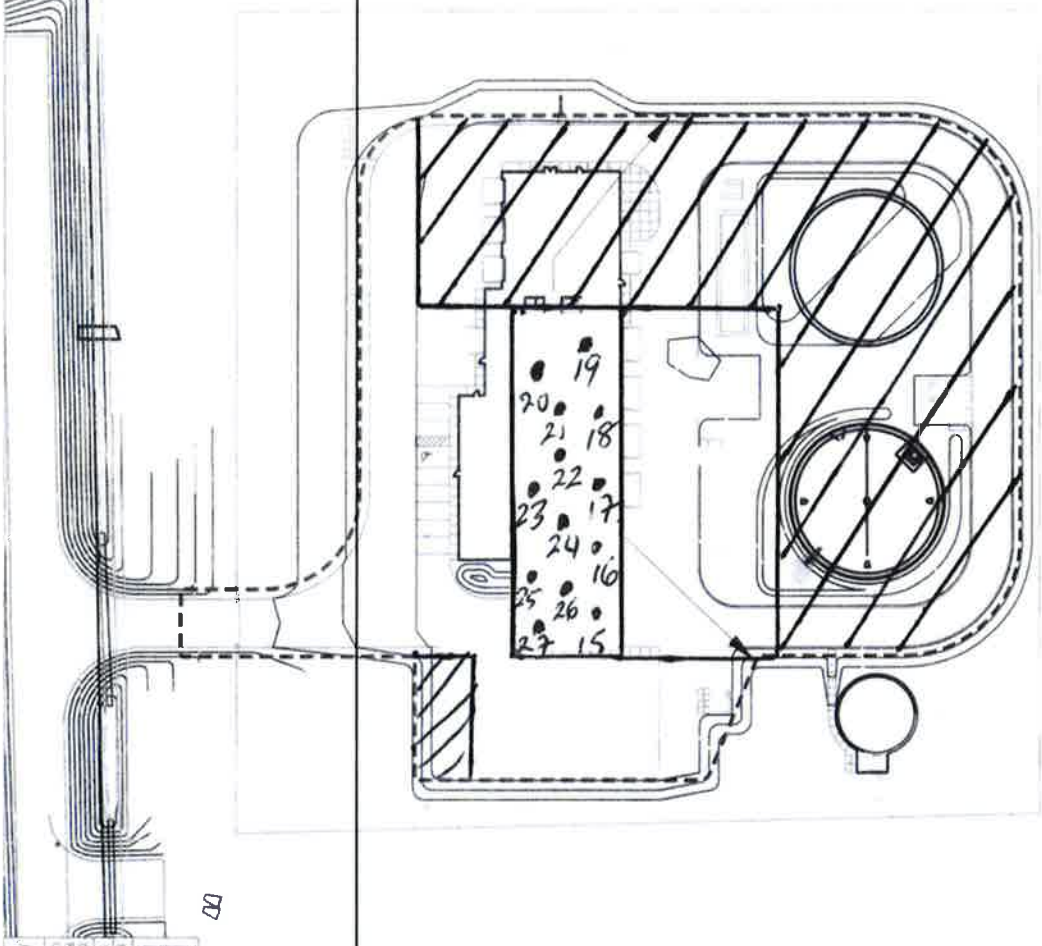
ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 12-5-17



6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/05/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3208
Model	3440	Moisture Std	865
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	114.3	102.1	12.0	95.4	P	
2		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	121.7	106.6	14.2	99.6	P	
3		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	121.6	105.2	15.7	98.3	P	
4		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	125.1	106.8	17.1	99.8	P	
5		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	116.2	103.2	12.7	96.4	P	
6		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	114.5	102.3	11.9	95.6	P	
7		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	115.9	104.1	11.3	97.3	P	
8		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	122.8	106.3	15.5	99.3	P	
9		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	123.6	105.0	17.7	98.1	P	
10		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	121.5	107.3	13.2	100	P	
11		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	122.8	107.2	14.6	100	P	
12		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	116.5	102.7	13.4	96.0	P	
13		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	123.6	106.0	16.5	99.1	P	
14		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	122.1	104.0	17.4	97.2	P	
15		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.0	102.0	10.9	95.3	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/05/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3208
Model	3440	Moisture Std	865
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	116.1	104.1	11.5	97.3	P	
17		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	118.7	105.5	12.5	98.6	P	
18		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	122.4	105.0	16.6	98.1	P	
19		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	124.0	108.6	14.2	102	P	
20		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	119.6	107.2	11.6	100	P	
21		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	114.8	103.3	11.2	96.5	P	
22		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	115.8	104.6	10.7	97.8	P	
23		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	115.6	103.9	11.2	97.1	P	
24		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	115.5	103.3	11.8	96.5	P	
25		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	113.1	102.2	10.7	95.5	P	
26		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	114.2	102.3	11.8	95.6	P	
27		DT	6	Building site pad	-1'8"	S-1	0.00	107.00	13.20	116.2	104.4	11.3	97.6	P	

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 12, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 21 12/11/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**21**
Day & Date	**Monday 12/11/2017**
Weather	**45°/ Sunny**
On-Site Time	**4.25**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**5.75**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **09:45A** Departure **02:00P**

* Travel time and mileage will be billed in accordance with the contract.

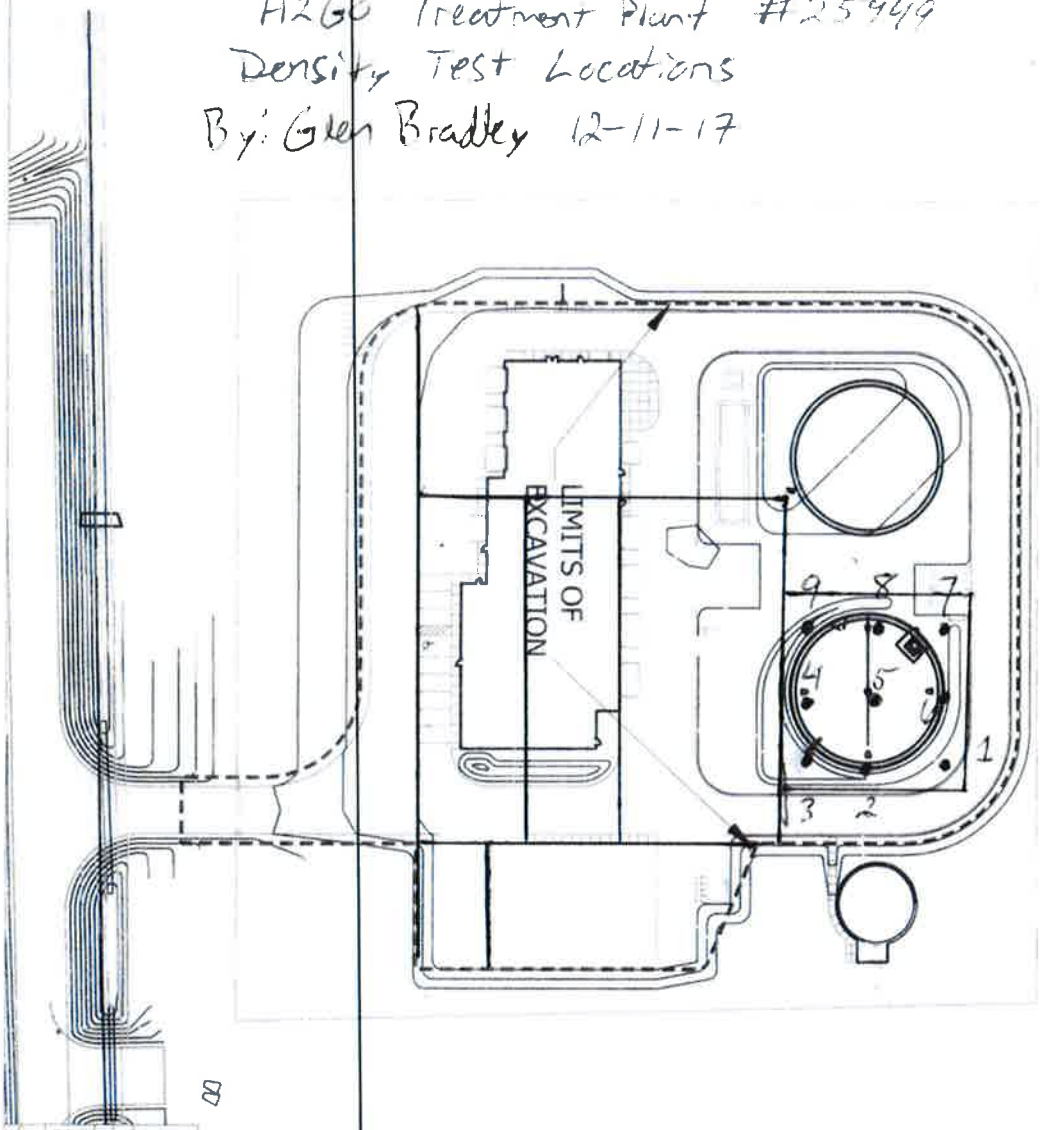
Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 12-11-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/11/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3179
Model	3440	Moisture Std	836
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	113.2	105.2	7.6	98.3	P	
2		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	112.2	102.3	9.6	95.6	P	
3		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	111.0	102.0	8.9	95.3	P	
4		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	113.8	104.7	8.7	97.9	P	
5		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	110.7	102.0	8.5	95.3	P	
6		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	115.1	105.7	8.9	98.8	P	
7		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	114.3	102.2	11.9	95.5	P	
8		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	113.1	104.1	8.7	97.3	P	
9		DT	6	Building site pad	+10"	S-1	0.00	107.00	13.20	112.8	103.1	9.4	96.4	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 13, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 22 12/12/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**22**
Day & Date	**Tuesday 12/12/2017**
Weather	**60°/ Sunny**
On-Site Time	**5.00**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**6.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30** Time of Arrival **10:00A** Departure **03:00P**

Chargeable Items

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

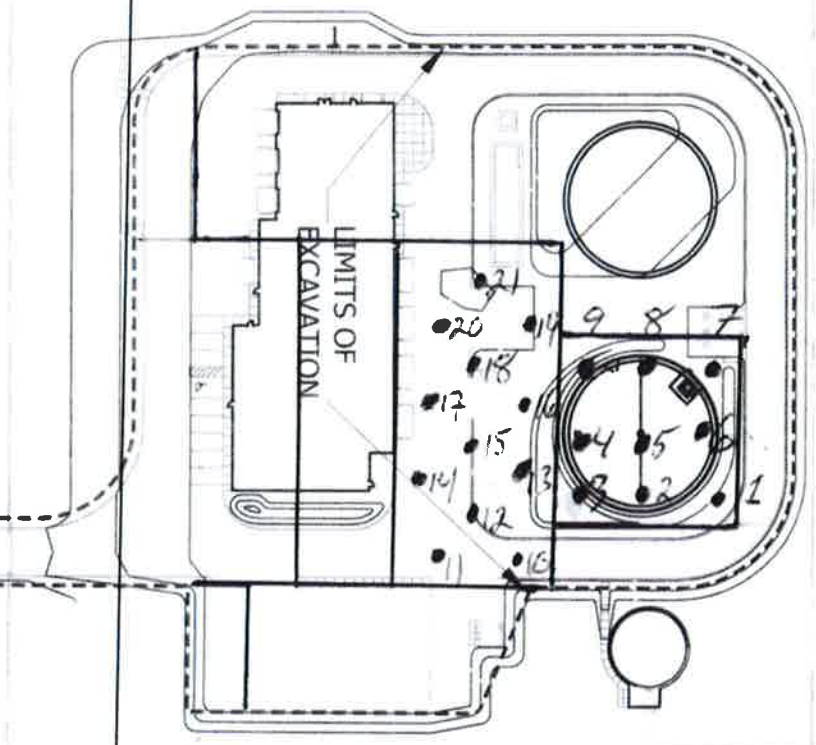
The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant
Density Test Locations
By: Glen Bradley 12-12-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/12/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3197
Model	3440	Moisture Std	850
Ser. No.	500		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	124.6	107.2	16.2	100	P	
2		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	122.9	106.0	16.1	99.1	P	
3		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	125.1	107.9	16.0	101	P	
4		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	125.5	108.0	16.2	101	P	
5		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	122.4	105.5	16.1	98.6	P	
6		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	124.4	107.1	16.1	100	P	
7		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	119.4	104.2	14.7	97.4	P	
8		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	116.2	104.1	11.6	97.3	P	
9		DT	6	Building site pad	+1'5"	S-1	0.00	107.00	13.20	124.5	107.1	16.2	100	P	
10		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	123.1	109.0	12.9	102	P	
11		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	121.8	105.7	15.2	98.8	P	
12		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	117.7	104.3	12.9	97.5	P	
13		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	122.0	108.5	12.5	101	P	
14		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	117.9	107.4	9.8	100	P	
15		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	120.5	104.8	15.0	97.9	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/12/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 11			
Make	Troxler	Density Std	3197
Model	3440	Moisture Std	850
Ser. No.	500		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	121.8	108.2	12.5	101	P	
17		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	122.7	109.8	11.7	103	P	
18		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.4	102.6	13.5	95.9	P	
19		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	115.5	102.1	13.0	95.4	P	
20		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	119.8	104.4	14.8	97.6	P	
21		DT	6	Building site pad	0	S-1	0.00	107.00	13.20	116.3	106.5	9.2	99.5	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 13, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 23 12/13/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**23**
Day & Date	**Wednesday 12/13/2017**
Weather	**38°/ Sunny**
On-Site Time	**7.25**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**8.75**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30** Time of Arrival **09:00A** Departure **04:15P**

Chargeable Items

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

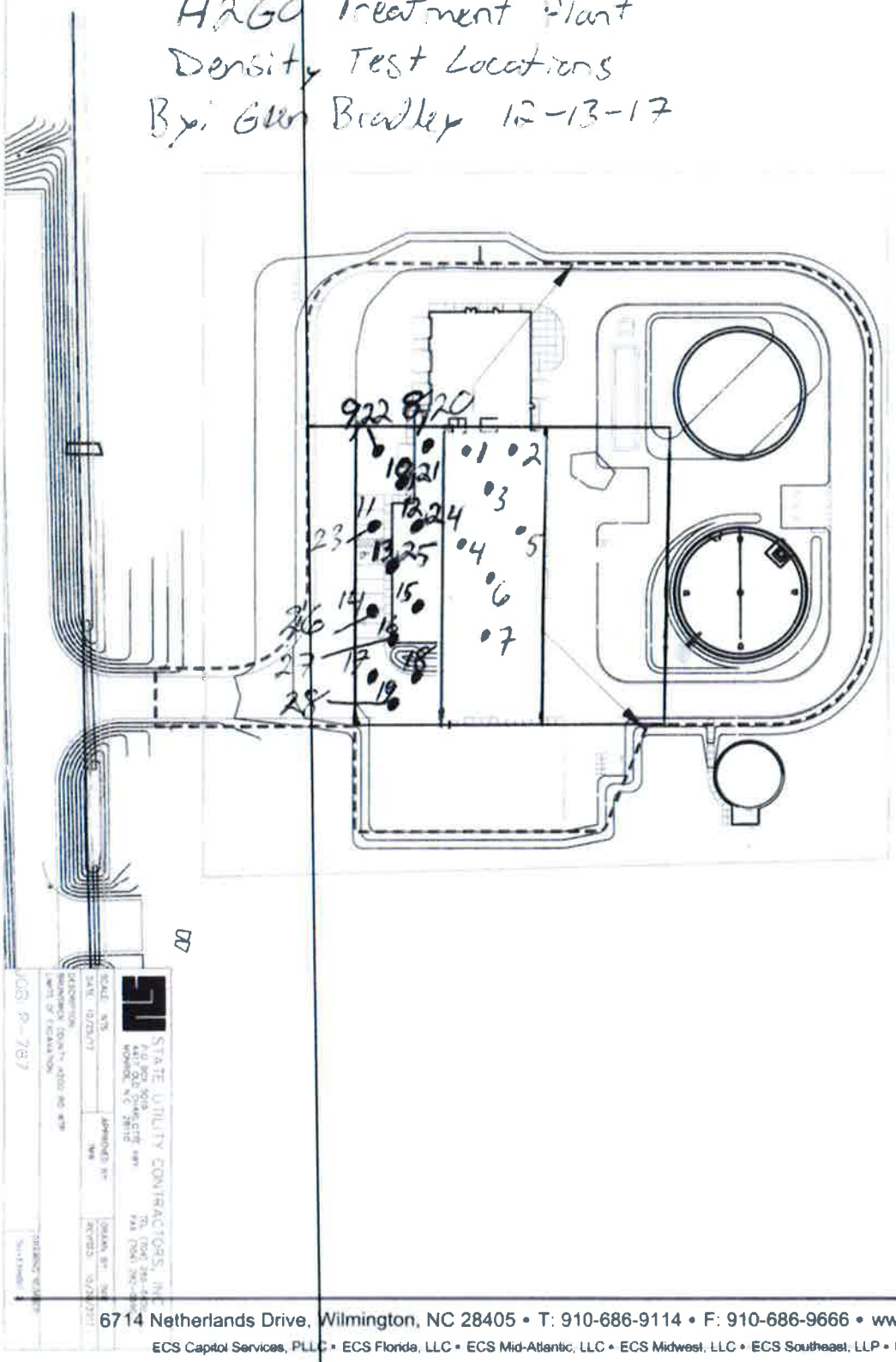
Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at location #'s 3-7, 23,24, and 26-28.

Locations 3-7 had a percent moisture content that was too high. The area was also visibly unstable and pumping. Locations 23, 26 and 28 had percent moisture content that was too high, was visibly unstable and did not meet 95% compaction. Locations 24 and 27 had a percent moisture content that was too high and the area was visibly unstable.

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant
Density Test Locations
By: Glen Bradley 12-13-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/13/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 24			
Make	Troxler	Density Std	2904
Model	3440	Moisture Std	422
Ser. No.	2334		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	114.5	103.8	10.3	97.0	P	
2		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	122.9	108.2	13.7	101	P	
3		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	123.7	105.8	17.0	98.9	F	Percent moisture too high and visibly unstable
4		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	123.5	105.6	16.9	98.7	F	Percent moisture too high and visibly unstable
5		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	122.7	104.5	17.5	97.7	F	Percent moisture too high and visibly unstable.
6		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	124.2	106.1	17.1	99.2	F	Percent moisture too high and visibly unstable
7		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	123.4	104.0	18.6	97.2	F	Percent

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/13/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 24			
Make	Troxler	Density Std	2904
Model	3440	Moisture Std	422
Ser. No.	2334		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
															moisture too high and visibly unstable
8		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	110.8	102.9	7.7	96.2	P	
9		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	117.1	106.5	9.9	99.5	P	
10		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	120.2	107.8	11.6	101	P	
11		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	119.2	105.7	12.7	98.8	P	
12		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	121.0	103.3	17.1	96.5	P	
13		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	119.6	103.9	15.2	97.1	P	
14		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	122.7	106.7	15.1	99.7	P	
15		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	119.3	104.8	13.8	97.9	P	
16		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	119.3	104.8	13.8	97.9	P	
17		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	120.7	104.1	16.0	97.3	P	
18		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	120.2	104.7	14.8	97.9	P	
19		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	122.1	105.3	15.9	98.4	P	
20		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	116.9	105.4	10.9	98.5	P	
21		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	120.8	105.6	14.4	98.7	P	
22		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	118.8	105.6	12.5	98.7	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/13/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 24			
Make	Troxler	Density Std	2904
Model	3440	Moisture Std	422
Ser. No.	2334		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
23		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	118.8	97.6	21.6	91.2	F	
24		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	120.8	102.7	17.6	96.0	F	High percent moisture and visibly unstable
25		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	116.0	102.5	13.1	95.8	P	
26		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	112.9	99.7	13.2	93.2	F	
27		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	120.4	102.7	17.2	96.0	F	High percent moisture and visibly unstable
28		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	117.9	101.4	16.3	94.8	F	High percent moisture and visibly unstable

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 15, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 24 12/14/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**24**
Day & Date	**Thursday 12/14/2017**
Weather	**50°/ Sunny**
On-Site Time	**6.50**
Lab Time	**0.50**
Travel Time*	**1.00**
Total	**8.00**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **30**

Chargeable Items

Time of Arrival **09:00A** Departure **03:30P**

* Travel time and mileage will be billed in accordance with the contract.

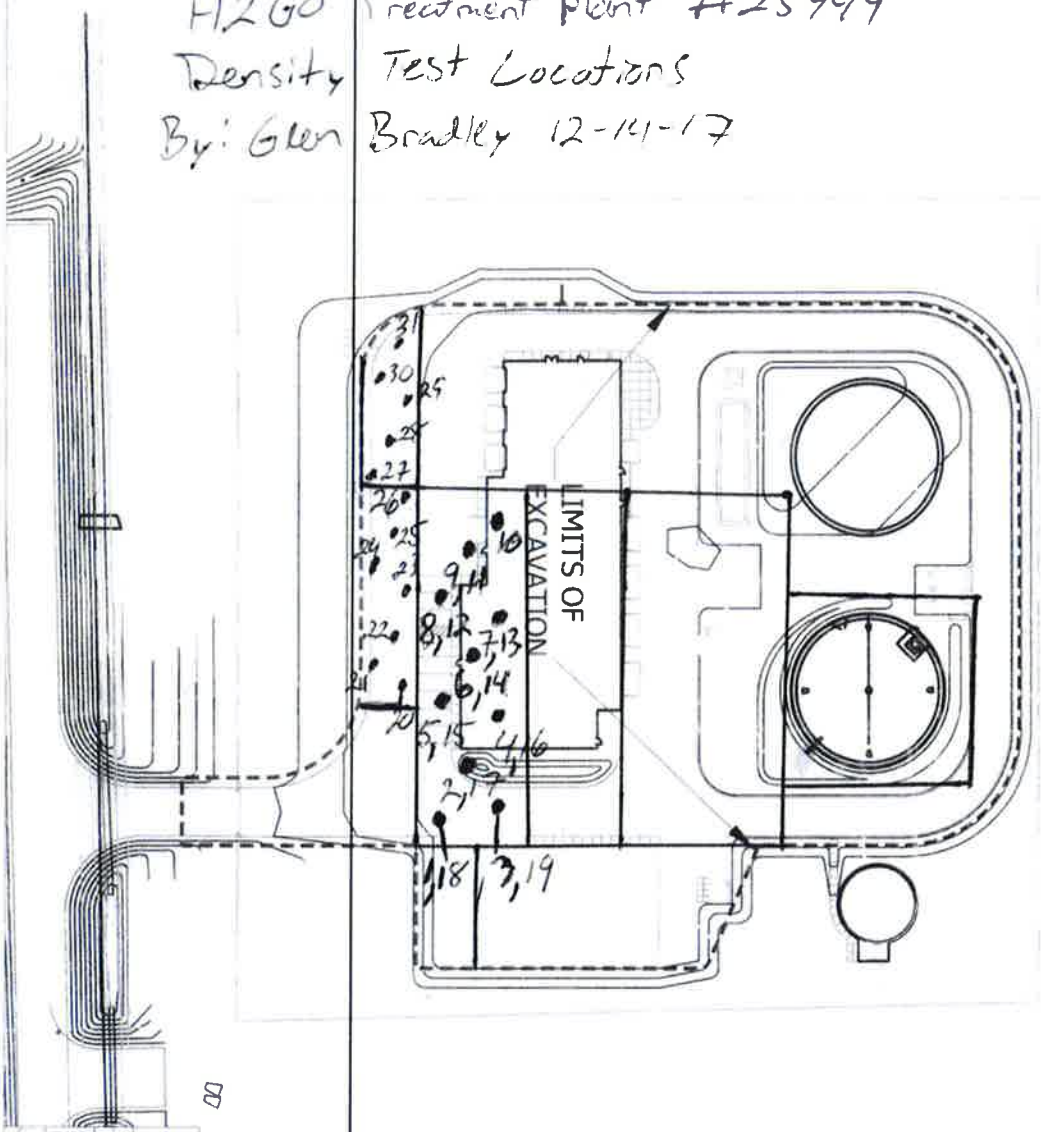
Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698).

By **Glen M Bradley, — Field Technician** 1800

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 12-14-17



NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/14/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 24			
Make	Troxler	Density Std	2915
Model	3440	Moisture Std	418
Ser. No.	2334		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	110.1	101.6	8.5	95.0	P	
2		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	122.3	104.5	17.1	97.7	P	
3		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	120.1	105.0	14.3	98.1	P	
4		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	116.9	104.0	12.4	97.2	P	
5		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	119.3	103.8	14.9	97.0	P	
6		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	116.6	103.8	12.3	97.0	P	
7		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	119.0	105.4	12.9	98.5	P	
8		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	117.2	104.8	11.9	97.9	P	
9		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	112.4	102.3	9.9	95.6	P	
10		DT	6	Building site pad	-1'6"	S-1	0.00	107.00	13.20	124.4	107.7	15.5	101	P	
11		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.2	104.0	11.7	97.2	P	
12		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	115.5	101.7	13.5	95.0	P	
13		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	111.8	102.1	9.5	95.4	P	
14		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	111.6	101.7	9.6	95.0	P	
15		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	120.9	106.9	13.1	99.9	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM 6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/14/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM 6938			
Nuclear Gauge No. 24			
Make	Troxler	Density Std	2915
Model	3440	Moisture Std	418
Ser. No.	2334		

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data				P / F	Comments
										Wet Density (pcf)	Dry Density (pcf)	Moisture Content (%)	Percent Comp. (%)		
16		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.4	103.8	16.9	97.0	P	
17		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	119.6	105.3	13.6	98.4	P	
18		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	114.7	101.8	12.7	95.1	P	
19		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	118.7	103.9	14.2	97.1	P	
20		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	116.9	102.9	13.7	96.2	P	
21		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	115.7	102.0	13.5	95.3	P	
22		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	116.0	102.2	13.6	95.5	P	
23		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	118.4	104.4	13.5	97.6	P	
24		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	116.3	103.1	12.8	96.4	P	
25		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	117.0	102.0	14.6	95.3	P	
26		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	115.3	102.3	12.7	95.6	P	
27		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	117.9	105.5	11.8	98.6	P	
28		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	119.2	107.0	11.3	100	P	
29		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	116.1	102.8	13.0	96.1	P	
30		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	124.1	107.0	16.0	100	P	
31		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	116.9	105.2	11.1	98.3	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 18, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

__X__ Field Reports
__X__ For your use
__X__ As requested

ENCL:

Field Report # 25 12/15/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Material Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**25**
Day & Date	**Friday 12/15/2017**
Weather	**45º/ Sunny**
On-Site Time	**6.25**
Lab Time	**0.50**
Travel Time*	**0.75**
Total	**7.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **21**

Chargeable Items

Time of Arrival **10:00A** Departure **04:15P**

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested, to check the compaction of soils for the building site pad. Please see the attached sketch for the approximate density test locations.

Utilizing the nuclear test method (ASTM D-6938) to check the compaction of soils; test results indicated that the compacted material, at the areas and depths tested, met the project requirements of 95% of the maximum dry density as obtained in our laboratory using the standard Proctor method (ASTM D-698), except at location 1.

Test location 1 failed due to high percent moisture, did not meet 95% compaction and was visibly unstable.

The project superintendent was notified of the test results.

By **Glen M Bradley, — Field Technician** 1800

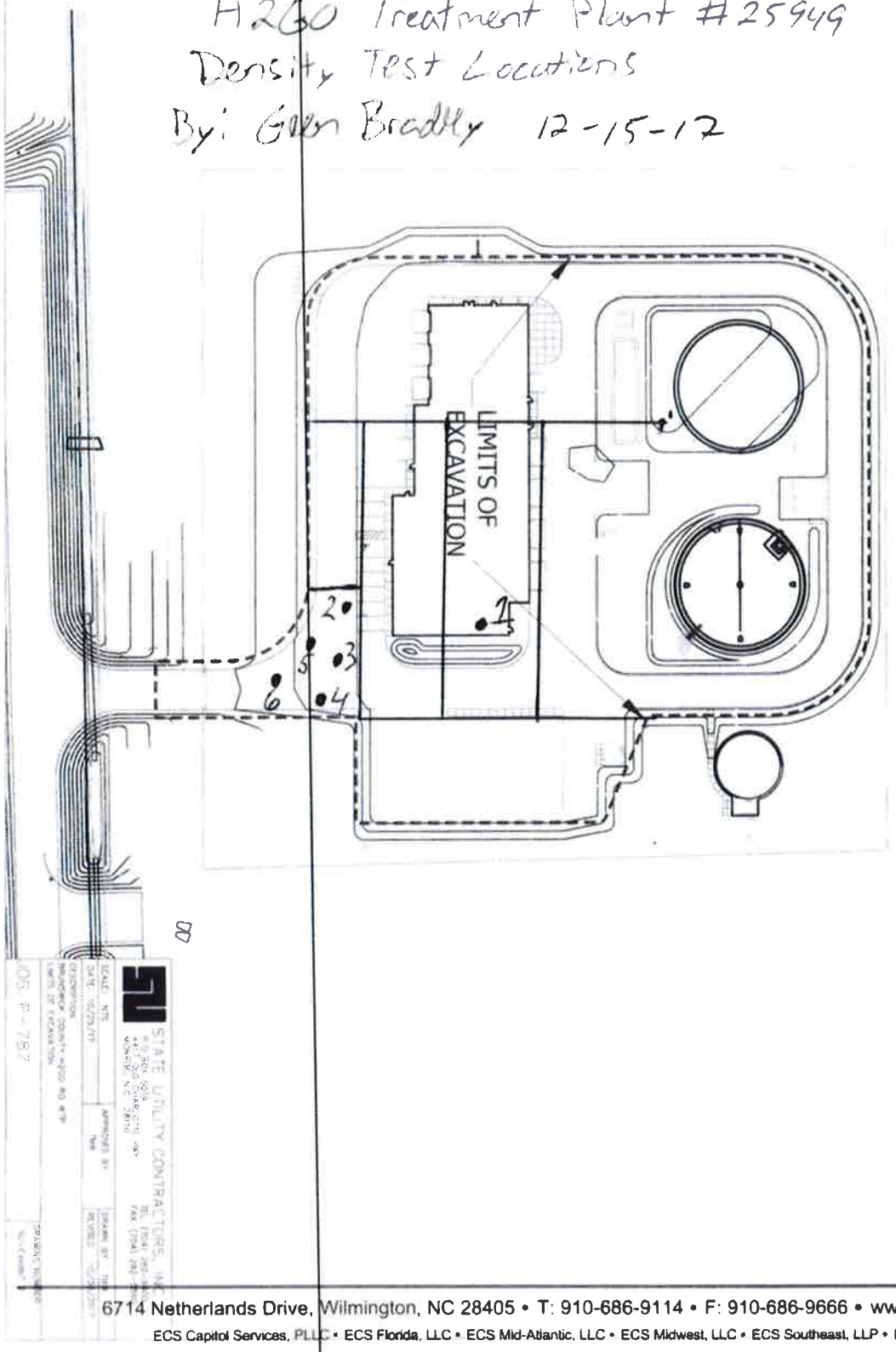
ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

NC Registered Engineering Firm F-1073
SC Registered Engineering Firm 3239

H2GO Treatment Plant #25949
Density Test Locations
By: Glen Bradley 12-15-12



6714 Netherlands Drive, Wilmington, NC 28405 • T: 910-686-9114 • F: 910-686-9666 • www.ecslimited.com

ECS Capitol Services, PLLC • ECS Florida, LLC • ECS Mid-Atlantic, LLC • ECS Midwest, LLC • ECS Southeast, LLP • ECS Texas, LLP

NC Registered Engineering Firm # F-1078

ECS SOUTHEAST, LLP

Field Compaction Summary, ASTM D6938

Project No: 25949 Project Name: H2GO Reverse Osmosis WTP - Contract 4 Date: 12/15/17

Client: State Utility Contractors, Inc.

Contractor: State Utility Contractors, Inc.

Technician: Glen M Bradley

Test Method ASTM D6938			
Nuclear Gauge No. 24			
Make		Density Std	2905
Model		Moisture Std	424
Ser. No.	2334		

Sample No.	Description	Proctor Method	Uncorrected Max. Density	Uncorrected Opt. MC
S-1	Orangish Brown, Silty, F-M Sand, Some Clay	Standard Proctor Method (ASTM D-698)	107.00	13.20

Test No.	Lot No.	Test Mode	Probe Depth (in.)	Station / Location	Lift / Elev	Sample No.	% Oversize	Corrected Maximum Dry Density (pcf)	Corrected Optimum Moisture Content (%)	Test Data: Wet Density (pcf)	Test Data: Dry Density (pcf)	Test Data: Moisture Content (%)	Test Data: Percent Comp. (%)	P / F	Comments
1		DT	6	Building site pad	-10"	S-1	0.00	107.00	13.20	121.3	100.9	20.3	94.3	F	Percent moisture too high and visibly unstable
2		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	116.4	102.3	13.8	95.6	P	
3		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	120.7	107.1	12.8	100	P	
4		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	123.9	105.7	17.2	98.8	P	
5		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	114.3	103.6	10.3	96.8	P	
6		DT	6	Building site pad	-2'4"	S-1	0.00	107.00	13.20	118.3	103.3	14.5	96.5	P	

Test Mode: DT = Direct Transmission BS = Back Scatter

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

LETTER OF TRANSMITTAL

December 19, 2017

State Utility Contractors, Inc.
PO Box 5019
Monroe, NC 28111-5019

ATTN: Todd Wasson, P.E.

RE: **H2GO Reverse Osmosis WTP - Contract 4**

ECS Job # **22:25949**

Permits:

Location: **146 Gregory Road**
Belville, NC

We are enclosing:

X Field Reports
X For your use
X As requested

ENCL:

Field Report # 26 12/18/2017

Winslow E. Goins, P.E.
Geotechnical Principal Engineer

Darrell J. Henderson, E.I.T.
Construction Materials Project Manager

This report (and any included attachments) shall not be reproduced, except in full, without the prior written approval of ECS.

NC Registered Engineering Firm # F-1078

ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
(910) 686-9114 [Phone]
(910) 686-9666 [Fax]

FIELD REPORT

Project No.	**22:25949**
Report No.	**26**
Day & Date	**Monday 12/18/2017**
Weather	**60°/ Cloudy**
On-Site Time	**0.25**
Lab Time	**0.50**
Travel Time*	**0.75**
Total	**1.50**
Re Obs.Time	**0.00**

Project	**H2GO Reverse Osmosis WTP - Contract 4**
Location	**Belville, NC**
Client	**State Utility Contractors, Inc. - Todd Wasson, P.E.**
Contractor	**State Utility Contractors, Inc. - Accounts Payable**

Remarks

Trip Charges* Tolls/Parking* Mileage* **20**

Time of Arrival **10:00A** Departure **10:15A**

Chargeable Items

* Travel time and mileage will be billed in accordance with the contract.

Summary of Services Performed (field test data, locations, elevations & depths are estimates) & Individuals Contacted.

The undersigned arrived on site, as requested to check the compaction of soils for the building site pad. Upon arriving on site the undersigned was notified by Jimmy Coore with State Utilities that the testing was cancelled for this date due to the project being shut down until further notice.

By **Glen M Bradley, — Field Technician** 1800

1108820

SECTION 01210

ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cash Allowances

B. Contingency Allowances

1.02 CASH ALLOWANCES

A. Costs Included in Cash Allowances: Cost of product to Contractor, delivery to Site, shipping from site (as applicable), and other services as identified in the applicable Specification Section, unless stated otherwise in the Allowance Schedule and subsequent Attachments.

B. Costs Not Included in Cash Allowances but Included in Contract Lump Sum: Applicable taxes, product handling at Site including loading and transporting (as applicable), unloading, uncrating, and storage; protection of products from elements and from damage; and labor, materials and equipment for installation, testing and start-up for a complete and operable system, unless otherwise stated in Allowance Schedule.

C. Engineer Responsibilities
   1. Consult with Contractor and Owner for inspection of equipment stored by the Owner to be incorporated into the project.
   2. Prepare Change Order, if necessary.

D. Contractor Responsibilities
   1. Arrange for and process Shop Drawings and Product Data submittals as necessary. Arrange for shipping and delivery of equipment as necessary.
   2. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.
   3. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

E. Differences in costs will be adjusted by Change Order.

F. Allowance Schedule
   1. Section 11064 – Vertical Turbine Pumps: See Attachment 1 for ClearWater Proposal dated April 1, 2020.
      a. Include the stipulated allowance sum of $184,680.00 for purchase and delivery of three (3) vertical turbine pump discharge heads, columns, bowl assemblies, and associated appurtenances from Fairbanks Nijhuis. Allowance shall also include shipment to and delivery from Charles E. Underwood, Inc. for inspection and servicing of the three (3) 250 Hp motors. The three (3) 250 Hp motors are located in storage at 9100 Lackey Rd NE, #6, Leland, NC 28451.
      b. Three (3) pump suction cans previously purchased by the Owner are held in storage. These items are located at 9100 Lackey Rd NE, #6, Leland, NC

28451. Cost for the Contractor to load, transport, unload and incorporate these items into the Work pursuant to the Construction Documents shall be included in the Contract Lump Sum Bid Price.

2. Section 13203 – Horizontal Calcite Contactor Vessel (Pressure) System: See Attachment 2 for the Tonka Water Quotation dated 3/18/20.
   a. Include the stipulated allowance sum of $890,912.00 for equipment (including paint), shop testing, field service, submittal drawings and operation and maintenance manuals identified as **Item A: Calcite Contactor Systems.**
   b. **Item B: Items Previously Furnished by Tonka Water** identifies all items previously purchased by the Owner and held in storage. With the exception of the calcite contactor pressure vessel materials, these items are located at 9100 Lackey Rd NE, #6, Leland, NC 28451. The calcite contactor pressure vessel materials are located at 9911 Chappell Loop Road, Belville, NC 28541.
   c. As stated, the calcite contactor pressure vessel materials and the control panel shall be shipped from the project site to Tonka Water for additional work as identified in Item A: Calcite Contactor Systems.
   d. Pallets 1 through 11 identified in Item B will need to be transported from storage to the project site by the Contractor as needed for incorporation into the project Work. Cost for the Contractor to load, transport, unload and incorporate these items into the project Work pursuant to the Construction Documents shall be included in the Contract Lump Sum Bid Price.

1.03 CONTINGENCY ALLOWANCES

A. Include in Contract a stipulated sum of $350,000.00 for use upon Owner's instruction as a contingency allowance.

B. Contractor's costs for products, delivery, installation, labor, insurance, payroll, taxes, bonding, equipment rental, overhead, and profit will be included in Change Orders authorizing expenditure of funds from this contingency allowance.

C. Funds will be drawn from contingency allowance only by Change Order.

D. At closeout of Contract, funds remaining in contingency allowance will be credited to Owner by Change Order.

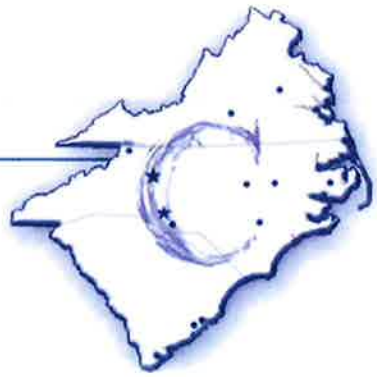
PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT 1
CLEARWATER PROPOSAL

ClearWater, Inc.
www.clearwaterinc.net



April 1, 2020

Mr. Charles Davis
The Wooten Company
120 N. Boylan Ave.
Raleigh, NC 27603

RE: Brunswick H2GO WTP
Fairbanks Vertical Turbine Pumps & Existing Motors
Clearwater proposal CW 200010

Dear Mr. Davis:

We are pleased to recommend and offer the following proposal for the specified equipment in spec section 11064 for the above referenced project.

Our proposal is as follows:

VERTICAL TURBINE PUMPS
2,250 GPM @ 259' TDH
200 HP 1200 RPM
3/60/460 VAC POWER

Three (3) Fairbanks model 18H – five (5) stage vertical turbine pumps with the following features and accessories:

- *Cast Iron bowl assembly to include the following:*
  - *316 SS dynamically balanced enclosed impellers*
  - *2 3/16" 416SS bowl shaft*
  - *316 SS casing & 416SS impeller wear rings*
  - *Bismuth bronze bowl bearings*
  - *316 SS bolting*
- *Flanged Steel Column assembly to include the following:*
  - *1 15/16" 416SS product lubricated open lineshaft and threaded couplings*
  - *Rubber lineshaft bearing inserts*
  - *316SS bearing retainers*
  - *14" flanged steel column:*
    - *AWWA thickness*
    - *Maximum lengths of 10'*
    - *316 SS column bolting*

        - *14' can setting*
- *Discharge Head Assembly*
    - *Type "L" 20" x 14" x 30" flanged aboveground fabricated steel discharge head for mounting on to 24" can*
    - *175# Packed stuffing box*
    - *Split Bronze gland*
    - *14" CL150 flanged discharge*
    - *stainless steel hardware*
    - *416SS drive shaft*
    - *304SS shaft sleeve*
    - *threaded coupling*
    - *stainless steel nameplate*
- *Painting*
    - *Sandblast SSPC-SP10 of bowl exterior, column and discharge head*
    - *Two (2) coats of Tnemec Series N140 as follows:*
        - *bowl assembly OD*
        - *column assembly ID/OD at 4-6 mils per coat*
        - *discharge head ID/OD at 4 - 6 mils per coat*
        - *Standard manufacturers coating on motors*
- *Factory Pump Testing & Engineering as follows:*
    - *Hydrostatic test – non-witnessed at 150 percent of shutoff head for a minimum of 5 minutes*
    - *Certified non-witnessed factory pump performance tests per HI-1U standards and certified by Factory PE*
    - *Curve approval of test results prior to shipment*
- *Standard one (1) year factory warranty*
- *Pump to be used with existing motors and pump cans supplied in 2017 under previous project.*

One (1) lot of engineering and field services for the pump equipment to include the following:

- *Six (6) sets of factory submittals (paper) for the pumps after receipt of an approved PO*
- *Six (6) sets for factory O&M manuals (paper) for the pumps*
- *Six (6) sets of certified factory pump test curves and report (electronic copies)*
- *One (1) trip of one (1) day each for installation inspection prior to grouting in of pump cans*
- *One (1) trip of one (1) day for pump start up, field testing and training as follows:*
    - *Check pump rotation*
    - *Set pump impeller clearances*
    - *Install packing*
    - *Run pumps*
    - *Field drawdown test of pumps at design point*
    - *Provide written report of SU service*

- *Contractor to supply all necessary and required materials, supplies and equipment required for start-up and field testing*
- *One (1) trip of one (1) day for field vibration testing*

EXISTING MOTORS

Clearwater will provide the following services to inspect and check out the three existing motors we provided the owner 2 years ago that have been in storage at owner's facility.

- *Clearwater will pick up motors at owner's storage facility and transport all three motors to our shop*
- *Loading motors on truck by others*
- *Disassemble each motor and perform visual inspection*
- *Bake windings*
- *Inspect mechanical fits*
- *Megger and surge test motor windings*
- *Check and balance rotor*
- *Provide and install new SKF factory bearings*
- *Assemble motor*
- *Test run and check motor at shop*
- *Deliver all three motors back to project site*
  - *Unloading and storage by others*
- *Upon inspection should any other repairs be required we will advise owner and update proposal.*

PRICING SUMMARY

VERTICAL TURBINE PUMPS.....$175,200.00

MOTOR INSPECTIONS ..... $ 9.480.00

Note: Above pricing does not include any applicable taxes

GENERAL NOTES AND CLARIFICATIONS:

1) *All unloading and storage of shipped equipment is by others*
2) *All freight is FOB factory and included in the above pricing*
3) *Any applicable taxes are not included in the above pricing*
4) *Owner equipment ID tags are by others*
5) *Seller is bidding equipment with the performance shown on the previously-transmitted submittal curves.*
6) *All anchor bolts, pipe, valves, fittings, gauges, vents, seal water systems, instrumentation, monitors, vibration detectors, controls, starters, VFD's, MCC's local controls panels, floats, level indicators, metal supports, templates, nuts, bolts,*

washers, leveling shims, grout and grouting, jacking bolts, grease and lube lines, grease and lube fittings, bearing support brackets and beams, and interconnecting wiring are not included in the above price, and are to be supplied by others, unless specifically stated in the above proposal per each equipment description.

7) *All lubricants, oil, grease, water, gauges, meters, flow meters, and any other miscellaneous supplies and equipment needed for startup is not included and to be supplied by others.*
8) *Field installation of all drivers, shafting, couplings, bearings, protective guards, gauges, guide rails, pump bases and controls where applicable are not included and by others.*
9) *Installation of all accessory items that are shipped separately is by others.*
10) *Our pricing only includes those items clearly and specifically stated detailed in the above proposal, any items not clearly outlines in the above are not supplied by Clearwater Inc. and any of our manufacturers.*
11) *We will agree to meet all H.I. vibration standards by field testing.*
12) *All standard Clearwater Inc. terms and conditions will apply. All standard terms and conditions of our represented principals will also apply.*
13) *Any travel, and living expenses related to witness testing at the manufacturer's site, of the equipment being purchased, is not included in our pricing.*
14) *Any retainage considerations on the above equipment sold will be negotiated on a job by job basis after the receipt of a purchase order.*
15) *Submittals schedule is as follows:*
    a. *4 – 6 weeks*
16) *The estimated delivery schedule for the above equipment is as follows:*
    a. *Turbine Pumps: 14 - 16 weeks after release for manufacture*
    b. *The delivery schedule proposed is an estimate only and may change depending on availability of parts / manufacturer's work load, holiday schedules, etc. Better estimates of delivery can be provided after manufacturer provides acknowledgement of order after release for manufacture.*

We appreciate the opportunity to offer you this proposal. Should you have any questions regarding this proposal, or if we can provide additional information or assistance, please do not hesitate to contact our office.

Sincerely,

Gregg Hauser

Gregg Hauser
ClearWater, Inc

Cc: Ryan Crotts

ATTACHMENT 2
TONKA WATER QUOTATION

TONKAWATER™
A U.S. WATER BRAND





Quotation

Brunswick Regional Water and Sewer H2GO

Tonka Water, a U.S. Water Brand is the basis of design for this project.

Addressee:	Brunswick Regional Water and Sewer H2GO
Engineer:	The Wooten Company
Quotation #:	19413 – R3
Quotation Date:	3/18/20

We are represented on this project by:

Steven Young
Premier Water
4726-C Park Rd.,
Charlotte, NC 28209
(704) 231-9964
steven@premier-water.com

Tonka Water Contact:
Mark Machacek, P.E.
13305 Water Tower Circle
Plymouth, MN 55441
USA
Main: 763.559.2837
Mark Cell: 763.276.0818
mmachacek@uswaterservices.com

Attachments:
Facepiping scope of supply drawings

U.S. WATER
a Kurita company

Item A: Calcite Contactor System
Reference: Specification Section 13203

Design Parameters	
Total Design Flow:	2778 gpm
Loading Rate:	3.3 gpm/ft^2
Number of Vessels:	2
Number of Cells Per Vessel:	3
Dimensions:	12'-0" diameter x 36'-0" overall length
Working Pressure:	100 psi
Test Pressure:	130 psi
Approx. Shipping Weight Per Vessel:	47,000 lbs
Approx Operating Weight Per Vessel:	461,000 lbs

Tonka Water Horizontal Calcite Contactor Vessel is designed in accordance with ASME and bearing the ASME stamp. Stairway/walkway, by others.

Note: Head and shell material to be used from previously cancelled project. Should detailed inspection show corrosion beyond acceptable levels, customer will be notified prior to further work being completed. Loading of head and shell material at jobsite onto trucks included.

Each vessel will have the following internal components:

- Tonka Water standard header-lateral over-drain treated water collection and backwash water collection assembly, schedule 80 PVC, factory installed.
- Underdrain system consisting of a factory installed Schedule 80 PVC header lateral underdrain system structurally supported and equipped with Tonka Water non-metallic underdrain nozzles located on 12" centers provided previously. Nozzle pressure drop calculations signed by PE.

  NOTE: Underdrain openings are to be equipped with threaded caps installed at the factory until concrete grout is to be installed into the contactor by the installing contractor. Contractor is responsible for removal of the caps and installing the Tonka Water underdrain nozzles after the concrete grout has been poured and cured.

Each contactor will have the following external accessories:

- One (1) elliptical manway per cell: 14" x 18"
- Five (5) sample taps per cell in the locations specified.
- Structural support saddles.
- Lifting lugs, as required.
- Nozzles
  - One (1) 8" flanged influent nozzle, per cell.
  - One (1) 8" flanged effluent nozzle, per cell.
  - One (1) 18" flanged calcite feed, per cell.

- One (1) 2" npt air release, threaded coupling, per cell.
- One (1) 4" flanged level sensor, per cell.

Support gravels and contactor media

- Graded support gravels in the specified gradations included to provide a vertical bed depth of 15". Graded support gravel shipped in 100 pound, one cubic foot bags for installation by others. Approximate total bags: 1058
- Crushed or granulated calcite with an effective size of 1.5 mm to 3.0 mm and a uniformity coefficient not exceeding 1.5 included to provide a vertical bed depth of 60". Calcite to be shipped in supersacks for installation by others. 4234 cubic feet.

Facepiping. Tonka Water includes Sch 80 PVC facepiping to the limits indicated on the attached drawing. Spool piece below calcite hopper to be 316 stainless. Partial facepiping shipment sent during previous project – facepiping not shipped previously will be supplied.

> **Note:** Valves within the limits of the facepiping shown on the sketch may not be included with this quotation. Review valves section of this quotation to determine the specific valves included by Tonka Water. Pipe supports are not included.

Calcite Loading Hopper. Six (6) 316 stainless steel hoppers, as specified. Any supports for calcite loading spool piece/valve/hopper, by others.

Instrumentation

- Two (2) loss of head gauge panels, including influent pressure gauge, effluent pressure gauge and differential pressure gauge; panel is shipped loose for installation by others. Uni-strut pipe clamps are included.
- Two (2) differential pressure indicating transmitters
- One (1) 10" magnetic flow meter with transmitter for measuring backwash influent to the filter, shipped loose for installation by others. Total number of meters: 1.
- Two (2) Pressure transmitters, as specified.

Tonka Water Contactor control panel

- One (1) 316SS NEMA 4X rated enclosure complete with PLC, power supply, I/O racks, terminal blocks, relays, timers, switches, indication, etc., as required for a complete operating system.
- Allen Bradley CompactLogix PLC, or engineer approved equal shall be provided. PLC shall include a minimum of 10% spare I/O capacity including digital and analog I/O. Power integrity shall be furnished via Uninterruptable Power Supply (UPS).
- Ethernet I/P via fiber optic data highway connection. Space will be provided in coordination with the control system integrator (CSI) for space allotted inside the control panel for the communications equipment (fiber optic patch panel, network switch, and media converters), furnished by the CSI, along with the fiber optic cable.

- Panel Enclosure: 316 stainless steel, NEMA 4X, with temperature controls, transient surge protection, etc, as required for outdoor installation. All panel components shall be Nema 4X rated components.
- Operator interface terminal (OIT) shall be Series 1000 Panel-View Plus OIT color touch screen by AllenBradley.
- The OIT shall be panel mounted and shall indicate the following, via a series of custom designed screens:
    - Contactor system status (flows, levels, turbidities, etc.)
    - Backwash
    - Bar graph and Digital Displays of Times In BW Monitor Screen
    - Alarms/alarm acknowledges
    - Status of exterior signals
    - Individual contactor status (service, backwash, alarm, etc.)
    - Other functions, indication and information as required for a complete operating system
    - Timers: Countdown timers' setting inputs and displays shall be available on the OIT to set and indicatethe following:
    - Backwash
    - Filter to waste (if required)
    - Transient Voltage Surge Suppression, included according to the specification
- Shop Testing Prior to Shipment: Prior to shipment the contactor control panel shall be fully tested with all alarms, indication and I/O fully simulated at the factory prior to shipment. All screens shall be tested along with all alarm functions and other control parameters, verified by factory certification as to inspector and date inspected. Testing shall be subject to verified witnessing by the engineer if required.

Notes: A) Junction boxes adjacent to the calcite contactor control panel not included.
B) Partially complete panel shipped to customer from previous project will be evaluated and the balance of components will be supplied for a complete panel. Evaluation and completion will be done at Tonka Water facility, with shipment from customer storage to Tonka Water included.

Paint

- Interior – Shop sandblasted per SSPC-SP10, prime and finish painted according to the specification.
- Exterior – Shop sandblasted per SSPC-SP6 and prime painted according to the specification. Finish coat by others.

Field service consisting of 2 trips, 6 days total for installation inspection, media installation supervision, start-up and operator training. If additional supervision is required, it will be offered at the rate of $900 per day plus travel and per diem expenses.

Submittal drawings and data for engineer's approval prior to fabrication of equipment.

Installation, operation and maintenance manuals, as required.

Item B : Items Previously Furnished by Tonka Water

The following will be shipped from Brunswick Regional Water and Sewer H2GO by Tonka Water for fabrication.

Calcite Contactor Pressure Vessel Materials Head and shell materials, support angle, and misc metals will be loaded and transported to fabrication. Loading and freight from customer site included in this scope along with freight for transport of the completed pressure vessels back to jobsite.

Control Panel Enclosure and misc parts to be shipped to Tonka Water for completion – 1 pallet. Return freight to Tonka Water included in this scope along with freight for transport of completed control panel back to jobsite.

The following will need to be moved from Brunswick Regional Water and Sewer H2GO location to jobsite on 11 pallets.

Pallets 1-10

Calcite Contactor function valves. Tonka Water provided the following lug-style butterfly valves (calcite loading to be knife gate) with electric actuators. All actuated rate set valves equipped with limit stops and limit switches. Valves are shipped loose for installation by others. Local control stations provided, as specified.

Function	Size (in.)	Quantity	Actuator
Raw Water Influent (RWI):	10	6	Electric
Treated Water Effluent (FWE):	10	6	Electric
Backwash Influent	10	6	Electric
Backwash Effluent (BWE):	10	6	Electric
Backwash Rate Set (BWR):	10	1	Electric (modulating)
Air Release (ARV):	1	6	Automatic
Calcite Loading	18	6	Electric

Pallet 11

Instrumentation

- Six (6) calcite bed level sensors, as specified, with one (1) controller per vessel

Internal Components for Tank

- Tonka Water non-metallic underdrain nozzles

Facepiping hardware Miscellaneous fittings, gaskets, and fasteners

TONKAWATER™
A U.S. WATER BRAND

Price Summary

Item		Price
A.	Tonka Water Calcite Contactor	$890,912
B.	Items Previously Furnished By Tonka Water	N/A
	Total Base Price	**$890,912**

U.S. Water bases this proposal on the invoice schedule as shown below:

20% Upon Drawing Submittal
20% Upon Release for Fabrication
60% Upon Shipment

Delivery:

1. Submittal drawings have been supplied previously, but will be reviewed and re-submitted in approximately 2-3 weeks after receipt of a fully signed and executed purchase order.
2. Shipment of equipment will be made in approximately 20-24 weeks after receipt of approved drawings and existing heads and shells at fabricator.

Please note that these timelines are approximate. Actual lead times will be dependent on material lead times and fabrication shop capacity at time of order.

The attached CONDITIONS OF SALE AND WARRANTIES that are incorporated herein. For your convenience, this sheet may be used as your order for this equipment.

Items Ordered	
P.O. Number	
Total Net Price	
Firm Name and Address	
By (Print)	
Signature	
Date	

U.S. WATER SERVICES, INC.

Purchase orders should be addressed to:
U.S. Water Services, Inc.
12270 43rd Street
St. Michael, MN 55376

We do not include the following:

1. Mechanical or electrical installation.
2. Unloading or rigging, except for loading of raw tank materials at customer jobsite onto truck for fabrication. The contractor must provide a suitable access to the jobsite.
3. On-site storage or protection of equipment.
4. Pipe, valves or fittings other than those specifically described herein.
5. Pipe supports or hangers.
6. Motor starters, motor controls, disconnects, or any other electrical equipment other than those specifically described herein.
7. Electrical wiring or conduit.
8. Chemical feed tubing, conduit piping, hangers or supports.
9. Pumps or pumping equipment other than those specifically described herein.
10. Concrete, concrete grout or rebar.
11. Disinfection or disinfection / start-up chemicals.
12. Lubricants.
13. Pneumatic tubing or conduit.
14. Control panel wall mounting material or hardware.
15. Anchor bolts or anchoring calculations, unless specifically described herein.
16. Any items not specifically described in this proposal.
17. Seismic design considerations of equipment unless otherwise noted.

Notes:

1. Equipment is quoted f.o.b. factory with full freight allowed to the jobsite.
2. Our proposal does not include any sales or use taxes.
3. If the above proposal includes valves, piping, etc., these are to be shipped loose for assembly and installation by others unless specifically noted to the contrary.
4. The attached U.S. Water standard Terms and Conditions are incorporated by reference into this quotation, will be a part of any binding agreement between you and U.S. Water, and cannot be modified by you whether by the terms of your purchase order or otherwise, except to the extent expressly accepted by U.S. Water in writing. You agree to abide by the terms of Section 1 ("General"), Section 3 ("Quotations") and Section 17 ("Confidential Information") of the U.S. Water standard terms and conditions with respect to the information contained in this quotation and any other information provided to you by U.S. Water, regardless of whether you submit an order or whether you and U.S. Water enter into a binding agreement regarding the purchase of the products described herein.
5. Please note that a copy of the contractor's payment and performance bond is required to be forwarded to us as a part of normal credit approval procedures.
6. U.S. Water requires partial payments based on shipped material and purchaser's account being current prior to scheduling a field technician for equipment start-up.
7. U.S. Water will provide field services as outlined above in this quotation. U.S. Water's field service rate is $1200.00 per day plus travel and per diem expenses. If U.S. Water field service personnel arrive on-site after a schedule is established and the project is not ready for the intended services to be performed, U.S. Water will invoice for additional days, if required. If the time required is greater than listed in this quotation, U.S. Water will invoice purchaser at the above field service rate plus travel and per diem expenses.
8. This proposal meets the requirements of the American Iron and Steel (AIS) Act, if specified.

TONKAWATER™
A U.S. WATER BRAND

Conditions of Sale and Warranties

1. Exclusive Terms and Conditions

Together with any other terms the parties agree to in writing, these terms and conditions of sale form the exclusive terms ("Agreement") whereby Buyer agrees to purchase, and Seller agrees to sell goods and provide advice, instruction and other services in connection with the sale of those goods ("Services"). Notwithstanding any provisions communicated in any way by Buyer to Seller prior to this agreement including any terms contained in any request for quote by Buyer, Buyer agrees that this agreement will control the relationship by accepting goods and services from Seller, even if Buyer sends to Seller other terms and conditions to which Seller may not respond.

2. Buyer Obligations

Seller will not control the actual operation of either Buyer's systems or goods at the site, and unless otherwise specifically agreed in writing, installation of goods shall be the responsibility of Buyer. Goods and services provided hereunder are based upon the information Buyer makes available to Seller, and Seller reserves the right to utilize the most compact and feasible design compatible with sound engineering practices, and to make changes in details of design, construction and arrangement of goods unless precluded by limitations (including, but not limited to actual space and feed water/substance quality specifications) specified by Buyer in writing at the time an order is placed. If no such limitations are specified, Seller shall not be held responsible for incompatibility of the goods and services due to changes in feed water/substance quality specifications or site conditions nor for incompatibility with actual space or design limitations, which were not initially disclosed by Buyer and become apparent at a later date. For services to be accurate and goods to work as intended, Buyer must fulfill the following obligations ("Obligations"): (a) provide Seller complete and accurate information and data relevant to the scope of work to be provided, such as information related to Buyer's site conditions, systems, related equipment and processes, feed water or other substances to be treated or measured with the Goods , including any hidden, unapparent, or changing conditions that may affect the effectiveness of the Goods; (b) operate all related systems and the goods within the agreed to control parameters or, if none, within industry customary operating conditions; (c) maintain all related systems and Goods in good operating condition and repair; and (d) maintain and handle goods in a proper and safe manner. If Buyer's fails to fulfill the foregoing obligations, Seller shall be relieved of any obligations with respect to warranties or any other commitments made to Buyer in writing, and Seller shall have no liability for any loss, damage or injury which Buyer may sustain or for which Buyer may be liable.

3. Payment and Prices

Unless otherwise specified in writing in section 10 of this proposal document, payment is due net thirty (30) days from the date of Seller's invoice. If Seller shall have any doubt at any time as to Buyer's ability to pay, Seller may decline to make deliveries except on receipt of satisfactory security. The prices quoted herein do not include taxes. Buyer shall be directly responsible, and reimburse Seller, for the gross amount of any present or future sales, use, excise, value-added, or other similar tax applicable to the price, sale of delivery of any products or services furnished hereunder. Buyer shall furnish Seller with evidence of exemption acceptable to the taxing authorities if applicable. [For multi-year agreements, pricing stated shall remain firm for 12 months, after which Seller shall be entitled to adjust pricing upward on an annual basis according to the designated formula used by Seller in Buyer's country and which shall be notified to Buyer.] Unless otherwise specified, all prices are ExWorks Seller's facility. Buyer agrees to reimburse Seller for collection costs, including 2% interest per month, should Buyer fail to timely pay. Buyer shall have no rights to any setoffs of any nature relating to any payments due under the agreement.

4. Payment for Excessive Usage; Lost and Damaged Goods

If payment for goods is based on some factor other than the actual amount of goods delivered (e.g., payment is for a fixed amount, or based on usage or production), then Buyer agrees to pay for all Goods (a) consumed as a result of Buyer's failure to comply with obligations as set forth in Section 2; or (b) lost or damaged after delivery to Buyer. Buyer shall provide Seller all information necessary to calculate amounts due and enable Seller to audit those records.

5. Deliveries

Unless stated otherwise in the proposal, Seller shall deliver all products to Buyer EXW Seller's facility, place of manufacture, or warehouse, according to INCOTERMS 2000. Shipment dates, if applicable, noted in this proposal represent Seller's best estimate of probable delivery time considering conditions known at the time this Proposal was prepared. Upon acceptance of Buyer's purchase order or, where specified in the purchase order, upon receipt of Buyer's notification to proceed with fabrication of equipment that satisfies Seller's requirements for meeting the delivery schedule, Seller shall commence fabrication of equipment. The place of delivery specified therein shall be firm and fixed, provided that Buyer may notify Seller no later than 45 days prior to the scheduled shipment date of the products of an alternate point of delivery. Provided the parties agree a variation to take into account any additional cost [or delay] incurred by Seller in implementing this change, the alternate place of delivery shall become the agreed place of delivery for all purposes under this agreement.

6. Consigned Goods

Buyer shall bear all risk of loss and damage to all consigned goods in Buyer's possession or control, notwithstanding Buyer's exercise of reasonable care. Seller shall have the right to enter Buyer's premises at all reasonable times to inspect such Goods and related records. Upon request, Buyer agrees to return such goods to Seller pursuant to Seller's shipping instructions.

7. Limited Warranties

Seller warrants that the goods shall conform to published specifications and shall be free from defects in material and workmanship when at all times operated in accordance with Seller's written instructions; and that the services will be performed with the degree of skill which can reasonably be expected from a seller engaged in a comparable business and providing comparable services under comparable circumstances. Unless otherwise provided in any warranty schedule that may be attached hereto, the foregoing warranties are valid: (a) for chemicals and services, for 6 months from their date of delivery or the provision of Services; (b) for consumables, including filters and membranes, 12 months from their date of delivery, (c) for goods other than chemicals and consumables, the earlier of, 15 months from receipt, or 12 months from start-up/first use. Unless expressly agreed in a "performance warranty document" signed between the parties on a separate basis, there is no performance warranty on goods and services or warranty on process results. For goods not manufactured by Seller, the warranty shall be the manufacturer's transferable warranty only. Any claim for breach of these warranties must be promptly notified in writing or the claim will be void. Seller's sole responsibility and Buyer's exclusive remedy arising out of or relating to the goods or services or any breach of these warranties is limited to, at Seller's option: (a) replacement of non-conforming goods or refund of purchase price of the non-conforming Goods; and (b) re-performance of the services at issue, or a refund of the amount paid for the Services at issue. No allowance will be made for repairs or alterations made by Buyer without Seller's written consent or approval. Goods may not be returned to Seller without Seller's written permission. Seller will provide Buyer with a "return material authorization" number to use for returned goods. Buyer, as the original purchaser, is not entitled to extend or transfer this warranty to any other party. The foregoing warranties are in lieu of and exclude all other warranties, statutory, express or implied, including any warranty of merchantability or of fitness for a particular purpose.

8. Use of Equipment, Tanks, and Containers
Tanks and SBC's owned by Seller shall be used only for the storage of goods approved by Seller and, at Seller's request, shall be returned to Seller within thirty (30) days.

9. Compliance with Laws; Permits
Buyer is responsible for compliance with all laws and regulations applicable to the storage, use, handling, installation, maintenance, removal, registration and labeling of all goods from and after Buyer's receipt of the goods, as well as for the proper management and disposal of all wastes and residues (including containers) resulting from Buyer's use of the Goods. Buyer agrees to ensure that all Goods and Services provided to Buyer for export are exported only in compliance with applicable export control laws and regulations. Permits and licenses of a permanent nature, or which are required to operate apparatus or equipment or to use the Goods, shall be procured by Buyer at Buyer's sole expense.

10. Installation
For equipment purchase if applicable, installation costs of the equipment and materials supplied shall be the responsibility of the Buyer, unless otherwise provided within the Seller's proposal. Otherwise, unless stipulated in the Seller's proposal, Buyer agrees to pay for start-up supervision and operator instruction, at the Seller's prevailing rate per day. Buyer also agrees to pay reasonable expenses for transportation room and board for Seller's personnel. Standard terms of sale include two sets of operating instructions. If additional sets are required, they are available at an additional charge. Upon receipt of request for additional sets, a price quotation will be forwarded.

11. Differing Site Conditions and Hazardous Materials
In the event that Seller encounters any Hazardous Materials (shall mean toxic substances, hazardous substances, pollutants, contaminants, regulated wastes, or hazardous wastes as such terms may be defined or classified in any law, statue, directive, ordinance or regulations promulgated by any applicable governmental entity) at the Buyer's site, other than Hazardous Materials introduced by Seller or that are otherwise the express responsibility of Seller under this Agreement, Buyer shall immediately take whatever precautions are required to legally eliminate such hazardous conditions so that the Seller's work under this Agreement may safely proceed.

12. Emergencies
In the event an emergency condition should occur where the protection of either the plant equipment, employees at site, or the surrounding community are threatened, Seller may procure the required and necessary equipment, personnel, or subcontract support. Seller must provide immediate notice to Buyer regarding the emergency and then provide a report after reviewing the events and itemizing all expenditures. Buyer will reimburse Seller for all emergency related expenses.

13. Excusable Delay/Non-Performance
Seller shall not be liable nor in breach or default of its obligations under this Agreement to the extent performance of such obligations is delayed or prevented, directly or indirectly, due to causes beyond the reasonable control of Seller, including, but not limited to: acts of God, fire, terrorism, war (declared or undeclared) epidemics, material shortages, insurrection, act (or omissions) of Buyer or Buyer's suppliers or agents, any act (or omission) by any governmental authority, strikes, labor disputes, transportation shortages, or vendor non-performance. The delivery or performance date shall be extended for a period equal to the time lost by reason of delay or non-performance, plus such additional time as may be necessary to overcome the effect of the delay or non-performance. If Seller is delayed by any acts (or omissions) of Buyer, or by the prerequisite work of Buyer's other contractors or suppliers, Seller shall be entitled to an equitable price and performance adjustment as applicable.

14. Confidentiality and Intellectual Property
Both parties agree to keep confidential the other party's proprietary non-public information, if any, which may be acquired in connection with this Agreement. Buyer will not, without Seller's advance written consent, subject Goods to testing, analysis, or any type of reverse engineering. Seller retains all intellectual property rights including copyright which it has in all drawings and data or other deliverables supplied or developed under this Agreement, subject to Buyer's right to use such drawings and data for its own use without additional cost. Buyer acknowledges that Seller is in the business of selling the Goods subject to this Agreement and agrees that it will not file patent applications on the Goods, or processes and methods of using the Goods, without Sellers express written permission. Buyer further agrees that in any event any such patents will not be asserted against Seller or its customers based upon purchase and use of such Goods. Buyer shall be fully liable for any infringement of patent rights of third parties arising out of the products supplied hereunder where the construction, and other characteristics of such products including modification of the Goods and Services, is prescribed to the Seller, or completed independently, by the Buyer or agent(s). Buyer shall fully defend and indemnify the Seller in case of such claim(s). Any software Seller owns and provides pursuant to this Agreement shall

remain Seller's property. Seller provides to Buyer a limited, non-exclusive and terminable license to such software for the term of this Agreement. Buyer agrees not to copy, sub-license, translate, transfer, reverse engineer, or decode the software. Unless otherwise expressly agreed by Seller, this license shall terminate and the software shall be returned to Seller upon termination of this Agreement, or the material breach of the terms in this section.

15. Limitation on Liability

To the extent permitted by law, the total liability of the Seller for all claims arising out of or relating to the performance or breach of this Agreement or use of any Goods or Services shall not exceed the annual contract value of this Agreement. Seller shall not be liable for any advice, instruction, assistance or any services that are not required under this Agreement or for which Seller does not charge Buyer. In no event will either party be liable to the other for lost profits or revenues, cost of capital or replacement or increased operating costs, lost or decreased production, claims of Buyer's customers for such damages or any similar or comparable damages, or for any incidental, special, consequential or indirect damages of any type or kind, irrespective of whether arising from actual or alleged breach of warranty, indemnification, product liability or strict liability, or any other legal theory. If Buyer is supplying Seller's Goods or Services to a third party, Buyer shall require the third party to agree to be bound by this clause. If Buyer does not obtain this agreement for Seller's benefit for any reason, Buyer shall indemnify and hold Seller harmless from all liability arising out of claims made by the third party in excess of the limitations and exclusion of this clause.

16. Conflicts; Survival, Assignment

If there is any conflict between this Agreement and any written proposal or quotation provided by Seller, then the terms and conditions set forth in the proposal or quotation shall prevail. If any term or condition of this Agreement or any accompanying terms and conditions are held invalid or illegal, then such terms and conditions shall be reformed to be made legal or valid, or deleted, but the remaining terms and conditions shall remain in full force and effect, and the Agreement shall be interpreted and implemented in a manner which best fulfills our intended agreement. This Agreement may only be assigned by Seller to any affiliate.

17. Termination and Cancellation

This Agreement and any performance pursuant to it may be terminated or suspended by either party if the other party (a) is the subject of bankruptcy or insolvency proceedings; or (b) defaults in its material obligations under this Agreement, and such default is not cured within thirty (30) days. Upon the termination of this Agreement: (a) Buyer agrees to pay for all Goods in Buyer's possession or for which title has passed to Buyer, at current prices or at such other prices as have been agreed to in writing; and (b) all amounts owing, if any, for the equipment or tanks relating to those Goods shall immediately become due and shall be paid within thirty (30) days of receipt of an invoice. In the event of cancellation of an order by Buyer, a cancellation charge will be made against the Buyer, in proportion to the

work completed by Seller, or obligated against the order, plus any cancellation charges assessed against Seller by Seller's suppliers.

18. Governing Law and Dispute Resolution

This Agreement shall be governed by the substantive laws of the State of Minnesota. The UN Convention on the International Sale of Goods shall not apply. In the event of a dispute concerning this Agreement, the complaining party shall notify the other party in writing thereof. Management level representatives of both parties shall meet at an agreed location to attempt to resolve the dispute in good faith. Should the dispute not be resolved within thirty (30) days after such notice, the complaining party shall seek remedies exclusively through arbitration. The seat of arbitration shall be the federal district court in Minneapolis, MN, and the rules of the arbitration will be the Commercial Arbitration Rules of the American Arbitration Association, which are incorporated by reference into this clause.

SECTION 01312

PROJECT COORDINATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section specifies administrative and supervisory requirements necessary for Project coordination including, but not necessarily limited to:
   1. Coordination.
   2. Administrative and supervisory personnel.
   3. General installation provisions.
   4. Cleaning and protection.

1.02 GENERAL COORDINATION REQUIREMENTS

A. Responsibilities of Contractor:
   1. Coordinate construction activities for the Project to assure efficient and proper installation of each part of the Work.
   2. Where availability of space is limited, coordinate installation of components to assure maximum accessibility for maintenance. Make adequate provisions to accommodate components scheduled for later installation.
   3. Where necessary, prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings. A copy of all memoranda shall be submitted to the Engineer.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of schedules.
   2. Installation and removal of temporary facilities.
   3. Delivery and processing of submittals.
   4. Progress meetings.
   5. Installation meetings.
   6. Project Close-out activities.

C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
   1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work. Refer to other sections for disposition of salvaged materials that are designated as Owner's property.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01314

PROJECT MEETINGS

PART 1 GENERAL

1.01 MEETINGS

A. Pre-construction conference shall be held prior to the beginning of the Work.

B. Construction progress meetings shall be held monthly.

C. Project close-out conference shall be held during the final phases of the Work.

D. Engineer may schedule additional meetings.

E. Meetings scheduled by the Engineer shall be held at the Brunswick Regional Water and Sewer H2GO office in Leland, NC.

F. Contractor's project superintendent shall attend meetings.

G. Notify suppliers and subcontractors to attend meetings as appropriate or as required by Engineer.

H. Contractor shall schedule pre-installation conferences as required in the individual specification sections.

I. Notify Engineer of project meetings scheduled by the Contractor.

J. Engineer will schedule and administer meetings throughout the progress of the Work, except for meetings held by the Contractor for normal coordination of the Work.

K. Meeting agenda shall include, but not be limited to, the following: Project Administration, Submittals, Construction Schedules and Methods, Safety and Health Regulations, Project Coordination, Payment Application, Change Orders, and Site Inspections.

L. Engineer will prepare agenda with copies to participants, preside at meetings, prepare minutes and distribute to participants for meetings scheduled by the Engineer.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section includes, but is not limited to, requirements for the following:
   1. Submittal procedures.
   2. Construction progress schedule.
   3. Schedule of values.
   4. Proposed product list.
   5. Project record documents.
   6. Certificates of compliance.
   7. Catalog data.
   8. Shop drawings.
   9. Manufacturer's installation procedures.
   10. Samples.
   11. Test reports.
   12. Operation and maintenance instructions.
   13. Warranties.
   14. Spare parts and maintenance materials.

1.02 SUBMITTAL PROCEDURES

A. Transmit each submittal with cover letter to Engineer at The Wooten Company, 120 N. Boylan Avenue, Raleigh, NC 27603.

B. Sequentially number transmittal forms. Re-submittals to have original number with an alphabetic suffix.

C. Cover letter for each submittal package shall list the following:
   1. Contractors name:
   2. Owners name: Brunswick Regional Water and Sewer H2GO
   3. Project name: Contract 4 – Reverse Osmosis Water Treatment Plant
   4. Wooten Job No.: 3081-AB

D. Individual submittals shall each be listed by the following information:
   1. Submittal reference no.
   2. Specification section number.
   3. Drawing and detail number when appropriate.
   4. Equipment.
   5. Type submittal.
   6. Supplier.
   7. Manufacturer.

E. Apply Contractor's stamp to each submittal, signed or initialed and dated, certifying that Contractor has reviewed submittal for conformance with requirements of Contract Documents, and has coordinated submittal with related work.

F. Schedule submittals to expedite Project, and deliver to coordinate submission of related items. Allow a minimum of fifteen (15) working days for Engineer's review.

G. Identify variations from Contract Documents and Product limitations as they relate to the satisfactory performance of the Project.

H. Provide space for Contractor and Engineer review stamps.

I. Revise and resubmit submittals as required; identify changes made since previous submittal.

J. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report inability to comply with provisions.

K. Work requiring submittal review by Engineer shall not be started until review has been obtained.

L. Engineer's review of submittals shall not relieve Contractor of responsibility for complete compliance with Contract Documents.

1.03 ADMINISTRATIVE SUBMITTALS

A. Construction Progress Schedule
   1. Submit five (5) copies of the initial progress schedule 15 days after date of Owner-Contractor Agreement. One copy shall be returned to the Contractor.
   2. Progress schedule shall be, as a minimum, a horizontal bar chart with a separate line for each major section of Work. Identify the first work day of each week.
   3. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.
   4. Indicate the expected monthly pay requests.
   5. Submit revised schedule with each Application for Payment as required for updating, identifying changes since previous version. Indicate estimated percentage of completion for each item of Work at each submission.
   6. Indicate submittal dates required for critical shop drawings, product data, samples, and product delivery dates.
   7. Indicate specific work sequences and requirements as indicated in Section, Summary of Work.

B. Schedule of Values
   1. Submit three (3) copies of the schedule of values at least three (3) weeks prior to the first partial payment request. Schedule shall divide the lump sum contract items into major work tasks. Use the table of contents as a guide for itemizing the schedule. Schedule will be used only as a basis for review of the Contractor's request for payment.
   2. Engineer may request additional delineation of work tasks and supporting data of the values, as he deems appropriate. Revise schedule and resubmit.
   3. Revise schedule to list approved Change Orders, with each request for payment.

C. Project Record Documents
   1. Maintain on site, one set of the following record documents; record actual revisions to the Work:
      a. Contract Drawings.
      b. Project Manual.
      c. Addenda.
      d. Change Orders and other Modifications to the Contract.
      e. Reviewed submittals.
   2. Store Record Documents separate from documents used for construction.
   3. Record information concurrent with construction progress.

4. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
    a. Manufacturer's name and product model and number.
    b. Product substitutions or alternates utilized.
    c. Changes made by Addenda and Modifications.
5. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
    a. Measure elevations of structures in relation to bench mark datum.
    b. Measure and reference horizontal and vertical locations of underground utilities and appurtenances to existing permanent surface improvements that are indicated on the Drawings.
    c. Measure and reference location of internal utilities and appurtenances concealed in construction to visible and accessible features of the Work.
    d. Field changes from construction Drawings.
    e. Details not on original Contract Drawings.
6. Submit documents to Engineer with final Application for Payment.

1.04 TECHNICAL SUBMITTALS

A. General
    1. Submit the following as required by the individual sections of the technical specifications.
    2. Unless noted otherwise, submit the number of copies that Contractor requires, plus three (3) copies that will be retained by Engineer.

B. Certificates of Compliance
    1. Certificates shall certify that the Products delivered to the project are in conformance with the specifications.
    2. Certificates may be recent or previous test results on Product, but must be acceptable to Engineer.
    3. Certification shall not relieve the Contractor of responsibility for complying with requirements of the specifications.

C. Catalog Data
    1. When shop drawings are not required, the catalog data shall include the following as a minimum:
        a. Parts schedule that identifies the materials to be used in each of the various parts.
        b. Sufficient detail to serve as a guide for assembly and disassembly of the product and to serve as guide for ordering parts.
    2. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Work in the Shop Drawing submittal.

D. Shop Drawing
    1. Shop drawings shall consist of drawings, diagrams, illustrations, schedules, performance charts, brochures and other data, prepared specifically for a portion of the Work.
    2. Shop drawings shall indicate the type, size, quantity, arrangement, location, mode of operation, component materials, utility connections, wiring and control diagrams, anchorage's, supports, factory applied coatings, and other information necessary to ensure satisfactory fabrication, installation and operation of the completed Work.

3. Shop drawings shall establish the actual detail of manufactured or fabricated items, indicate proper relation to adjoining work, amplify design details of mechanical and electrical equipment in proper relation to physical spaces in the structure, and incorporate minor changes to design and construction to suit actual requirements.

E. Manufacturer's Installation Procedures
   1. Installation procedures should indicate manufacturer's recommendations for proper installation of Product.

F. Samples
   1. Submit samples as required by the individual specification sections. Samples shall be physical examples to illustrate the materials and workmanship. Submit in sufficient size and quantity to clearly illustrate the functional characteristics of the Product, with integrally related parts and attachment devices, and the full range of color to be provided.

G. Test and Start-Up Reports
   1. Submit three (3) copies of report to the Engineer within seven (7) days of performing the test.
   2. Report shall include the following as a minimum:
      a. Owners name: Brunswick Regional Water and Sewer H2GO
      b. Project name: Contract 4 – RO Water Treatment Plant
      c. Wooten job number: 3081-AB
      d. Firm performing work.
      e. Individual performing work.
      f. Specification section no.:
      g. Product tested or started.
      h. Date and time of work.
      i. Type of test or start-up.
      j. Specific location in the Project: (i.e. Structure name and location within the structure by a rough sketch.)
      k. Results.
      l. Opinion of firm doing the work as to the test or start-up being in compliance with the Contract Documents.
   3. When requested by Engineer, the testing or start-up firm shall provide additional interpretation of results.

H. Operation and Maintenance Instructions
   1. Submit three (3) copies of operation and maintenance instructions within 45 days after approval of the shop drawings.
   2. Submit instructions in a navy blue vinyl, loose leaf binder containing the name of the equipment covered on the front and the spine of the binder. Provide tab dividers appropriately labeled.
   3. As a minimum, the submittal shall contain complete operation and maintenance instructions, drawings, and complete parts list.
   4. In addition, for equipment requiring periodic lubrication, provide two (2) lubrication charts; one shall be included in the binder, and the other shall be provided in weatherproof 10 mil. laminated plastic and shall be permanently affixed to the equipment. Charts shall contain pertinent information concerning the lubricating requirements including manufacturer's name, name of equipment, recommended service interval, and recommended lubricant, location of each of the points of lubrication.

I. Warranties
   1. Provide duplicate notarized copies.
   2. Assemble documents from Subcontractors, suppliers, and manufacturers.
   3. Provide Table of Contents and assemble in three D side ring binder with durable plastic cover.
   4. Submit prior to final Application for Payment.
   5. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of acceptance as start of warranty period.

J. Spare Parts and Maintenance Materials
   1. Provide products, spare parts, maintenance, and extra materials in quantities specified in individual specification Sections.
   2. Deliver to Project site and place in location as directed by the Owner. Obtain Owner's signature and date bill of materials as delivered to the site as required by this paragraph. Provide a copy of signed bill of materials to Engineer with request for payment.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Quality assurance and control of installation.

B. Inspection and testing laboratory services.

C. References.

D. Field samples.

E. Manufacturers' field services and reports.

1.02 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Manufacturer shall have the minimum number of years of proven successful experience required in each section in the design, manufacture, and servicing of Products specified.

B. In lieu of the required experience, manufacturer may provide a cash deposit or bond equal to the cost of the Product, but pro-rated to the number of years of actual experience.

C. Products from a manufacturer who does not meet the experience requirements must meet technical requirements.

D. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.

E. Comply fully with manufacturers' instructions, including each step in sequence.

F. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

G. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

H. Perform work by persons qualified to produce workmanship of specified quality.

I. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.03 INSPECTION AND TESTING LABORATORY SERVICES

A. Contractor shall provide the services of an independent firm to perform soil and material inspections, testing and other services specified in the individual specification sections of this Contract Document.

B. Testing laboratory shall be authorized to operate in the state in which Project is located.

C. Testing laboratory shall have a full-time registered Engineer on staff to review services.

D. Testing equipment shall be calibrated at reasonable intervals with devices of an accuracy traceable to either National Bureau of Standards (NBS) standards or accepted values of natural physical constants.

E. Prior to start of Work, submit testing laboratory name, address, and telephone number, names of full-time registered engineer, field inspector, and responsible project manager. Laboratory subject to the approval of the Engineer.

F. The same independent firm shall perform retesting. Contractor shall pay for retesting required by the failure of the initial test to meet the requirements of the specifications.

1.04 LABORATORY RESPONSIBILITIES

A. Testing Laboratory shall have the following responsibilities for the Project:
   1. Attend pre-construction conferences and progress meetings as required by the Engineer.
   2. Collect and test samples of mixes.
   3. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
   4. Perform inspection, sampling, and testing in accordance with Contract Documents and specified standards.
   5. Ascertain compliance of soil compaction and material mixes with requirements of Contract Documents.
   6. Promptly notify Engineer and Contractor of observed irregularities or nonconformance of Work or Products.
   7. Perform additional inspections and tests required by Engineer when specified tests have failed.

1.05 LIMITS ON TESTING LABORATORY AUTHORITY

A. The authority of the Testing Laboratory is limited as follows:
   1. May not alter requirements of Contract Documents.
   2. May not approve or accept any portion of the Work.
   3. May not assume duties of Contractor.
   4. Has no authority to stop the Work.

1.06 LABORATORY REPORTS

A. After each inspection and test, the independent testing firm shall submit report(s) as specified in Section, Submittal Procedures.

1.07 CONTRACTOR RESPONSIBILITIES

A. Unless specified otherwise, deliver to laboratory at designated location, adequate samples of materials proposed to be used that require testing. The proposed mix designs shall be included with delivery.

B. Cooperate with laboratory personnel, and provide access to the Work and to manufacturer's facilities as specified.

C. Provide incidental labor and facilities to provide access to Work to be tested, to obtain and handle samples at the site and at source of products to be tested, to facilitate tests and inspections, storage, and curing of test samples.

D. Notify Engineer and laboratory 24 hours prior to expected time for operations requiring inspection and testing services.

1.08 REFERENCES

A. Conform to reference standard by date of issue current to date of Bid opening.

B. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Contractual relationship of parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.09 FIELD SAMPLES

A. Install field samples at site as required by individual specification sections for review.

B. Acceptable samples represent a quality level for the Work.

C. Remove field samples and clean area prior to final inspection unless specified otherwise in the individual specification sections.

1.10 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. Require suppliers and manufacturers to provide a qualified technician for required services as outlined by the individual equipment and material specification sections.

B. Submit qualifications of technician to Engineer 30 days in advance of required work. Technician subject to approval of Engineer.

C. Technicians shall report observations, site decisions, and instructions given to Contractor, installers, and Owner's staff that are supplemental or contrary to manufacturers' written instructions directly to the Engineer.

D. Submit test and start-up report as specified in Section, Submittal Procedures.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, water, and sanitary facilities.

B. Temporary Controls: Barriers, enclosures and fencing, water control, dust control, erosion and sediment control, and protection of the work.

C. Construction Facilities: Access roads, parking, progress cleaning, project signage, and field offices.

1.02 TEMPORARY UTILITIES

A. Electricity
   1. Provide and pay for required power service for construction from Utility source.

B. Lighting
   1. Provide and maintain lighting for construction operations as required by Contractor.
   2. Provide and maintain lighting to exterior staging and storage areas after dark for security purposes as required by Contractor.

C. Water
   1. Provide, maintain, and pay for suitable quality water, including any necessary service(s) required for construction operations. Exercise measures to conserve water during construction.
   2. Owner will provide water used for construction through a metered location. Contractor will be required to make a $1,000 deposit to Owner for a 3-inch hydrant meter and will be billed monthly at the rate of $3.50 per 1,000 gallons used, except for water used for initial line testing, initial ground storage tank testing and initial backwash storage tank testing.
   3. Water used for initial line testing (volume for filling line), initial ground storage tank testing (volume for filling tank), and initial backwash storage tank testing (volume for filling tank) will be provided by Owner at no charge. Water required for any follow-up test will be billed to the Contractor at a rate of $3.50 per 1,000 gallons used.
   4. Contractor shall be required to extend water lines or provide hauling as required for Contractor's use from existing site hydrants as designated by the Owner.

D. Sanitary Facilities
   1. Provide and maintain required facilities and enclosures as necessary to comply with the laws and ordinances of the authority having jurisdiction and the State of North Carolina.
   2. General Contractor shall provide the above sanitary facilities for all contractors, sub-contractors, Owner and Engineer at the Project Site.

1.03 TRAFFIC CONTROL

A. On public and private road rights-of-way provide traffic control devices when construction encroaches within the right-of-way. Devices shall include, but not be limited to, cones, drums, flares, warning signs, temporary pavement marking, warning lights, and flagman.

B. Traffic control devices shall provide the following:
   1. Protection of motorists, pedestrians and workers from accident hazards.
   2. Advance public information of proposed work sites.
   3. Establishment of an orderly and safe flow of traffic and to minimize traffic congestion.
   4. Provision of access for emergency vehicles.

C. Traffic control devices shall be used in accordance with the latest edition of the NC DOT "Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)."

D. Provide personnel trained in traffic control.

1.04 TEMPORARY CONTROLS

A. General
   1. Temporary controls shall be the responsibility of each Contractor for their respective work unless noted otherwise.

B. Barriers
   1. Provide barriers to prevent unauthorized entry to construction areas for the safety of the public, the protection of the work, and to protect existing facilities and adjacent properties from damage from construction operations.
   2. Provide protection for plant life designated to remain. Replace damaged plant life.
   3. Protect vehicular traffic, stored materials, site, and structures from damage.

C. Water Control
   1. Grade site to drain. Provide, operate, and maintain pumping equipment to maintain excavations free of water.
   2. Protect site from running water.

D. Dust Control
   1. Execute Work by methods designed to minimize raising dust from construction operations.
   2. Provide positive means to prevent airborne dust from dispersing into atmosphere.

E. Erosion and Sediment Control
   1. Provide Erosion and Sediment Control as indicated on the Drawings and specified in Section 02370, Erosion Control.

F. Protection of Installed Work
   1. Protect installed Work and provide special protection where specified in individual specification Sections.
   2. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.
   3. Prohibit traffic from landscaped areas.

1.05 CONSTRUCTION FACILITIES

A. General
   1. Construction facilities shall be the responsibility of each Contractor for their respective work unless noted otherwise.

B. Access Roads
   1. Contractor shall construct and maintain temporary drives as necessary to access public thoroughfares and existing drives to serve the construction area.

2. Provide means of removing mud from vehicle wheels before entering streets.

C. Parking
   1. When site space is not adequate, arrange for temporary off site surface parking areas to accommodate construction personnel.
   2. Do not allow vehicle parking in existing right-of-way or to block existing drives.
   3. Do not allow vehicle parking on private property without prior approval.

D. Progress Cleaning
   1. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
   2. Remove waste materials, debris, and rubbish from site periodically and dispose off site.

E. Project Signage
   1. Contractor shall provide project sign of exterior grade plywood and wood frame construction, painted, with exhibit lettering by professional sign painter. Submit layout based on example in Supplementary General Conditions, to Engineer for approval.
   2. List title of Project, name of Owner, Engineer, and Contractor.
   3. Erect on site at location established by Engineer.
   4. No other signs are allowed, without Owner's permission, except those required by law.

F. Field Offices
   1. Contractors shall locate a temporary office trailer at the Project Site. Each office shall be equipped with a phone for use by the Contractor's Superintendent.
   2. Contractor shall provide office facilities for the Engineer and his representative. The office shall have minimum floor area dimensions of 8' x 10', contain windows, cylinder locked door and raised floor. Heating and air conditioning equipment shall be provided. Lighting shall provide a minimum of 50 foot-candles. Provide a minimum of three receptacles. Furniture shall consist of a desk, chair, legal size four-drawer file cabinet, and drafting board.
   3. Locate field office as approved by Engineer.

1.06 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, and materials, prior to Final Inspection.

B. Clean and repair damage caused by installation or use of temporary work.

C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Products.

B. Transportation and handling.

C. Storage and protection.

D. Product options.

E. Substitutions.

1.02 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components specified in the Contract Documents for reuse.

B. Owner Furnished Equipment: Means equipment supplied to the site by the Reverse Osmosis Equipment Manufacturer (ROEM) and through the assignment of the contract "Reverse Osmosis Equipment Procurement". All provisions of this Section shall apply to ROEM supplied equipment.

1.03 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Ship fabricated assemblies in largest sections permitted by carrier regulations and properly marked for ease of field erection.

C. Promptly inspect shipments to assure that Products comply with specified requirements, quantities are correct, and Products are undamaged.

D. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.04 STORAGE AND PROTECTION

A. Keep on site storage of material to a minimum.

B. Store and protect Products in accordance with manufacturer's instructions in unopened original packages, with seals and labels intact and legible. Store sensitive Products in weather-tight, climate-controlled enclosures.

C. For exterior storage of fabricated Products, place on sloped supports, above ground.

D. Provide off site storage and protection when site does not permit on site storage.

E. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

F. Store loose granular Products on solid flat surfaces in a well drained area. Prevent mixing with foreign matter.

G. Arrange storage of Products to permit access for inspection. Periodically inspect to assure Products are maintained under specified conditions.

1.05 DAMAGED PRODUCTS

A. Remove damaged Products from Project site.

1.06 PRODUCT OPTIONS

A. Products Specified by Reference Standards: Product meeting standard and specific requirements of these specifications.

B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming Three Manufacturers with an "or equal" Provision for Substitutions: Submit a request for substitution for manufacturer not named during the shop drawing submittal.

1.07 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions for items not listed in Section, Equipment Materials List or included in the Bid Form Attachment, during the regular shop drawing submittal process. Submit "or approved substitute" Products listed on the Equipment Materials within thirty (30) days from the date of Owner-Contractor Agreement.

B. Substitutes shall not be allowed from the list submitted with the Bid Form, except for the following reasons:
   1. Item of equipment is no longer available.
   2. "Or approved substitute" product is not approved by Engineer.

C. Submit the following information for review and approval by Engineer of "or approved substitute" pieces of equipment as listed in the Equipment Materials List:
   1. Name of product.
   2. Name of manufacturer.
   3. List a minimum of five (5) similar installations.
   4. Length of experience in the manufacturer of the specified equipment.
   5. Basic product data.
   6. Identify variations in methods and materials of construction, mode of operation, and performance characteristics of the "or approved substitute" Product from the named manufacturers equipment.
   7. Additional information as required by Engineer to verify the "or approved substitute" ability of the proposed equipment.

D. Substitution submittal procedure for products not on Equipment Material List or Bid Form Attachment during shop drawing review:
   1. Submit written request for substitution with shop drawing submittal.
   2. Submit data outlined in paragraph "C" above.
   3. Submit number of copies as required by the shop drawing submittal.
   4. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence as required by the specifications.

E. Requests for substitutions constitutes a representation that Contractor:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of specified product.
   2. Shall provide the same warranty for Substitution as for specified product.

3. Shall coordinate installation and make changes to other Work which may be required for Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension that may subsequently become apparent.
5. Shall reimburse Owner for review associated with reapproval by authorities.

F. Additional requirements are indicated in Section, Quality Control, Article 1.02.

G. Engineer is sole judge of equality for proposed "or approved substitute" equipment. Should an "or approved substitute" item be rejected by Engineer, Contractor is responsible for providing the specified equipment without an increase in Contract Price or Time.

H. Substitutions will not be considered without separate written request, or when acceptance will require revision to the Contract Documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not used

END OF SECTION

SECTION 01700

EXECUTION REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination.

B. Cutting and patching.

C. General installation provisions.

D. Cleaning and protection.

E. Final inspection and tests.

F. Adjusting.

G. Close-out procedures.

1.02 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specifications sections.

D. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.03 CUTTING AND PATCHING

A. General
   1. Do not cut, or alter the work of other contractors without written approval of the Engineer.
   2. Work removed shall be replaced or repaired by the Contractor who removed or damaged the work, and a craftsman, skilled in the trade that the particular replacement requires, shall do the work. (i.e.: A mason, not an electrician, shall replace masonry removed by the Electrical Contractor.)
   3. Conduct removal operations in a manner that will eliminate hazards to persons and property and prevent the release of dust and rubbish into the air. Existing work, which is to remain and is damaged by contract operations shall be replaced with new materials at no additional cost to the Owner.
   4. For replacement of work removed, comply with specifications for type of work to be done.

B. Inspection
   1. Inspect existing conditions of work including elements subject to movement or damage during cutting and patching, and excavating and backfilling.
   2. After uncovering work, inspect conditions affecting installation of new products.

C. Preparation prior to cutting
   1. Provide shoring, bracing, and support as required to maintain structural integrity of project.

2. Provide protection for other portions of project.
3. Provide protection from elements.

D. Performance
1. Execute fitting and adjustment of products to provide finished installation to comply with specified tolerances, finishes.
2. Execute cutting and demolition by methods to prevent damage to other work and provide proper surfaces to receive installation of repairs and new work.
3. Execute excavating and backfilling as specified in Section, Trenching for Utilities.
4. Restore work, which has been cut or removed; install new products to provide completed work in accordance with requirements of contract documents.
5. Refinish entire surfaces as necessary to provide an even finish.
   a. Continuous Surfaces: To nearest intersections.
   b. Assembly: Entire Refinishing.

1.04 GENERAL INSTALLATION PROVISIONS

A. Require Installer of each major component to inspect conditions under which Work is to be performed. Clean substrate surfaces prior to applying next material or substance. Do not proceed until unsatisfactory conditions have been corrected.

B. Comply with manufacturer's recommendations to the extent that they are more explicit or stringent than requirements contained in Contract Documents.

C. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.

D. Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to the Engineer for final decision.

E. Check dimensions before starting each installation.

F. Install each component during weather conditions and Project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.

G. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.

H. Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Engineer for final decision.

1.05 CLEANING AND PROTECTION

A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration.

B. Clean and maintain completed construction as frequently as necessary through the construction period. Adjust and lubricate components as required to ensure proper operation.

C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, or dangerous exposure

during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Thermal shock.
5. Air contamination or pollution.
6. Water or ice.
7. Abrasion.
8. Heavy traffic.
9. Misalignment.
10. Improper shipping or handling.
11. Theft.
12. Vandalism.

D. Clean Project prior to final inspection. Project clean up shall include, but not be limited to, the following:

1. Clean glass.
2. Clean surfaces exposed to view as recommended by manufacturer.
3. Remove temporary labels.
4. Vacuum carpeted areas.
5. Clean fixtures to a sanitary condition.
6. Repaint damaged paint surfaces.
7. Clean debris from roofs, gutters, down spouts, and drainage systems.
8. Sweep paved areas.
9. Rake clean landscaped surfaces.
10. Remove waste and surplus materials.
11. Remove temporary construction facilities.

1.06 FINAL INSPECTION AND TESTS

A. Prior to final acceptance place equipment in operation and make necessary adjustments for proper operation. Test equipment under normal operating conditions in the presence of Engineer. Test shall show conclusively that requirements of the specifications have been fulfilled.

B. Complete punch list items within 30 days of receipt from Engineer. Owner may have work not completed within 30 days performed by others with the cost deducted from Contractor's final payment. Additional engineering and inspection services required as a result of Contractor not completing punch list within 30 days shall be at Contractor's expense.

1.07 ADJUSTING

A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

B. Provide proper fluids in equipment.

C. Provide proper filters in equipment.

1.08 CLOSE-OUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and is complete in accordance with Contract Documents and ready for Engineer's inspection.

B. Provide submittals to Engineer that are required by governing or other authorities.

C. Submit set of Record Documents indicating changes during construction as required in Section, Submittal Procedures.

D. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and final amount due.

E. Submit the following with final Application for Payment:
   1. Affidavit of Release of Liens
   2. Consent of Surety for Final Payment
   3. Affidavit of Payment of Debts and Claims
   4. Final Certified Payroll Information

F. Submit warranties as required by individual equipment specifications.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 02082

SPECIALTY VALVES

PART 1 GENERAL

1.01 SCOPE

A. The Section includes, but is not limited to, the following:
   1. Solenoid Valves
   2. Piston Actuated Valves
      a. Pressure Reducing Valve
      b. Pump Control Valve
      c. Surge/Pressure Relief Valve
   3. Flap Valves

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Trenching for Utilities
   2. Section 02510 Water Distribution System
   3. Section 11064 Vertical Turbine Pumps
   4. Section 13206 Prestressed Concrete Water Tank

1.03 REFERENCES

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. American Water Works Association (AWWA) Publications:
      a. C550 Protective Epoxy Interior Coatings for Valves and Hydrants.
   2. National Sanitation Foundation (NSF)
      a. 61 Drinking Water System Components - Health Effects

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:
   1. Affidavit of Compliance: Affidavits shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met.
      a. Solenoid Valves
      b. Piston Actuated Valves
      c. Flap Valve
   2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
      a. Solenoid Valves
      b. Piston Actuated Valves
      c. Flap Valve
   3. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Solenoid Valves
      b. Piston Actuated Valves
      c. Flap Valve

4. Test Reports: Upon testing of the installed system, field test reports shall be submitted in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
5. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the following:
   a. Solenoid Valves
   b. Piston Actuated Valves
   c. Flap Valve

PART 2 PRODUCTS

2.01 SOLENOID VALVES

A. Provide 2 way solenoid valves that comply with the following requirements:
   1. Size as indicated on the Drawings.
   2. Brass valve body and NEMA type 4X solenoid enclosure.
   3. Power: 120V, single phase, 60 Hz.
   4. Suitable for system working pressure: 150 psi
   5. Provide manual override operator and slow closing operation.
   6. Valve shall be normally open (NO) or normally closed (NC) as indicated on the Drawings.
   7. Provide cast iron or brass body strainer with stainless steel strainer sized to match line size and located ahead of valve.

B. Valve shall be as manufactured by Automatic Switch Co (ASCO), Herion, Magnatrol Valve Corp. or approved substitute.

2.02 PISTON-ACTUATED VALVES

A. General: Provide hydraulically operated piston actuated valves with the following requirements:
   1. Globe or angle pattern valve as required for the location indicated on the Drawings.
   2. Inner valve assembly shall be top and bottom guided by means of replaceable bearing bushings.
   3. Repairs shall be possible without removing the valve from the line.
   4. The minimum travel of the piston shall be equal to 25% of the diameter of the seat.
   5. The piston shall be guided above and below the seat a distance equal to no less than 75% of the diameter of the seat.
   6. Piston shall be cushioned and designed to insure positive closure.
   7. Valve shall have a valve position indicator (indicator rod).
   8. Ball valves provided on control piping for isolation.
   9. The hydraulic pilots, controlling main valve operation, shall have a range for adjustment, be easily accessible and so arranged to allow for their removal from the main valve while the main valve is under pressure.
   10. An external high efficiency strainer with blow-off in the control circuit to protect pilot and speed control valves.
   11. Valve shall be completely piped ready for installation.
   12. Components in contact with the liquid shall be in compliance with NSF 61.
   13. Full ported.
   14. There shall be no metal to metal contacts within the valve.
   15. Suitable for system working pressure of 150 psi with 100 psi surge pressure.

16. Material of construction:
    a. Valve body: Cast iron conforming to ASTM A 126 Class B
    b. Trim: Bronze conforming to ASTM B-62
    c. Flanges: 125 lb conforming to ANSI standards
    d. The main bushing and bottom cap cylinder shall be bronze with Teflon coating. Teflon coated parts shall receive two coats of Teflon TFE with a total minimum thickness of 10 mils.
17. Provide one set of spare parts for normal maintenance of each valve. Spare parts shall include, but not be limited to, seats, seals, and cups.
18. Provide pet-cocks for attachment to valve body for receiving gauges for testing purposes.
19. Power for solenoid(s): 120 V, single phase, 60 Hz.
20. Solenoid enclosure: NEMA 4X
21. Valves shall be as manufactured by Golden Anderson, Ross Valves, or approved equal.
22. All valves shall be of one manufacturer.
23. All valves shall be tested at the factory for simulated field conditions and hydrostatic tested at 100% above the maximum pressure for which the valve is to operate.

B. Pressure Reducing Valve
1. Description: Valve shall function to reduce higher upstream pressure to a lower, constant pre-adjusted downstream pressure regardless of variations in flow rate or changes in upstream pressure by varying the flow rate passing through the valve and have all the features and capabilities as specified herein.
2. Valves shall meet the requirements under Paragraph A above and include the following accessories:
    a. Check Feature (cushioned) – Valves shall include an internal check feature.
    b. Manual operator.
    c. Anti-cavitation trim feature to prevent cavitation damage to valve internals.
3. Location: As shown on Drawings.
4. Size: 10-inch.
5. Inlet pressure: 60-100 psi
6. Outlet pressure: 10-20 psi (adjustable)

C. Pump Control Valve
1. Description: Valves shall function to minimize the pump starting and stopping surges by varying the opening and closing speed of the valve.
2. Location: As shown on Drawings.
3. Size: As indicated on Drawings.
4. Valve shall meet the requirements under Paragraph A above and contain the following:
    a. SPDT double break limit switch, 120V, single phase, 60 Hz, mounted on the valve cover and actuated by the visual travel indicator.
    b. Three way solenoid valve with a manual operator and independently adjustable opening and closing speed controls.
    c. Two way solenoid valve for power failure quick closure with adjustable closing speed control.
    d. SPDT NEMA 4 pressure switch with isolation valve mounted on the pump side of the control valve.
5. Electronic Controller
    a. General:

1) Each pump control valve shall include an electronic controller that shall function as the interface between the valve and the pump starter. The electronic controller shall properly sequence and control the pump start-up and pump shut-down procedure, providing both visual and electronic status outputs for operating personnel.
2) Electronic controller shall include automatic recognition of common fault conditions and shall provide proper fault response sequencing to the pump control valve and pump starter as well as visual and electronic fault notification to operating personnel.
3) The electronic controller shall be the regularly produced product of the valve manufacturer.

b. Construction:
1) The electronic controller shall include a solid state processor capable of monitoring a minimum of ten (10) digital input signals, and providing a minimum of four (4) powered output signals and 15 digital output signals. The processor shall have a minimum of 2 MG logic memory, minimum 120 K database memory, and 9 µsec scan time.
2) Local operator status shall be provided by illuminated LCD touchscreen panel, minimum 5.7" screen size, 256 color. Data input shall be possible by virtual keypad via the touch-screen panel. Remove communication and status monitoring shall be available by means of an RS232 port connection.
3) A regulated power supply shall be provided, suitable for 115 to 120 VAC single phase supply voltage, 60 hz, with maximum 30 amp surge current rating. Output voltage shall be regulated 24 VDC ±5%, 0.6 amp rated with 0.8 amp over-current protection. A separate 5 amp circuit breaker shall be provided on the incoming supply voltage connection.
4) The electronic controller shall be housed in a NEMA 4X fiberglass enclosure with gasketed door, gasketed touchscreen panel, continuous stainless steel henge, stainless steel twist/hatch door fasteners, and padlockable door hasp.
5) The enclosure shall include a minimum 120 watt heater with integral thermostat. A gasketed Local-Off-Remote (L-O-R) slelector switch shall be provided. A gasketed emergency shut-down pushbutton shall be provided (locking type, with manual reset). Labeled, screw-type terminal blocks shall be provided for all input and output connections and supply voltage connection. A minimum of eight (8) spare terminal blocks shall be provided.

c. Inputs:
1) The electronic controller shall be capable of monitoring the following inputs: presence of supply voltage, status of L-O-R selector switch, status of Emergency Shutdown pushbutton, digital remote pump start/stop command signal, two (2) digital valve closed/not closed signals, digital pump discharge pressure switch signal, digital auxiliary system over-ride/shut-down signal, digital remote alarm reset signal.
2) All digital inputs shall be dry contact type and shall be powered by the electronic controller 24 VDC power supply.
3) Local inputs shall be entered by means of the LCD touchscreen panel and shall include: set-up screen for setting of timers and user-selectable options, local pump start command, local pump stop command, local alarm override command.

d. Outputs:
   1) The electronic controller shall provide the following powered outputs: motor start signal, normal solenoid pilot/valve opening signal, emergency solenoid pilot, valve close signal.
   2) Powered outputs shall be powered by the incoming VAC supply voltage and protected by the 5 amp circuit breaker.
   3) The electronic controller shall provide the following non-powered digital outputs: motor start signal, normal valve open signal, normal valve close signal, emergency valve close signal, L-O-R switch in Local signal, L-O-R switch in Remote signal, valve not fully closed alarm, auxiliary system override/shutdown alarm, insufficient pressure on start-up alarm, valve failed to open on start-up alarm, loss of pressure while pumping alarm, valve closed without command alarm, valve failed to close after shut-down command alarm, emergency shut-down button activated alarm, power failure alarm.
   4) Non-powered outputs shall be dry contact, isolated relay type rated for 230 VAC / 30 VDC with maximum allowable 63 amp rating (resistive load).
   5) Remote monitoring of the electronic controller shall be possible by communication via the RS232 port connection provided with the processor.

e. Timers and settings:
   1) The electronic controller shall include the following timers and settings, programmable from a set-up screen and virtual keypad:
      i) VDT Timer – Allowable time for pump to develop pressure on start-up.
      ii) VDT-2 Timer – Delay valve opening after pressure developed on start-up.
      iii) VIT Timer – Allowable time for valve to begin opening.
      iv) VCD Timer – Allowable time for valve to close.
      v) PFT Timer – Delay time for automatic pump re-start following power failure.
   2) If valve fails to close within VCD timer setting, controller can be set to allow pump to continue to run or to initiate an emergency shut-down sequence of valve and pump.
   3) Following a power failure, upon restoration of power, controller can be set to require a reset of the power failure alarm or to permit an automatic restart of the pump upon restoration of power and expiration of the PFT timer setting.
   4) Normal operating conditions:
      i) Refer to Section 13445, SCADA System for a written description of the normal operating conditions of the valve.

D. Surge/Pressure Relief Valve
   1. Description: Valves shall function to open quickly when the system pressure exceeds the setting for which the pilot is set. The valve shall close slowly at an adjustable speed once the system pressure subsides below the setting of the pilot.
   2. Location: As shown on Drawings.
   3. Size: As indicated on Drawings.
   4. For all surge/pressure relief valves, provide the following accessories (per each valve):

a. Limit switch to provide open status of valve.
b. Speed control valve.
c. Anti-cavitation trim feature to prevent cavitation damage to valve internals.

2.03 FLAP VALVE

A. Flap valves shall be of the circular port design with offset single pivot hinge. The valve shall consist of three parts: flap gate, body, and hinge pin. The flap valve shall meet the following requirements:
1. The flap gate and body shall be cast iron conforming to ASTM A-126 Class B. The valve end shall be flanged unless indicated otherwise on the Drawings.
2. Hinge pin shall be bronze.
3. Valve seating shall be bronze to bronze. Both gate and seat ring faces shall be machined to a smooth finish.
4. Valve shall be manufactured by Clow Valve Co., M&H Valve Co., Waterman Industries, Inc. or approved equal.

2.04 VALVE ACCESSORIES

A. General:
1. Provide accessories required for proper and accessible operation of valve at location indicated on the Drawings.
2. Accessories shall be compatible to proper valve operation as recommended by valve manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves and accessories indicated on the Drawings and in complete accordance with the manufacturer's recommendations.

3.02 START UP SERVICES

A. Provide the services of manufacturer's representative to check the valve(s) installation, supervise initial start up, and instruct Owner's personnel in proper operation and maintenance of the valve(s). A minimum of one trip to the site will be required, consisting of a minimum of one 8 hour working day. Regardless of the time spent at the site, services will not be considered complete until the valve operates as intended for a minimum of one (1) week of operation.

B. Operate valve under actual field service to demonstrate that the valve performs to the specified flow capacity and head conditions. During the field test, make adjustments as necessary for proper operation.

C. The following valves shall require start up services:
1. Piston Actuated Valve

D. Submit copy of tests and checks performed in the field, complete with recordings, where applicable, to the Engineer.

3.03 PAINTING
1. Equipment shall receive the manufacturer's standard coating for the intended application. Coatings shall be suitable in every way for the intended application.

END OF SECTION

SECTION 02230

CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work shall include, but not be limited, to the following:
   1. Access roads.
   2. Clearing and grubbing.
   3. Removal of surface debris.
   4. Demolition and removal of existing paving and structures.
   5. Temporary and permanent ground cover.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02370 Erosion Control
   2. Section 02920 Lawns and Grasses.

1.03 WARRANTY AND FINES

A. Contractor is liable for damages to public and private property and fines as may be placed on the Project by the governing agencies due to failure to provide adequate erosion control devices.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 PROTECTION

A. Take reasonable care during construction to avoid damage to vegetation outside of the construction limits. Temporarily tie back ornamental shrubbery and tree branches, where appropriate, to minimize damage. Trees that receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Treat tree trunks damaged by equipment with a tree dressing.

B. Locate and protect property corners and survey control stakes prior to start of clearing operations.

C. Provide temporary gates and fences as necessary to prevent unauthorized vehicular access to the site.

D. Mark clearing limits.

3.02 ACCESS ROADS AND STAGING AREA

A. Clear for access roads.

B. Limit clearing and grubbing for access roads to a maximum width for two-way traffic of 30 feet for 20-foot drive and 5 foot shoulders.

C. Access roads shall have the following:
   1. Provide "Temporary Construction Entrance" per the standard detail on the Drawings at connection to State Roads.
   2. 6 inches of ABC stone.
   3. Provide temporary seeding of shoulders as access drives are installed.
   4. Provide storm pipes under drives at points of concentrated water flow.

D. Clear for a staging area as indicated on the Drawings. Total area to be cleared shall be approved by the Engineer. Area for parking and storage of material shall have 6 inches of ABC stone.

E. Allow reasonable use of access drive by other Contractors, Owner, Engineer, and others authorized to be on the site by the Owner.

F. When no longer required remove stone and restore access drives and staging area to original contours. Scarify and seed access drives and staging areas.

3.03 INSTALL EROSION CONTROL DEVICES

A. Clear areas required to install erosion control devices, which shall be in place and operational prior to other land disturbing activity. Install erosion control devices in accordance with Section, Erosion Control.

3.04 BORROW AND DISPOSAL AREAS

A. Obtain and pay for erosion control permit for borrow and disposal areas as required by Contractor.

B. Install and maintain erosion control devices in accordance with Contractor's approved plan.

3.05 CLEARING AND GRUBBING

A. Clear total width of permanent easement. Clear within temporary construction easement only as necessary for construction.

B. Grub within the permanent easement only as necessary for the installation of the work. Do not grub within the temporary construction easement.

C. Clearing shall consist of cutting and removal of vegetation to the existing ground surface and removal of debris. Debris shall include, but not be limited to, fences, steps, walls, chimneys, footings, foundation slabs, basements, signs, junked vehicles, and other rubble.

D. Grubbing shall consist of the removal of roots over 3 inches in diameter, matted roots, stumps, and other vegetable matter to 12 inches below existing grade.

E. Do not precede grading operation by grubbing operation by more than seven days.

F. Fill holes and depressions and bring cleared and grubbed area to a uniform contour to match existing grade. Provide positive drainage.

G. Remove and properly dispose of cleared and grubbed material from the site. Make reasonable effort to channel timber resulting from clearing operations into a beneficial use.

H. Burning shall not be permitted at the site.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide labor, equipment, and material to perform site preparation and earthwork as specified herein and indicated on the Drawings. Work shall include, but is not limited to, the following:
   1. Survey staking as required for construction.
   2. Topsoil stripping and stockpiling.
   3. Dewatering.
   4. Protection of existing facilities.
   5. Site grading.
   6. Excavation, trenching, and backfilling for structures and foundation including stone base as indicated on the Drawings.
   7. Borrow material including, but not limited to, material, excavating, hauling, placing, and compacting.
   8. Maintenance and stability of site.
   9. Disposal of waste and surplus material.
   10. Soil testing.

B. Examine the site to determine the extent of excavating, grading, and related items necessary to complete the work.

C. The following is provided for information only and the convenience of the Contractors. A potential borrow site has been identified in Navassa, NC that has NCDOT approved compactable fill material. Contact information for this site is as follows: Vince Labar, Landsdown Earth & Pipe, Inc., 3214 Summerfield Drive, Monroe, NC 28110, office – 704-753-5400, cell – 540-379-6990, fax – 704-353-7007.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02230 Clearing and Grubbing
   2. Section 02315 Trenching for Utilities
   3. Section 02370 Erosion Control

1.03 MEASUREMENT AND PAYMENT PROCEDURES

A. Work in this section shall be included in the lump sum Base Bid, unless specifically noted otherwise, and shall include, but not be limited to, the following:
   1. Topsoil stripping, stockpiling and spreading after the completion of the grading.
   2. Backfilling of area stripped of topsoil and filling from existing grades to new subgrade elevation. Providing borrow material for backfilling and filling.
   3. Excavating for structures.
   4. Stone base as indicated on the Drawings.
   5. Dewatering.
   6. Use of explosives.
   7. Protection of existing service lines and utility structures.
   8. Maintenance and Stability of site grading.

9. Disposal of waste and surplus material.
10. Soil Testing.

B. The following work shall be paid by the unit price as indicated in the Bid Form:
   1. Undercut of unsuitable material: Cu Yd

C. Unit price work shall be approved by the Engineer prior to proceeding with the work.

D. Measurement: Measurement shall be on the actual quantities removed. Take measurements for determination of unit price quantities in the presence of the Engineer. Maintain daily log sheets of measured quantities. Log sheets must be signed by Engineer and submitted with payment request. Payment shall not be made for unit price quantities that have not been verified by the Engineer.

E. Payment for the unit price items shall be for all labor, materials, equipment, and services required or reasonably implied by the Contract Documents and shall include, but not be limited to, the following:
   1. Undercut of unsuitable material: Complete removal and disposal of undercut material including, but not limited to, excavating, loading, hauling, and properly disposing of excavated material. Providing satisfactory material for backfilling shall include, but not be limited to, material, loading, hauling, placing and compacting in accordance with these specifications.
   2. At the Contractor's option, the sandy soils (SC and SM) of the undercut material can be stockpiled on-site and used for structural fill at the site. See Paragraph 3.08.A for requirements of using these soils for structural fill. All remaining excavated undercut material shall be disposed of as identified in paragraph 1.03.D.1 above.

1.04 REFERENCES

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. American Society of Testing Materials (ASTM)
      a. C33 Concrete Aggregates.
      b. D698 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49 Kg) Rammer and 12-inch Drop (Standard Proctor).
      c. D1556 Density of Soil in Place by the Sand-Cone Method.
      d. D1586 Penetration Test and Spilt-Barrel Sampling of Soils.
      e. D2167 Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
      f. D2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
      g. D2487 Classification of Soils for Engineering Purposes.
      h. D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.05 DEFINITIONS

A. Backfill: A specified material used in refilling a cut, trench, or other excavation, placed at a specified degree of compaction.

B. Capillary Water Barrier: A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity, which is placed beneath a building

slab with or without a vapor barrier to cut off the capillary flow of water to the area immediately below the slab.

C. Compaction: Process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of compaction" shall be expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D698 (Standard Proctor).

D. Excavation: The removal of soil or rock to obtain a specified depth or elevation.

E. Fill: Specified material placed at a specified degree of compaction to obtain an indicated grade or elevation.

F. Hard Material: Solid, homogeneous material which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment with ripper teeth. Material having a standard penetration resistance as determined by ASTM D1586 60 and 150 blows per foot is defined as "hard material."

G. Lift: Layer of soil placed on top of a previously prepared or placed soil.

H. Rock: Solid, homogeneous material which cannot be removed without the systematic drilling and blasting exceeding one (1) cubic yard in volume. Material having a standard penetration resistance as determined by ASTM D1586 greater than 150 blows per foot is defined as "rock." Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

I. Soil classification shall be in accordance with ASTM D2487.
   1. Satisfactory materials: Soils classified as GW, GP, GC, GM, SP, SC, SM, SW, ML, and CL.
   2. Unsuitable materials: Soils considered as unsatisfactory shall be materials that do not comply with the requirements of satisfactory above and include, but shall not be limited to, the following:
      a. Soil containing organic matter, debris, stones larger than 6 inches, or frozen material. Stones greater than 4 inches will not be permitted in the top 12 inches.
      b. Soils classified as Pt, CH, MH, OH, and OL.
   3. Cohesionless: Classified as GW, GP, SW, and SP. Soils classified as GM and SM shall be classified as cohesionless only when the fines have a plasticity index of less than 10.
   4. Cohesive: Classified as GC, SC, ML, CL, MH, and CH. Soils classified as GM and SM shall be classified as cohesive only when the fines have a plasticity index greater than 10.

J. Subgrade: Lowest elevation upon which fill or other work will be placed in the absence of unsuitable material.

K. Topsoil: Natural, friable soil, representative of productive soils in the vicinity of the site. Topsoil shall be free from roots, stones larger than 1 inch, objectionable weed seeds, toxic substances, and materials that hinder grading, planting, and maintenance operations.

1.06 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following.
      a. Structural fabric.
   2. Manufacturer's Installation Procedures.
      a. Structural fabric
   3. Test Reports: Submit for the following:
      a. Moisture-density relations of soils.
      b. Field moisture content.
      c. Soil classification.
      d. In-place field density.
      e. Geotechnical engineer's daily field reports.
   4. Permits
      a. Erosion control permits for borrow and disposal site(s).

PART 2 PRODUCTS

2.01 MATERIAL

A. Capillary water barrier: A clean crushed stone, crushed gravel, or uncrushed gravel conforming to ASTM C33 coarse aggregate grading size 57.

B. Stone Base: A clean crushed stone, crushed gravel, or uncrushed gravel conforming to ASTM C33 coarse aggregate grading size ABC

C. Structural Fabric: Provide structural fabric specifically designed and manufactured to stabilize soft soils under an aggregate base for roads and parking areas. Fabric shall provide a permeable layer, planar flow, and tensile reinforcement for retaining the soil matrix. Fabric shall be inert to commonly encountered chemicals, hydrocarbons, resistant to mildew, rot, and ultraviolet light exposure, and meet or exceed the following test standards:

	Test	ASTM	
2.	Fabric weight (oz / sq yd)	D-1910	6
3.	Grab tensile strength (lbs.)	D-1682	200
4.	Mullen burst strength (psi)	D-3786	320
5.	Puncture strength (lbs.)	D-751	80

PART 3 EXECUTION

3.01 GENERAL

A. Provide erosion control measures as specified in Section, Erosion Control and clearing and grubbing as specified in Section, Clearing and Grubbing.

B. Protect existing structures and features to remain.

C. Dispose of excavated material in such a manner that it will not obstruct the water flow, endanger existing improvements or Work in progress, impair the use or appearance of the existing facilities, or be detrimental to the completed Work.

D. It is recommended that grading operations take place during the drier months from May to October, if practical.

E. Weather Limitations: Proceed with fill and backfill operations based on the following weather conditions:
   1. Temperature must be above freezing.
   2. In windy, hot, or arid conditions with a high rate of evaporation add moisture to the material to maintain the optimum moisture content.
   3. Do not proceed in rain or on saturated subgrade.

F. Repair or undercut and backfill soils that become damaged by construction activity or unsuitable due to being left exposed to the weather at no additional cost.

G. Do not place material on surfaces that are muddy, frozen, or contain frost.

H. Excavation carried below the elevation indicated on the Drawings shall be backfilled and compacted in accordance with these specifications.

I. Remove and properly dispose of unsatisfactory and excess material from the site.

3.02 CONSTRUCTION STAKING

A. Provide construction staking as indicated in paragraph 4.05 of the General Conditions. Engineer will only provide key reference points and benchmarks.

B. Contractor shall report to Engineer whenever a reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations. Contractor shall be responsible for the accurate replacement or relocation of such reference points or property monuments by a registered professional surveyor in the State of North Carolina.

3.03 PROTECTION OF UNDERGROUND FACILITIES

A. Refer to paragraph 4.04 of the General Conditions and 4.04.A.2 of the Supplementary Conditions concerning the protection of Underground Facilities.

B. Investigate underground facility locations prior to the start of construction.

C. Repair damage to existing facilities at no additional cost to the Owner.

D. A change in conditions may be considered due to the location of the existing facilities as allowed in the General Conditions. This does not include the cost for repair of damaged facilities not properly located in advance of construction.

3.04 WATER CONTROL

A. The geotechnical investigation found the upper soils were typically 5 percent above their optimum moisture content.

B. Inspect the site prior to mobilizing to determine the appropriate equipment for site grading and foundation work.

C. Perform work to prevent surface water from accumulating in excavations, and unfinished fill areas. Perform grading and excavation so the work area and affected operations shall be continually and effectively drained.

D. The geotechnical investigation found a high ground water table at the site, approximately 2 to 4 feet below the existing ground surface. Fluctuations of the groundwater table may be expected during the year due to seasonal and climatic changes.

E. Install a dewatering system prior to excavating beneath the ground water table. Maintain the water table approximately 2 feet below the bottom of the excavation.

F. Maintain dewatering until backfilling has proceeded above the natural ground water level and the structural weight is sufficient to prevent "floating" of the structure. Provide a job superintendent experienced in dewatering work.

G. Horizontal seepage at the contact between clayey soil layers and overlying sandy soils may result in seeps in construction excavation slopes at these contacts, even when the groundwater level is controlled 2 feet below the construction excavation grade. If significant seepage occurs at these contacts that potentially destabilizes the construction excavation slope, it may be necessary to intercept and control the seepage with slope drains.

H. Water from dewatering operations must be disposed of in accordance with the North Carolina Sedimentation Pollution Control Act.

3.05 USE OF EXPLOSIVES

A. Explosives may not be used on the Project.

3.06 TOPSOIL

A. Approximately 2 to 3 inches of topsoil was encountered at the Plant site. Strip topsoil from areas to be disturbed such that the underlying "clean" soils remain intact and stockpile separate from other excavated material. Locate topsoil so that the material can be used readily for the finished grading. Protect and maintain topsoil until needed. Place topsoil in thin lifts of 6 inch thickness or less after completion of work in accordance with Section, Lawns and Grasses.

B. Perform stripping with wide track dozer or other appropriate equipment to minimize disturbance to subgrade soils. Do not use rubber-tired equipment.

3.07 SITE GRADING

A. Following topsoil stripping, identify unsuitable subgrade areas as determined by the Engineer. Based on the very loose near-surface soils and shallow groundwater at the site, the ground surface is not expected to support rubber-tired construction equipment. It is anticipated that loose near-surface soils (estimated to be 3 to 4 feet in depth) will require undercut and replacement in the footprints of all structures and pavements at the site, plus 5 feet outside. The undercut excavations will require dewatering as recommended in Paragraph 3.04 of this section. The undercut bottoms shall be observed by the Engineer to determine if sufficient undercut has occurred prior to fill placement. Payment for in place repair or undercutting and backfilling of unsuitable areas shall be as indicated in the Measurement and Payment paragraph.

B. Perform undercutting of unsuitable soils with tracked excavators, top loading dump trucks or similar equipment approved for the use by the Engineer. Backfill undercut areas immediately.

C. In-Place repair shall consist of discing and recompaction of existing soils to a depth of approximately 12 inches.

D. At the direction of the Engineer provide a structural fabric for stabilization of unsuitable soil areas. Install fabric in accordance with the manufacturer's recommendation and the following minimum requirements.
   1. Provide a fabric overlap of 24 inches.

2. Back dump and spread aggregate over fabric at the aggregate specified thickness.
3. Compact aggregate with vibratory roller prior to allowing additional construction traffic.

E. Site grading shall be unclassified except as specifically indicated otherwise. Perform grading within the limits of the Project. Finished surface shall conform to the grades and cross sections indicated on the Drawings and be uniformly sloped for a positive drainage away from structures.

F. Excavate rock encountered in cut sections to a depth of 6 inches below finished subgrade and backfill with satisfactory material.

G. Scarify the existing subgrade surface to a minimum depth of 6 inches and recompact if subgrade density is less than the degree of compaction for the proposed fill material. Plow or bench existing ground surfaces steeper than one vertical to four horizontal in such a manner that the fill material will bond with or be keyed to the existing surface. Use compaction equipment suitable for the soil being compacted. Moisten or aerate material as necessary to obtain the optimum moisture content within plus or minus one percent to obtain specified compaction.

H. Approved compacted subgrade that is disturbed by construction or adverse weather shall be scarified and re-compacted as specified previously. Re-compaction over utilities shall be by hand tamping.

3.08 FILL AND BACKFILL

A. The soil types encountered within the anticipated excavation depths at this site include Unified Soil Classification designations of ML, CL, SM, and SC. The SC and SM soils, which are the predominate soil types to be excavated, can be used for structural fill. The moisture levels of these soils are expected to be well above compactable levels (especially those soils below the water table) and drying of these soils will be required prior to placement and compaction. Use of lime may be required if natural drying is not effective.

B. Offsite borrow should consist of sandy soils having Unified soil classifications of SW, SM, SC, and SP. SW and SP soils are preferable as the initial fill lift in undercut bottoms. These soils shall have standard Proctor maximum dry unit weights of at least 110 pcf, a maximum plasticity index of 15 percent, and maximum particle size of 2 inches.

C. Settlements due to the 2 to 4 feet of new site fill shall be allowed to substantially complete prior to construction of settlement-sensitive structures. All site grading shall be completed prior to any structure construction.

D. Place and compact fill and backfill material adjacent to structures in a manner that prevents wedging and eccentric loading on or against structures. Do not use equipment adjacent to structures that may overload structure. Backfill against structure only after concrete has attained the specified 28-day compressive strength. It is recommended that no self-propelled compaction equipment be used within 5 feet of structure walls.

E. Stone Base: Structures shall have a compacted crushed stone subgrade to the depth as shown on the drawings. For the Backwash Holding Tank, place a nonwoven geotextile below the bottom of the stone layer.

F. All structural fill shall be placed in 8 to 10-inch loose lifts (6 to 8 inches for utility trench backfill) and compacted to at least 95 percent of the standard Proctor maximum dry density (MDD) (ASTM D 698). The moisture content of structural fill shall be maintained within +/- 3% of optimum moisture during compaction. The top 12 inches beneath pavements and structures shall be compacted to at least

G. Place backfill and fill material in accordance with the following:
   1. Maximum uniform loose lifts: 8-10 inches (6-8 inches for utility trench backfill)
   2. Optimum moisture content: ± 3 percent of optimum
   3. Percent compaction at optimum moisture content (MDD) (ASTM D 698):
      a. From ex. grade to within one (1) foot of struc. subgrade: 95
      b. Final foot to subgrade under floor slabs and pavements: 98
   4. Under sidewalks and grass areas: 90

H. Fill placement and compaction shall be observed by a qualified soil technician working under the supervision of the Engineer. An appropriate number of soil density tests shall be conducted to confirm that adequate fill compaction is achieved.

I. Fill for asphalt pavement areas shall have soil classifications of SW, SM, SC, or SP, and a CBR of at least 10 percent. If off-site soils are placed at design subgrade, laboratory CBR testing shall be performed on these soils to confirm the CBR exceeds 10 percent.

3.09 EXCAVATION FOR STRUCTURES

A. Provide shoring or side slopes of excavations as necessary to protect workmen, and existing and new structures. Use, install, and remove shoring in accordance with State and Federal OSHA regulations.

B. Furnish, erect, and maintain required guardrails at exposed boundaries of excavation.

C. Perform excavation for utilities in accordance with Section, Trenching for Utilities. Install utilities to a minimum distance of five (5) feet beyond the face of the structure.

D. Make excavation to the dimensions and elevations for the structures as indicated on the Drawings. Extend excavation a sufficient distance from walls and footings to allow for placing and removal of forms.

E. Remove unsatisfactory material below required grade and replace with select backfill material as directed by Engineer.

F. Excavation carried below the depths indicated, without specific directions, shall be backfilled and compacted as specified herein to the proper grade. In excavations for footings the concrete shall be extended to the bottom of the over excavation. Work caused by over excavation shall be at the Contractor's expense.

G. The upper 9-inches of the subgrade after excavating for each structure should be compacted in place to at least 95% standard Proctor maximum dry density. The subgrade should be proof-rolled using a vibratory roller weighing a minimum of 10 tons (static load) until settlement from the last four complete passes does not exceed 1/8 inch. Any soft, unsuitable or unacceptable soils encountered in the subgrade should be replaced with structural fill placed and compacted to 95% of the standard Proctor maximum dry density.

3.10 ROCK EXCAVATION

A. Notify Engineer immediately in the event that rock is encountered when the Contract requires payment by the unit price.

3.11 BORROW MATERIAL

A. Provide borrow material required for fill and backfill to bring the site to the elevations indicated on the Drawings. Borrow material shall be subject to the approval of the Engineer. Notify Engineer as to the site selected for inspection and approval prior to transporting borrow material to the site.

B. Obtain erosion control permit as necessary for borrow pit grading operations.

C. Provide soil analysis for each type of material from proposed borrow pit(s) for Engineer's approval prior to placing borrow material. Contractor shall do necessary work to bring the borrow material to within plus or minus 1-1/2 percent of the optimum moisture content. A minimum of one sample per structure shall be obtained for analysis.

3.12 MAINTENANCE AND STABILITY

A. Maintain fills and embankments to the grade and cross section indicated on the Drawings until the final completion and acceptance of the Project. Repair areas that are damaged.

3.13 DISPOSAL OF SURPLUS MATERIAL

A. Dispose of surplus material not required or unsuitable for filling, backfilling, or grading in an approved spoil area in accordance with local ordinances.

B. Obtain erosion control permit as necessary for disposal site(s).

3.14 SOIL TESTING

A. Provide the services of a soil-testing firm as specified in Section 01450, Quality Control.

B. The testing laboratory soil specialist, as a minimum, shall be at the project site for the following:
   1. Monitor proofrolling of existing soils to determine requirements for undercutting unsuitable soils
   2. Monitor grading for the separation and wasting of unacceptable soils.
   3. Providing tests in accordance with the following schedule:
      a. Optimum moisture and laboratory maximum density: Provide one (1) test per type of material to determine optimum moisture and maximum density values in accordance with ASTM D698.
      b. Moisture content: Provide two (2) tests per day per type of material in accordance with ASTM D2216.
   4. Provide in-place field density in accordance with ASTM D1556 or other approved test and the following schedule:
      a. Provide a minimum of one (1) in-place bearing capacity test for every 1,200 sq ft of subgrade area under structures prior to the start of foundation work.
      b. While filling activities are in progress for structures and paved areas. Provide a minimum of one (1) in-place density test for every 1,200 sq ft of lift with a minimum of one (1) test for every lift.
      c. Provide a minimum of one (1) in-place bearing capacity test for every 100 feet of foundation trench.

C. Submit test reports and soil specialist daily logs in accordance with Section 01450, Quality Control.

SECTION 02315

TRENCHING FOR UTILITIES

PART 1 GENERAL

1.01 SCOPE

A. Provide labor, equipment, and material to perform required excavating, backfilling, and compacting for utilities and related structures as specified herein and indicated on the Drawings. Work shall include, but not be limited to, the following:
   1. Survey staking as required for construction.
   2. Protection of existing improvements.
   3. Location of installed utilities.
   4. Use of explosives.
   5. Dewatering.
   6. Excavating, backfilling, and compacting for utilities.
   7. Installation of electronic marker balls.
   8. Installation of warning / identification tape and tracer wire.
   9. Borrow material.
   10. Disposal of surplus material.
   11. Soil Testing.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02230 Clearing and Grubbing
   2. Section 02370 Erosion Control
   3. Section 02510 Water Distribution System
   4. Section 02530 Sanitary Sewer System
   5. Section 02920 Lawns and Grasses

1.03 MEASUREMENT AND PAYMENT

A. Include work specified in this Section in the lump sum or unit price cost for the utility installation as appropriate unless specifically specified elsewhere in the specifications.

B. The following work shall be paid by the unit price as indicated in the Bid Form:
   1. Undercut of unstable soils: Cu Yd
   2. Rock excavation: Cu Yd

C. Take measurements for determination of unit price quantities in the presence of the Engineer. Maintain daily log sheets of measured quantities. Log sheets must be signed by Engineer and submitted with payment request. Payment shall not be made for unit price quantities that have not been field verified by the Engineer. Measurement shall be based on the actual quantities removed but not exceeding the maximum trench dimensions as specified herein.

D. Payment for the unit price items shall be for all labor, materials, equipment, and services required or reasonably implied by the Contract Documents and shall include, but not be limited to, the following:
   1. Undercut of unstable soils: Complete removal and disposal of undercut material including, but not limited to, excavating, loading, hauling, and properly

disposing of excavated material. Providing Class I material for backfilling shall include, but not be limited to, material, loading, hauling, placing and compacting in accordance with these specifications.

2. Rock excavation: Complete removal and disposal of excavated rock material including, but not limited to, drilling, blasting, excavating, loading, hauling, and properly disposing of excavated material. Rock excavation for manholes shall be paid for on the maximum basis of 1-foot greater diameter than the outside diameter of the manhole and to a depth of 1 foot greater than the bottom of the manhole. Providing Class I material for backfilling shall include, but not be limited to, material, loading, hauling, placing and compacting in accordance with these specifications.

1.04 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. N.C. Department of Transportation - Standard Specifications for Roads and Structures (NCDOT).
   2. American Society of Testing Materials (ASTM)
      a. D698 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49 Kg) Rammer and 12-inch Drop (Standard Proctor).
      b. D1556 Density of Soil in Place by the Sand-Cone Method.
      c. D1586 Penetration Test and Spilt-Barrel Sampling of Soils.
      d. D2049 Test for Relative Density of Cohesionless Soils.
      e. D2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
      f. D2487 Classification of Soils for Engineering Purposes.
   3. Uni-Bell PVC Pipe Association
      a. B-5-89 Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Sewer Pipe.

1.05 DEFINITIONS

A. Backfill: A specified material used in filling the excavated trench and placed at a specified degree of compaction.
   1. Materials: Materials listed herein include processed materials plus the soil classifications listed under the Unified Soil Classification System, (USCS) (Method D2487 and Practice D2488). The soil materials are grouped into five broad categories according to their suitability for this application.
      a. Class I: Angular, 6 to 40-mm (1/4 to 1-1/2-in), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shell.
      b. Class II: Coarse sands and gravels with maximum particle size of 40 mm (1-1/2 in.), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.
      c. Class III: Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class.
      d. Class IV: Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL

are included in this class. These materials shall not be used for bedding, haunching, or initial backfill.

e. Class V: This class includes the organic soils OL, OH, and PT as well as soils containing frozen earth, debris, rock larger than 40 mm (1 1/2 in.) in diameter, and other foreign materials. These materials shall not be used for bedding, haunching, or initial backfill.

2. Backfill Zones: Each backfill zone shall extend the full width of the trench bottom.
   a. Foundation: Extending down from the bottom of bedding zone as defined below.
   b. Pipe Embedment
      1) Bedding: Extending from 4 inches below the pipe bottom to the pipe bottom for 30-inch diameter and smaller and 6 inches below the pipe bottom for pipes larger than 30 inches in diameter.
      2) Haunching: Extending from the bedding (bottom of the pipe) to the pipe spring line.
      3) Initial Backfill: Extending from the haunching (pipe spring line) to 1 foot above the top of the pipe.
   c. Final Backfill: Extending from the initial backfill to the finish ground elevation.

B. Laying Conditions:
   1. Type 1: Flat bottom trench with loose backfill.
   2. Type 2: Flat bottom trench with backfill lightly consolidated to centerline of pipe.
   3. Type 3: Pipe bedded in 4 inches minimum of loose soil and backfill lightly consolidated to top of pipe.
   4. Type 4: Pipe bedded on Class I material to 1/8 pipe diameter (4 inch minimum) Backfill compacted to top of pipe a minimum of 80 percent of standard proctor.
   5. Type 5: Pipe bedded in compacted Class I material to pipe centerline with 4-inch minimum under pipe. Backfill to top of pipe with Class I, II, or III and compact to 90 percent of standard proctor.

C. Compaction: Process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of compaction" shall be expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D698 (Standard Proctor).

D. Excavation: The removal of soil or rock to obtain a specified depth or elevation.

E. Hard Material: Solid, homogeneous material which is not included in the definition of "rock" but which may require the use of heavy excavation equipment with ripper teeth. Amount must exceed 1 cubic yard in volume. Material having a standard penetration resistance as determined by ASTM D1586 between 60 and 150 blows per foot is defined as "hard material."

F. Lift: Layer of soil placed on top of a previously prepared or placed soil.

G. Rock: Solid, homogeneous material which cannot be removed without the systematic drilling and blasting exceeding 1 cubic yard in volume. Material having a standard penetration resistance as determined by ASTM D1586 greater than 150 blows per foot is defined as "rock." Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

H. Pipe Springline: A line running horizontally through the center of the pipe.

I. Topsoil: Natural, friable soil, representative of productive soils in the vicinity of the site. Topsoil shall be free from roots, stones larger than 1 inch, objectionable weed seeds, toxic substances, and materials that hinder grading, planting, and maintenance operations.

1.06 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
      a. Warning / Identification tape.
   2. Test Reports: Submit for the following:
      a. Moisture-density relations of soils.
      b. Field moisture content.
      c. Soil classification.
      d. In-place field density.
      e. Geotechnical engineer's daily field reports.

PART 2 PRODUCTS

2.01 STONE

A. Class I material shall be #67 or #78M stone in accordance with NCDOT specifications Section 1005, General Requirements for Aggregate.

2.02 WARNING AND IDENTIFICATION TAPE

A. Tape shall be a minimum 3-inch wide polyethylene plastic tape manufactured specifically for identification of buried utilities with means of enabling detection by a metal detector to a minimum depth of 3 feet. Tape shall be color coded and continuously imprinted with warning and identification markings in bold black letters to read "CAUTION - BURIED (utility) LINE BELOW." Color and printing shall be permanent, unaffected by moisture or soil and shall be as follows:

	Utility	Color	Marking
1.	Water	Blue	Caution - Buried Water Line Below
2.	Gravity Sewer	Green	Caution - Buried Sewer Line Below
3.	Force Main	Green	Caution - Buried Force Main Below
4.	Electric	Red	Caution - Buried Electric Line Below
5.	Gas	Yellow	Caution - Buried Gas Line Below
6.	Telephone	Orange	Caution - Buried Telephone Line Below
7.	SCADA	Orange	Caution - Buried SCADA Line Below

B. Tape shall be by Blackburn Manufacturing, Joseph G. Pollard Co., or Reef Industries Inc.

2.03 TRACER WIRE

A. Tracer wire shall be #12 solid wire. All connections shall be by wire nuts and taped.

PART 3 EXECUTION

3.01 PROJECT SAFETY

A. Contractor is responsible for Project safety.

B. Perform work in conformance with applicable State and Federal safety regulations including, but not limited, to the following:
   1. North Carolina Safety and Health Standards for the Construction Industry (29CFR 1926 Subpart P).
   2. NC OSHA Industry Guide No. 14, Excavations.
   3. NC OSHA Industry Guide No. 20, Crane Safety.

C. Provide barriers, warning lights, and other protective devices at excavations as necessary for safety of workers and the public.

D. Provide sloping of bank, shoring, sheeting, or other means of maintaining the stability of the trench in accordance with the requirements of the Associated Contractor's Manual of Accident Prevention OSHA, Part 1926.P.

3.02 PROTECTION OF UNDERGROUND FACILITIES

A. Refer to paragraph 4.04 of the General Conditions and SC-4.04.A.2 of the Supplementary Conditions concerning the protection of Underground Facilities.

B. Investigate underground facility locations prior to the start of construction.

C. Repair damage to existing facilities at no additional cost to the Owner.

D. A change in conditions may be considered due to the location of the existing facilities as allowed in the General Conditions. This does not include the cost for repair of damaged facilities not properly located in advance of construction.

E. Separation distances shall be in accordance with utilities requirements.

3.03 CONSTRUCTION STAKING

A. Provide construction staking as indicated in paragraph 4.05 of the General Conditions. Engineer will only provide key reference points and benchmarks.

B. Contractor shall report to Engineer whenever a reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations. Contractor shall be responsible for the accurate replacement or relocation of such reference points or property monuments by a registered professional surveyor in the State of North Carolina.

3.04 LOCATION OF INSTALLED UTILITIES

A. Contractor shall be responsible for locating contract installed utilities as requested by third parties proposing to dig in the contract area until the date that the entire contract is recommended for final payment by Engineer to Owner.

3.05 WATER CONTROL

A. Prevent surface water from entering the trench.

B. When trench bottom is below the existing ground water table, install a dewatering system to maintain water table 1 foot below trench bottom. Provide a man experienced in dewatering work at the job site.

C. Maintain dewatering until backfilling has proceeded above the existing ground water level.

D. Dispose of water from dewatering operations in accordance with the North Carolina Sedimentation Pollution Control Act.

3.06 USE OF EXPLOSIVES

A. Explosives may not be used on the Project.

3.07 EXCAVATING

A. Excavation shall be by open cut, unless otherwise indicated on the Drawings or specified herein. Short sections of trench may be tunneled or direct bored with the approval of the Engineer.

B. Stockpile excavated material in such a manner that it will not obstruct the flow of runoff, streams, endanger Work, impair the use or appearance of existing facilities, or be detrimental to the completed Work.

C. Contractor shall segregate excavated material so as to maintain material suitable for backfill separate from material that is unsuitable.

D. Trench dimensions at the pipe embedment and foundation zone unless noted otherwise shall be as follows:
   1. Minimum width: Pipe outside diameter plus 18 inches.
   2. Maximum width: Pipe outside diameter plus 24 inches.
   3. Sides shall be vertical to a minimum of one foot above the top of pipe.

E. Shape trench bedding to provide uniform bearing for the full pipe length. Bottom shall be free of protrusions that could cause point loading on pipe. Provide bell holes as required for properly making pipe joint.

F. Do not over excavate. Excavation below grade without approval of Engineer shall be backfilled with Class I material at no additional cost.

G. Undercut soils that become unsatisfactory by construction activity or by being left exposed to the weather and backfill with Class I material at no additional cost.

H. Remove shoring, bracing, and sheeting, unless otherwise noted, as the trench is backfilled. Engineer shall have the authority to require that the sheeting be left in place.

I. Excavation of trench shall not advance more than 200 feet ahead of the installation. In no case should the excavation extend beyond that which can be backfilled by the end of the workday.

J. Correct unstable soil conditions encountered at trench foundation by one of the following methods:
   1. Excavate below grade as approved by Engineer and backfill with Class I material or approved substitute material at unit price bid or the cost to be included in pipe unit bid price as indicated in Section, Unit Prices.
   2. Provide piling and / or timber cradles in a manner approved by the Engineer. Payment will be made as a change to the Contract Price.
   3. Provide concrete cradle or encasement of concrete at unit price bid or the cost to be included in the lump sum price as indicated in Section, Unit Prices.

K. Rock and Hard Material
   1. Excavate rock and hard material to a minimum depth of 4 inches below the pipe for pipes smaller than 30 inches and 6 inches for pipes 30 inches and larger.

L. Pressure Lines:
   1. Provide a minimum 3 feet of cover, unless indicated otherwise on the Drawings.
   2. Excavate trenches to provide vertical curve chords that will not exceed the pipe manufacturer's recommended joint deflection.

3. Provide concrete thrust blocks having a compressive strength of 3,000 psi at 28 days at change in horizontal and vertical direction and reduction in the pipe size, unless other restraint systems are indicated otherwise on the Drawings. Cut trench sides vertical and square to receive concrete. Provide bearing area against trench wall as indicated on the Drawings.

M. Gravity Lines:
   1. Excavate trench to the alignment and grade indicated on the Drawings.

N. Utility Structures: Provide a minimum of 12 inches below subgrade and backfill with Class I compacted to 95 percent maximum density. If the soil conditions are found to be unsuitable for structural stability of the manhole, Engineer may require additional depth of Class I material.

3.08 BACKFILLING

A. Weather Limitations: Proceed with backfill operations based on the following weather conditions:
   1. Temperature must be above freezing and rising.
   2. In windy, hot, or arid conditions with a high rate of evaporation add moisture to the material to maintain the optimum moisture content.
   3. Do not proceed in rain or on saturated subgrade.
   4. Do not place material on surfaces that are muddy, frozen, or contain frost.

B. General
   1. Maintain backfill operation within 200 feet from pipe laying operation.
   2. Backfill trench to existing ground surface with select excavated material at the specified compaction.
   3. If excavated material is unsuitable to obtain specified compaction, provide suitable off-site borrow material for backfill.
   4. Re-excavate trenches improperly compacted. Backfill and compact as specified.
   5. Provide appropriate tamping equipment, and water to obtain proper moisture content, to achieve specified compaction of backfill.
   6. Conduct operation of heavy equipment above pipe installation as to prevent damage to pipe.
   7. Install warning / identification tape over utilities. Bury tape one foot below finished grade above the utility.
   8. Install tracer wire for non-metallic pressure pipe. Bury tracer wire with pipe. Wire shall be looped into valve boxes to allow access for direct contact location.

C. Backfill in pipe embedment zone (bedding, haunching, and initial backfill).
   1. General:
      a. Backfill with material as specified below. Material shall be free from objects larger than 2 inches.
      b. Where rock and hard material has been excavated below pipe bottom, backfill and compact bedding with Class I material. Class II or III material may be used for bedding with Engineer's approval.
      c. Place backfill material to assure placement of material under pipe haunches.
      d. Take care during placement and compacting of material to avoid movement of pipe.
   2. Place backfill in bedding and haunching zones in 6 inch maximum lifts and compact to 90 percent density. Place initial backfill in one lift do not compact. Provide backfill material in pipe embedment zone as specified below.

a. Pressure Lines (Flexible and Rigid Pipe)
   1) Excavation in Class I, Class II, Class III, and stable Class IV soils suitable for bedding, the bedding surface shall provide a firm foundation of uniform density. Backfill with select excavated material.
   2) Excavation in Class V, unstable Class IV soils, running water, and other unstable soil conditions, excavate a minimum of 4 inches below pipe bottom and provide Class I material for bedding and haunch zone. Backfill with Class I, II, or III material in initial backfill.

b. Gravity Sewer Lines, Rigid pipe (concrete and ductile iron)
   1) Excavation in Class I, Class II, Class III, and stable Class IV soils suitable for bedding, the bedding surface shall provide a firm foundation of uniform density. Backfill with select excavated material.
   2) Excavation in Class V, unstable Class IV soils, running water, and other unstable soil conditions, excavate a minimum of 4 inches below pipe bottom and provide Class I material for bedding and haunch zone. Backfill with Class I, II, or III material in initial backfill.
   3) Ductile Iron over 16 inch
      i) Depth 0 - 12 feet: Type 2 laying conditions same as for pressure pipe.
      ii) Depth over 12 feet: Provide Class I material for bedding and 4 inches up from bottom of pipe.

c. Gravity Sewer Lines, Flexible (PVC SDR 35)
   1) Depth 0 to 14 ft: Provide Class I material for bedding and haunching. Backfill with Class I, II, or III material in initial backfill.
   2) Depth over 14 ft: Provide Class I material for bedding, haunching, and initial backfill.

d. Gravity Sewer Lines, Semi-rigid pipe (PVC and ABS Truss Pipe)
   1) Depth 0 to 14 ft: Provide Class I material for bedding and haunching. Backfill with Class I, II, or III material in initial backfill.
   2) Depth over 14 ft: Provide Class I material for bedding, haunching, and initial backfill.

D. Final Backfill
   1. Backfill with materials free of stones and debris larger than 6 inches in dimension. Place backfill in lifts not exceeding the thickness and compacted to the minimum density specified below.
   2. Trench backfilled with noncohesive materials may be compacted with water flooding; except under roadways, shoulders of roadways, and other areas subject to vehicular movement, provided the method of compaction is approved by the Engineer and provides the degree of compaction required.
   3. Lifts and density:
      a. Undeveloped areas (i.e., forests, fields, and, croplands): Trench may be filled with bulldozer blade provided material fall will not damage pipe. Mound soil over the trench area sufficiently to settle level over time. Degree of compaction shall be 85 percent.
      b. Lawns: Backfill in 12-inch lifts and compact to 90 percent. Top 12 inches shall be free of material with a dimension over 2 inches.
      c. Roads (including Rights-of-way), drives, parking areas (including areas within 20 feet), and adjacent to existing utilities: Backfill in 6 inch lifts compact to 95 percent.
      d. Within 20 feet of foundations: Backfill in 6-inch lifts compacted to 95 percent.

E. Utility Structures: Bring backfill to grade in even lifts on all sides. Lift depths and compaction densities shall be as specified according to area of installation for pipe above. Backfill against cast-in-place concrete structure only after concrete has attained the specified 28-day compressive strength.

3.09 ANTI-SEEP COLLARS

A. Anti-seep Collars: Provide anti-seep collars to prevent groundwater flow along pipe in wetlands as indicated on the Drawings. Use select clay material for collars. Collars shall extend past trench walls and bear against undisturbed soils. Dimension of collars shall be as indicated on the Drawings. Do not place stone in area of anti-seep collars.

B. Concrete Collar: Provide Class B concrete with minimum cement content of 5 sacks per cubic yard (5.5 sacks for angular course aggregate); 6.8 gallons of water per sack water-cement ratio; 2-4 inch slump range; and 28-day strength of 2,500 psi.

C. Clay Collar: Provide clay of medium to high plasticity with a soil classification of CL or CH and a permeability of 10-5 cm / second. Place clay in 6-inch lifts and compact by use of a mechanical hydraulic tamper to 95 percent.

3.10 SOIL TESTING

A. Provide services of a soil-testing firm as specified in Section, Quality Control.

B. Testing laboratory soil specialist, as a minimum, shall be at the project site for the following:
   1. Provide a minimum of one (1) in-place density test for every 1,000 lf of trench.

C. Density tests shall be made in accordance with ASTM D-698, Standard Proctor Method.

D. Submit test reports and soil specialist daily logs in accordance with Section, Quality Control.

E. Based on test results, make corrections, adjustments, and modifications of methods, materials, and moisture content for proper trench compaction.

3.11 PAVEMENT PATCHING

A. Repair damaged pavement structure.

B. Cut existing pavement for utility installation in straight lines generally parallel to the utility. Properly dispose of removed pavement structure.

C. Extend pavement patch 1 foot beyond each side of trench on firm subgrade. Slope new surface to drain.

D. Asphalt Pavements: Replace asphalt pavement with a pavement structure equal to existing but no less than as detailed on the Drawings.

E. Concrete Pavements: Replace concrete pavement with pavement structure equal to existing but no less than as detailed as Drawings. Concrete shall be minimum 3,000 psi. When existing concrete joint is within 5 feet of trench remove existing concrete to joint. Provide expansion joint at edge of existing concrete. Surface treatment shall match existing.

F. Curbs, Gutters, and Sidewalks: Replace curbs and gutters, and sidewalks removed or damaged with similar sections to match the existing. Remove to nearest existing joint.

G. Approval of Other Authorities: Pavements under the jurisdiction of the NC Division of Highways shall be subject to the approval of a representative of that Division.

H. Raise existing and new manholes and valve boxes to finished pavement grade. Excavate around top of existing manhole and valve box as necessary. Remove existing top ring, and install new grade ring(s) as necessary. Install existing cover. Raise existing valve box. Provide concrete collar around manhole ring and valve box.

I. Pavement patching shall include the cost to adjust existing and new manhole and valve boxes to finished pavement elevations.

3.12 GRADING AND CLEAN-UP:

A. Provide for testing and clean up as soon as practicable, so these operations do not lag far behind the pipe installation. Perform preliminary clean up and grading as soon as backfill is complete.

B. Provide positive drainage of finished grade and drain away from structures. Finished grade shall be reasonably smooth, compacted, free from irregular surface changes and comparable to the adjacent existing ground surface.

C. Seed disturbed areas in accordance with Section, Lawns and Grasses.

D. Upon completion of backfilling, remove and properly dispose of excess material and waste.

END OF SECTION

SECTION 02370

EROSION CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work shall include, but not be limited to, the following:
   1. Erosion control at project site.
   2. Erosion control at borrows and disposal areas as required by Contractor. Cost shall include erosion control permits as necessary for borrow and disposal areas.
   3. Removal of surface debris.
   4. Temporary and permanent ground cover.
   5. Maintain and remove erosion control devices.
   6. Self Inspection and Monitoring

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02920 Lawns and Grasses

1.03 REFERENCED STANDARDS

A. "Erosion and Sediment Control Planning and Design Manual," issued by the N. C. Sedimentation Control Commission.

1.04 QUALITY ASSURANCE

A. Conform to rules and regulations of the Erosion Control Laws of the State of North Carolina, specifically the Sedimentation Pollution Control Act of 1973 (G.S. 113A) as amended, and the local jurisdiction where the project is located.

B. Post a copy of the approved erosion control permit, furnished by Owner, at the site prior to starting work. Maintain a copy of the approved erosion control plan at the site.

C. Provide permanent ground cover as soon as possible, and no later than 15 working days after completion of work in a specific area.

1.05 WARRANTY

A. Contractor is liable for damages to public and private property and fines as may be placed on the Project by the governing agencies due to failure to provide adequate erosion control devices.

PART 2 PRODUCTS

2.01 MATERIALS

A. Matting / Erosion Control Fabric (ECF): Matting and ECF shall be a 70% straw and 30% coconut blanket encased in a medium weight plastic netting (both sides). Matting shall be fully degradable but suitable until vegetation has been established. Installation of ECF shall be done with staples per temporary liner detail in the

construction drawings. Commercially available ECFs may be used upon approval of the engineer. Approval of fabrics will require manufacturer's design data regarding velocity, shear strength, ditch slopes, method of installation, decay cycle, repair techniques, and grass growth enhancement characteristics.

B. Wire Staples: 16 gauge steel wire, with minimum of 3" top and 4" long legs.

C. Gravel for Stone Filters: #57 crushed stone.

D. Filter Fabric: 7-1/2 oz. burlap fabric or other silt filtering fabric.

E. Riprap:
   1. Class A: Stone shall conform to NCDOT standards and shall range in size from 2 to 6-inches with the stone gradation being equally distributed within the required size range.
   2. Class B: Stone shall conform to NCDOT standards and shall range in size from 5 to 12-inches with the stone gradation being equally distributed within the required size range.
   3. Type 1: Stone shall conform to NCDOT standards and shall range in size from 5 to 17-inches with the stone gradation being equally distributed within the required size range.

PART 3 EXECUTION

3.01 INSTALL EROSION CONTROL DEVICES

A. Install erosion control devices, which shall be in place and operational prior to other land disturbing activity.

B. After installing erosion control devices as indicated on the Drawings, verify that reasonable measures have been taken to prevent the sedimentation of nearby watercourses, existing and new facilities, and adjacent property.

C. Should Contractor believe that additional measures are necessary to adequately prevent erosion, immediately notify Engineer. If rain is predicted before the Engineer can be notified, take measures as necessary to prevent siltation of nearby water courses and work will be paid for as provided in the General Conditions.

D. After installing erosion control devices, request an inspection by the local agency having jurisdiction and the Engineer.

E. Incorporate permanent erosion control work into the project at the earliest practicable time. Coordinate temporary erosion control measures with permanent erosion control measures and other work on the project to assure effective and continuous erosion control throughout the construction and post construction period.

F. Maintain erosion control devices during construction until the disturbed areas are stabilized and the agency having jurisdiction and the Engineer have approved the removal of the erosion control devices.

3.02 BORROW AND DISPOSAL AREAS:

A. Obtain and pay for erosion control permit for borrow and disposal areas as required by Contractor.

B. Install and maintain erosion control devices in accordance with Contractor's approved plan.

3.03 MAINTENANCE

A. Inspect erosion control devices after each rainfall. Make required repairs immediately. Remove sediment deposits when deposits reach approximately one-half of the capacity of the erosion control device.

B. Respread accumulated sediments on the project site in a manner that will not adversely affect erosion control facilities and permanent ground cover.

C. Silt Fence: Should the filter fabric decompose or become ineffective before approval of its removal by the Engineer, replace fabric immediately at no additional cost to the Owner.

D. Temporary Construction Entrance: Maintain entrance in a condition that will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with 2 inches of stone, as conditions require, at no additional cost to the Owner.

3.04 SEEDING

A. Disturbed areas not covered by new construction shall be seeded.

B. Provide temporary and permanent seeding in accordance with Section, Lawns and Grasses.

3.05 STABILIZATION AND CLEAN-UP

A. Remove erosion control devices upon the approval of the permanent stabilization of this site by the agency having jurisdiction of the area and the Engineer. Dress sediment deposits remaining in place after the erosion control devices are removed to conform to the existing grade, prepared and seeded. Include cost of removal and cleanup in the cost of the installation of the device.

3.06 SELF INSPECTION AND MONITORING

A. Provide self-inspection and reporting as required by the Sedimentation Pollution Control Act for the duration of the project. These inspections will performed to ensure that the approved sedimentation and erosion control measures on the Drawings are installed, maintained, and working adequately.
   1. The inspections need to be conducted after each phase of the project, and continue until permanent ground cover is established.
   2. The self-inspection forms and information regarding this program are provided at the following website: http://www.dlr.enr.state.nc.us/pages/sedimentationnew.html.
   3. Documentation of inspections shall be recorded on a single copy of the approved erosion and sedimentation control drawings. These Drawings and inspection reports shall be made available at the project site.

B. Provide weekly self-monitoring in accordance with the NPDES Stormwater permit for all construction activities.

END OF SECTION

SECTION 02510

WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes, but is not limited to, piping, valves, fire hydrants, water service line, and appurtenances for a complete potable water distribution system.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Trenching for Utilities
   2. Section 02445 Bore and Jack of Conduits

1.03 REFERENCES

A. Publications are referred to in the text by basic designation only.
   1. American Society of Sanitary Engineering (ASSE) Standards
      a. 1013 Reduced Pressure Principle Backflow Preventers
      b. 1015 Double Check Backflow Prevention Assembly
      c. 1069 Outdoor Enclosures for Backflow Prevention Assemblies
   2. American Society for Testing and Materials (ASTM)
      a. C443 Flexible Watertight Joints for Precast Manhole Sections
      b. C478 Precast Reinforced Concrete Manhole Sections
      c. C890 Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
      d. C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
      e. D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
      f. D1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
      g. D2241 Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
      h. D2466 Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
      i. D2467 Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
      j. D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
      k. D3350 Polyethylene Plastics Pipe and Fittings Materials.
      l. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe
   3. American Water Works Association (AWWA)
      a. B300 Hypochlorites
      b. B301 Liquid Chlorine
      c. C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
      d. C105 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
      e. C110 Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids

f. C115 Flanged Ductile-Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges
g. C150 Thickness Design of Ductile Iron Pipe
h. C151 Ductile-Iron Pipe, Centrifugally Cast, for Water
i. C153 Ductile-Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch, for Water Service
j. C502 Dry-Barrel Fire Hydrants
k. C504 Rubber-Seated Butterfly Valves
l. C508 Swing-Check Valves for Waterworks Service, 2 inch Through 24 inch NPS
m. C509 Resilient Seated Gate Valves for Water and Sewerage Systems
n. C510 Double Check Valve Backflow-Prevention Assembly
o. C511 Reduced-Pressure Principle Backflow-Prevention Assembly
p. C512 Air-Release, Air / Vacuum, and Combination Air Valves for Waterworks Service
q. C550 Protective Epoxy Interior Coatings for Valves and Hydrants
r. C600 Standard for Installation of Ductile Iron Water Mains and Their Appurtenances
s. C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
t. C651 Disinfecting Water Mains
u. C700 Cold-Water Meters-Displacement Type, Bronze Main Case
v. C702 Cold-Water Meters-Compound Type
w. C800 Underground Service Line Valves and Fittings
x. C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch through 12 inch, for Water Distribution
y. C901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inch through 3 inch for Water Service
z. C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, 14 inch through 36 inch, for Water Distribution
aa. M23 PVC Pipe - Design Installation

4. National Sanitation Foundation (NSF) Standards
   a. 14 Plastic Piping Components and Related Materials
   b. 60 Drinking Water Treatment Chemicals – Health Effects
   c. 61 Drinking Water System Components - Health Effects
   d. 372 Drinking Water System Components – Lead Content

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met. Submit for each of the following materials:
      a. Pipe and Fittings
         1) Ductile iron
         2) Polyvinyl Chloride (PVC)
            i) AWWA C900
            ii) Pressure rated
            iii) Schedule 40 & 80
         3) Copper pipe and tubing
         4) Polyethylene (PE) pressure pipe and tubing
         5) Stainless Steel

b. Valves
    1) Gate
        i) Resilient-Seated
        ii) Tapping
    2) Butterfly
    3) Check
    4) Air release
c. Fire hydrants
d. Pre-cast concrete manholes
e. Service valves and fittings
    1) Corporation valves
f. Backflow prevention assembly
g. Meters

2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
    a. Pipe and Fittings
        1) Ductile iron
        2) Polyvinyl Chloride (PVC)
            i) AWWA C900
            ii) Pressure rated
            iii) Schedule 40 & 80
        3) Copper pipe and tubing
        4) Polyethylene (PE) pressure pipe and tubing
        5) Stainless Steel
    b. Valves
        1) Gate
            i) Resilient-Seated
            ii) Tapping
        2) Butterfly
        3) Check
        4) Air release
    c. Pre-cast Concrete Manholes and appurtenances
        1) Manhole steps
        2) Pipe connectors
        3) Joint material
    d. Castings
    e. Tapping sleeves
    f. Valve boxes
    g. Fire hydrants
    h. Backflow prevention assembly and enclosure
    i. Meters
    j. Blowoff assembly
    k. Pressure Gauge
3. Reports:
    a. Field test report for each section of pipe for the following:
        1) Measured chlorine residual
        2) Bacteriological test
        3) Pressure test
    b. Field test report for each backflow prevention device.
4. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the following:

a. Valves
b. Fire hydrants
c. Meters
d. Backflow prevention assembly

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide a suitable pipe hook or rope sling when handling the pipe with a crane. Lifting of the pipe shall be done in a vertical plane. Under no conditions shall the sling be allowed to pass through the pipe unless adequate measures are taken to prevent damage to both the tongue and groove ends.

B. Deliver pipe in the field as near as practicable to the place where it is to be installed. Distribute pipe along the side of the trench opposite to the spoil bank. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe or coating.

C. Shield PVC pipe and fittings stored on site from the sun's ultraviolet rays by suitable cover, or indoor storage.

PART 2 PRODUCTS

2.01 GENERAL

A. Products with surfaces intended to be in contact with the drinking water shall be certified and listed in accordance with NSF 61 for potable drinking water.

2.02 DUCTILE IRON PIPE

A. Pipe and fittings 3-inch to 64-inch shall conform to AWWA C150 and C151 and the following requirements:
1. Size shall be as indicated on the Drawings.
2. Minimum pipe pressure class shall be 150 psi unless indicated otherwise on the Drawings.
3. Suitable for a system working pressure of 100 psi at the depth indicated on the Drawings with a laying condition as indicated in Section, Trenching for Utilities.
4. Interior lining to be used in a drinking water system shall be certified and listed in accordance with NSF 61.
5. Interior lining for Raw Water, Permeate, Treated Water, and Calcite Rinse Water Waste line ductile iron piping and fittings shall be Ceramapure PL 90 Ceramic Epoxy, or approved equal, designed for water containing high chloride concentrations and/or permeate water. See Section 02513 Water Pipe Liner.
6. Interior lining for Finished Water (in and after Ground Storage Water Tank) gray-iron or ductile-iron piping and fitting shall be cement-mortar lined with seal coat in accordance with AWWA C104 or Ceramapure PL 90 Ceramic Epoxy, or approved equal.

B. Ductile-iron pipe for below ground service shall have push-on or mechanical joints, unless noted otherwise on the Drawings, conforming to AWWA C150 and C151, and to the following requirements:
1. Provide mechanical joint fittings, unless noted otherwise on the Drawings.

C. Ductile-iron pipe for above ground service and in vaults shall have flanged joints, unless noted otherwise on the Drawings, conforming to AWWA C115.
   1. Pipes to be painted shall have only a shop primer on the outside by the manufacturer. Verify that proposed manufacturer's primer is compatible with the proposed paint system.

D. Fittings for ductile-iron pipe shall conform to AWWA C110, or C153 and to the following requirements:
   1. Joint type shall be as specified above for the supplied ductile-iron pipe.
   2. In lieu of exterior asphaltic coating, fittings may be provided with a 6-8 mil nominal thickness fusion bonded epoxy exterior coating in conformance with AWWA C550.
   3. Fittings shall be made of ductile-iron.

E. Gaskets shall be nitrile material for installation in areas as designated on the Drawings.

2.03 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

A. General
   1. Pipe and fitting size shall be as indicated on the Drawings.
   2. PVC materials shall comply with ASTM D1784 with a cell classification of 12454-B.
   3. Pipe shall be certified and listed for potable water distribution products in accordance with NSF 14 or 61 and bear the NSF seal on each section of pipe.

B. AWWA C900: C900 PVC pipe 4-inch to 48-inch shall conform to AWWA C900 and the following requirements:
   1. Outside diameter shall conform to ductile-iron pipe.
   2. Pipe shall be pressure class 235 with a standard dimension ratio of DR 18.
   3. Pipe shall have plain end and elastomeric-gasket bell ends, unless otherwise noted.
   4. Fittings shall conform to AWWA C110 or C153 and have mechanical joints. Fittings shall be made of ductile-iron. Interior of fittings shall be Ceramapure PL 90 lined. Concrete thrust blocking per Detail 4/C094 shall be provided, unless otherwise noted.
   5. All below grade C900 PVC at the water treatment plant site and at the well sites shall include additional mechanical thrust restraint at the MJ fittings, even if concrete thrust block are used, and shall include bell harness restraints at all pipe joints.
   6. Restraining mechanism for joint restraint must be approved by the pipe manufacturer. Restraining systems shall not result in a point load on the pipe. Gasketed-type restraint systems will not be allowed.
   7. Restraint for mechanical joint fittings shall be incorporated in the design of the follower gland and shall utilize multiple wedge segments that act against the pipe, increasing their resistance as the line pressure increases. The assembled joint shall maintain the maximum flexibility and deflection of all normal pipe sizes after burial. Restraining gland, wedge segments, and actuating bolts shall be manufactured of high strength ductile iron conforming to the requirements of ATSM A536, Grade 65-45-12. Mechanical joint restraining devices shall have a working pressure rating of 200 psi for 3-12" sizes and 235 psi for sizes 14-36" minimum and provide no less than a safety factor of 2:1.
   8. Restraint devices for bell and spigot joints of C900 PVC pipe shall consist of two split retainer rings. One clamping ring shall be installed on the spigot pipe,

and with the necessary restraining rods and nuts, connected to a second clamping ring located on the pipe barrel immediately behind the gasket bell. Restraint devices shall incorporate a series of machined serrations that provide positive restraint, exact fit and full support of the pipe wall. Devices shall carry a minimum 2:1 safety factor. Clamping ring shall be manufactured of high strength ductile iron in accordance with ASTM A536, Grade 65-45-12. Side clamping bolt and hex nuts shall be high strength steel in accordance with ASTM A 449 and zinc plated to B6333, Type III Sc. 1 for corrosion resistance. Restraining rods and hex nuts shall be high strength, low alloy steel in accordance with AWWA/ANSI C111/A21.11 and provide a minimum 45,000 psi yield and 60,000 psi tensile strength.

C. Schedule 40 & 80: Schedule 40 & 80 PVC pipe 1/2-inch to 12-inch shall conform to ASTM D1785 and the following requirements:
   1. Outside diameter shall conform to iron pipe.
   2. Pipe shall be schedule 40 or 80.
   3. Pipe shall have an integral elastomeric-gasket bell end or solvent weld joints.
   4. Fittings for the pipe shall conform to ASTM D2466 or D2467 as appropriate for the pipe schedule.

2.04 COPPER PIPE AND TUBING

A. Copper pipe and tubing shall conform to ASTM B-88 Type K and Type L standard specification for seamless copper water tube with copper or brass fittings. Type K to be used underground. Type L to be used above ground.

B. Soldered joint fittings shall conform to NSI B-16.22. Fittings to be of same manufacturer as pipe.

C. Screw joint fittings to be provided where required and indicated.

D. Screw joint unions shall be provided at each in-line valve, pressure regulator, pressure reducer and/or where indicated.

2.05 POLYETHYLENE PRESSURE PIPE AND TUBING

A. Polyethylene pressure pipe and tubing, 1/2-inch through 3-inch, shall conform to AWWA 901 and the following requirements:
   1. The line shall be the size indicated on the Drawings and shall be polyethylene tubing.
   2. The line shall be made from material having standard PE code designation PE 3408.
   3. The line shall have a minimum pressure class of 160 psi with a dimension ratio (DR) of DR-9.

2.06 TAPPING SLEEVE

A. Tapping Sleeve: Tapping sleeves shall be 304 stainless steel, flanged for the tapping valve and manufactured for a working pressure of 150 psi. Sleeve shall have a full body 360-degree gasket. Sleeve shall have a 3/4-inch test plug. Bolts and nuts shall be stainless steel. Tapping sleeves on raw water, permeate, or treated water lines shall be 316 stainless steel.

2.07 REDUCING COUPLINGS

A. Transition couplings for underground raw, permeate, and concentrate water lines outside the RO Building shall be suitable for transition from 316L stainless steel and Sch 80 PVC pipe to C-900 pipe as shown on the Drawings. Reduced coupling shall

be sized at each end based on outer diameter plain end pipe. Coupling shall be NSR 61 rated.

B. Center and end ring to be ductile iron per ASMT A 536, Grade 65-45-12. Gaskets to be EPDM. Nuts and bolts to be all 316 stainless steel

C. Center ring interior and exterior surface shall be coated with Ceramapure PL 90 Ceramic Epoxy, or approved equal. See Section 02513 Water Pipe Liner

D. End rings shall have a minimum 12 mil thickness of fusion epoxy coating for corrosion resistance. Coating shall be high quality thermosetting epoxy coating applied on a preheated surface by electrostatic spray application. Coating shall comply with AWWA C213 and be applied per coating manufacturer requirements. Coating to be AkzoNobel Resicoat R4-ES or equal.

E. Coupling shall be wrapped with ductile iron pipe wrap suitable for corrosive soils.

2.08 DISMANTLING JOINT

A. Dismantling joint to be provided in chemical feed vault on finished water line as shown the Drawings. Dismantling joint shall have minimum three-inch adjustment and be NSF 61 certified. Joint shall meet AWWA Standard C219 and be suitable for ductile iron pipe to magnetic meter connection. ANSI Class 150 bolt pattern.

B. End ring and body to be steel per ASMT A 36. Flanged spool AWWA C207 Class E, compatible with ANSI Class 125 and 150 bolt circles. Pipe to be ASTM A 36 late 1% cold expanded to size.

C. Nuts, bolts, and tie rods to be all 316 stainless steel.

D. Provide EPDM gaskets

E. Exterior and interior joint end ring, body, and flange shall have a minimum 12 mil thickness of fusion epoxy coating for corrosion resistance. Coating shall be high quality thermosetting epoxy coating applied on a preheated surface by electrostatic spray application. Coating shall comply with AWWA C213 and be applied per coating manufacturer requirements. Coating to be AkzoNobel Resicoat R4-ES or equal.

2.09 VALVES

A. General: Valves shall meet the following requirements:
   1. Size shall be as required for the pipe size and material as indicated on the Drawings and specified.
   2. Open by counterclockwise rotation.
   3. Provide an interior protective epoxy coating in accordance with AWWA C550 on ferrous surfaces in contact with the liquid with a minimum thickness of 16 to 20 mils.
   4. Components in contact with the liquid shall be in compliance with NSF 61.
   5. Standard system working pressure is 100 psi.
   6. Equip valves with a suitable means of operation.
   7. Ends shall be mechanical joint for underground location and flanged joint for above ground location/underground utility vaults.
   8. For buried valves over 5 feet deep, provide extension stems of cold rolled steel to bring the operating nut to within 2 feet of the ground surface. Extension stems shall also be provided as required for floor stands and to floor valve box.

9. Provide valve accessories as required for proper valve operation for valve locations as indicated on the Drawings and as recommended by valve manufacturer.
10. Similar valve types shall be of one manufacturer.

B. Gate Valves, Resilient-Seated: Gate valves on water system and potable water lines 3-inch to 20-inch shall conform to AWWA C509 for and to the following requirements:
   1. O-ring stem seal on non-rising (NRS) stem valves.
   2. Valves shall be non-rising stem (NRS) with wrench nut for underground locations and Outside Screw and Yoke (OS&Y) with handwheel for above ground locations unless noted otherwise on the Drawings.
   3. Valves 16-inch and larger shall be equipped with gearing to facilitate opening. Gear cases shall be totally enclosed type. Geared valves shall be equipped with indicators to show the position of the gate in relation to the water.
   4. Valves 20-inch and larger shall be equipped with a by-pass.
   5. Gates on raw water, permeate, and treated water lines shall be EPDM encapsulated. The gates at the by-pass vault shall be EPDM encapsulated as well.

C. Tapping Valves: Tapping valves shall conform to the specifications for the gate valves as indicated in this Section and the following:
   1. Valve shall be specifically modified for the passage and clearance of the tapping machine cutter.
   2. The mating end to the tapping sleeve shall be raised male surface to provide true alignment to the sleeve and tapping machine. The valve shall be compatible with the tapping sleeve.

D. Butterfly Valves: Butterfly valves for service on finished water lines 3-inch through 72-inch shall conform to AWWA C504 for potable water and to the following requirements:
   1. Valve body shall be ductile iron and mechanical joint for below ground locations and flanged short body in underground vaults and above ground locations. End mechanical joints shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11. End flanges shall conform to ANSI B16.1, class 125 and ANSI/AWWA C110/21.10.
   2. Valves shall be class 150B.
   3. Rubber seats shall mate with stainless steel or nickel-copper alloy seat surfaces.
   4. Valve shafts shall consist of one-piece unit extending completely through the valve disc for valves under 12-inches. Above this size, shaft shall be one piece or the stub-shaft type. Shafts shall be type 304 stainless steel.
   5. Valve discs shall be stainless steel.
   6. Valve Actuator
      a. Manual Actuator: Manual actuator shall be of the traveling nut type. Valves for buried service shall have a standard AWWA nut. Valves for above ground shall have valve extension and a handwheel, or chain wheel as indicated on the Drawings.
      b. Motor actuators shall be provided where shown on Drawings and shall be in accordance with Section 11100 Quarter Turn Electric Motor Actuators

E. Butterfly Valves. Butterfly valves for service on the raw water supply line, permeate line and treated water lines (after the calcite beds and inlet piping up to the ground storage water tank) shall meet NSF 61 and the following requirements:

1. Above-ground, 3-inch to 20-inch
   a. Provide fully lugged wafer style, 150 psi butterfly valves conforming to ANSI 150 lb flanges.
   b. Butterfly valves 20-inch & smaller on 150 psi service shall be fully lugged style wafer valves with Nylon coated cast iron bodies. Disks and stems shall be 316 stainless steel. Disk-stem will be through-stem direct drive double "D" design requiring no disk screws or pins to connect stem to disc with no possible leak path. Stem shall be mechanically retained in body neck and no part of stem or body exposed to line media.
   c. Seats shall be EPDM-Food Grade with tongue and groove design with primary hub seal and molded O-ring. Seat shall totally encapsulate the body with no flange gaskets required.
   d. Discs shall be spherically machined, hand polished disc edge and hub for minimum torque and maximum sealing capabilities. Valves shall have non-corrosive bushings and self-adjusting stem seals. Valves shall be bi-directional and tested to one hundred ten percent (110%) of full rating. No field adjustment shall be necessary to maintain performance.
   e. All manually operated butterfly valves 8" or greater shall have gear driven hand wheel operators, and all manually operated butterfly valves 6" or smaller shall have manual lever operators.
   f. All manually operated butterfly valves 8" or greater shall have gear driven hand wheel operators. Materials and equipment shall include a cast iron housing, bronze gear quadrant, 316 stainless steel worm gear shaft, 316 stainless steel fasteners, and non-water soluble grease.
   g. Motor actuators shall be in accordance with Section 11100 Quarter Turn Electric Motor Actuators.
   h. Valves shall be Bray Series 31 (ANSI 150) or approved equal.
2. Above ground, 24-inch and larger
   a. Provide Double Flanged Style Cast Iron Body, 150 psi butterfly valves on aboveground piping. Flanges shall be ANSI 150 lb.
   b. Butterfly valves 24"-inch & larger on 150 psi service shall be Double Flanged Style Valves with Nylon coated cast iron bodies. Discs shall be 316 SS and stems shall be 416 stainless steel. Disk-stem will be through-stem direct drive double "D" design requiring no disk screws or pins to connect stem to disc with no possible leak path. Stem shall be mechanically retained in body neck and no part of stem or body exposed to line media.
   c. Seats shall be EPDM-Food Grade with tongue and groove design with primary hub seal and molded O-ring. Seat shall totally encapsulate the body with no flange gaskets required.
   d. Discs shall be spherically machined, hand polished disc edge and hub for minimum torque and maximum sealing capabilities. Valves shall have non-corrosive bushings and self-adjusting stem seals. Valves shall be bi-directional and tested to one hundred ten percent (110%) of full rating. No field adjustment shall be necessary to maintain performance.
   e. All manually operated butterfly valves 8" or greater shall have gear driven hand wheel operators. Materials and equipment shall include a cast iron housing, bronze gear quadrant, 316 stainless steel worm gear shaft, 316 stainless steel fasteners, and non-water soluble grease.
   f. Motor actuators shall be provided where shown on Drawings and shall be in accordance with Section 11100 Quarter Turn Electric Motor Actuators.
   g. Valves shall be Bray Series 36 or approved equal

3. Below ground, 24-inch and larger (treated water line).
    a. Provide valve in conformance with AWWA C504 and Part 2.0.9.D above.
    b. Interior and exterior of valve body shall have minimum 20 mil fusion bonded epoxy coating for corrosion resistance.

F. PVC Butterfly Valves
1. Provide on PVC concentrate, flushing, and cleaning pipes.
2. Equal resilient seat butterfly valve, ANSI 150# PVC wafer body, polypropylene disk, 316 SS stem, EPDM seat with manual lever operator.
3. Valves shall be Asahi Type 57 or approved equal.

G. PVC Ball Type Check Valves
1. Provide on flushing and cleaning pump discharge lines, and as otherwise noted on Drawings.
2. Check valves, 4 to 8-inch, shall be ball type check valves with true union fittings and solid PVC body, flanged end connections, EPDM, seals, and pressure rated to 150 psi.
3. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb flanges
4. Valves shall be Asahi, Hayward or approved equal.

H. Swing-Check Valves: Swing-check valves 2 to 24-inch shall conform to AWWA C508 and to the following requirements:
1. Provide lever and weight for swing check control.
2. Metal to Metal seat construction.
3. Ends shall be flanged.

2.10 AIR VALVES

A. Automatic air release valves shall be the combination type and allow both the release of air from the pipe (Air Release Mode) and the introduction of air into the pipe (Vacuum Break Mode).

B. Valves shall have a 2-inch threaded inlet.

C. The body of these valves shall be conical shaped and constructed of 316 stainless steel. The float shall be Delrin and the float spindle shall be of 316 stainless steel. The valve seat and all internal working parts shall be of corrosion resistant materials.

D. The ARV shall seal at 0 psi and have an overall operating range of 0-250 psi.

E. The ARV shall close watertight when liquid enters the valve and allow air to enter in the event of a vacuum. The ARV shall have a rolling cup seal diaphragm for indefinitely variable operation to provide a soft working behavior for water hammer inhibition.

F. All automatic air release valves shall be H-Tec model 986. All valves shall be installed in accordance with manufacturer's recommendations and shall have ISO 9001 certification.

2.11 MANHOLES

A. Provide manholes made of precast concrete sections in conformance with ASTM C478, NC Department of Transportation, and the following requirements:
1. General
    a. Provide manholes to the depth as indicated on the Drawings. Manhole inside diameter shall be 4 feet unless noted otherwise on the Drawings.

b. Precast concrete manholes shall be as manufactured by Adams Concrete, Carolina Precast Concrete, Inc., D & M Concrete Specialties, Inc., N. C. Products Corp., Stay Right Tank, Tindall Concrete Products, Inc. or approved substitute.

2. Precast Concrete Sections
   a. Minimum wall thickness shall be 5-inches.
   b. Base: Cast monolithically without construction joints or with an approved PVC waterstop in the cold joint between the base slab and the walls. The width of the base extensions on Extended Base Manholes shall be no less than the base slab thickness.
   c. Riser: Minimum lay length of 16 inches.
   d. Eccentric Cone: Top inside diameter shall be 24 inches. Width of the top ledge shall be no less than the wall thickness required for the cone section.
   e. Transition Cone: Provide an eccentric transition from 60-inch and larger manholes to 48-inch diameter risers, cones, and flat slab top sections. Minimum slope angle for the cone wall shall be 45 degrees.
   f. Transition Top: Provide an eccentric transition from 60-inch and larger manholes to 48-inch diameter risers, cones, and flat slab top sections. Transition Top sections shall be furnished with vents as shown on the manhole details. The maximum amount of fill over the transition top section shall be 20 feet. Transition Tops shall not be used in areas subject to vehicle traffic.
   g. Flat Slab Top: Designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into Special Flat Slab Tops shall be sized to fit within the manhole ID and the top and bottom surfaces. Provide a float finish for exterior slab surface.
   h. Precast or core holes for pipe connections. Diameter of hole shall not exceed outside diameter of pipe by more than 3-inches.
   i. Grade Rings: May be used to adjust ring and covers to finished grade. No more than 12 vertical inches of grade rings will be allowed per manhole. Grade Rings shall be no less than 4 inches in height.
   j. Lifting Devices: Devices for handling precast components shall be provided by the precast manufacturer and comply with OSHA Standard 1926.704.
3. Joints
   a. Manufacturer in accordance with tolerance requirements of ASTM C 990 for butyl type joints.
   b. Minimize number of joints. Do not use riser section for manholes up to 6 feet tall and no more than one riser for each additional 4 feet in height.
   c. Flexible Joint Sealants: Provide preformed butyl rubber based sealant material conforming to Federal Specification SS-S-210A, Type B - Butyl Rubber or O-ring rubber gasket conforming to ASTM C443.
4. Flexible Pipe Connectors: Provide flexible connectors for pipe to manhole that conform to ASTM C923. Location of connectors shall vary from Project Drawings no more than 1/2-inch vertically and 5 degrees horizontally.
5. Manhole Steps:
   a. Steps shall be made of 1/2-inch grade 60 steel encapsulated by co-polymer polypropylene and have serrated tread and tall end lugs.
   b. Secure steps to the wall with compression fit in tapered holes or cast-in-place. Align steps along a vertical wall and shall not be located over a pipe opening. First step shall be a maximum of 26 inches from the bottom.
   c. Steps shall be by American Step Co., Inc., Bowco Industries, Inc., M. A. Industries, Inc. or approved substitute.

2.12 CASTINGS

A. General
   1. Made of gray iron, ASTM A-48 - class 30, or ductile iron, ASTM A536, grade 65-45-12.
   2. Castings shall be free from imperfections not true to pattern. Casting tolerances shall be plus or minus 1/16 inch per foot of dimension. Top shall set neatly in frame, with edges machined for even bearing and proper fit to prevent rattling and flush with the edge of frame.
   3. Castings shall be as manufactured by Neenah Foundry Co., U.S. Foundry & Manufacturing Corp., Vulcan Foundry, or approved equal.

B. Manhole Ring and Cover:
   1. Minimum clear opening shall be 22 inches.
   2. Minimum weight for frame and cover shall be 300 pounds and suitable for Heavy Duty Highway Traffic Loads of H-20.
   3. Frame shall have four 3/8-inch anchor bolt holes equally spaced.
   4. "Water" shall be cast on the cover as appropriate. Casting shall bear the name of the manufacturer and the part number.
   5. Provide cover with two 1-inch perforated holes unless noted as watertight on the Drawings.
   6. Provide the following where indicated on the Drawings:
      a. Ring and cover shall be watertight.
      b. Bolt down cover. Bolt down covers shall be provided with four (4) 3/8-inch stainless steel hex head bolts at 90 degrees.

2.13 VALVE ACCESSORIES

A. Valve Box, Below Ground: Boxes shall be high strength cast iron of the screw or telescopic type. Box shall consist of a flare base section, center extension as required, and a top section with the word "WATER" cast in the cover. Length of box shall be such that full extension of box is not required at the depth of water main cover.

B. Extension Stem (if necessary): Stem shall be sized so as to transmit full torque from the operating mechanism to the valve stem without binding, twisting, or bending. Stem shall be made from extra heavy steel pipe. Stem shall be complete with couplings for connection to valve and floor stand where required. When valve extension kits are used they must be as recommended by the valve manufacturer.

2.14 INDICATOR POST

A. Indicator post shall be made of carbon steel or ductile iron. Post shall be UL Listed and FM approved. Design shall allow for the addition of a supervisory switch. The operating wrench shall be easily removed by Owner. Wrench shall also be able to be locked to the post with a padlock (owner supplied) to prevent unauthorized operation.

B. Post Indicator shall be the vertical type, having two large window openings covered with a heavy clear plexiglass at the post top. Aluminum target plates shall be provided with the words OPEN and SHUT cast in large, easy-to-read, raised letters located directly behind each window.

C. Stem, indicators and working parts shall be fully protected from moisture and weather damage by complete enclosure.

D. Operating nuts shall be 1-1/4 inches square. Provide wrench with the indicator post.

E. Provide tamper switch to allow for connection to building security system. Gate valve tamper switches shall be installed on valve in accordance with manufacturer's instructions. The mechanism shall be contained in a weatherproof die cast aluminum housing, which shall provide a 3/4 inch tapped conduit entrance and incorporate the necessary facilities for attachment to the valve. Switch housings shall be finished in red baked enamel. Switch mechanism shall have a minimum rated capacity of one amp, 125 volt AC - .25 amp. 24 volt DC. Assembly shall be tamper-proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting. Gate valve switches shall be Underwriter's Laboratories listed and Factory Mutual approved. Provide and turn over to Owner a wrench for tamper boxes.

2.15 SERVICE VALVES AND FITTINGS

A. Water service valves and fittings shall conform NSF 61 and AWWA C800 for normal pressure and the following requirements:
   1. Service valves and fittings shall conform to Owner's standards. If Owner's standards conflicts with these specifications, consult with Engineer before proceeding.
   2. Service saddle: Provide service saddle for service pipe connection to main pipe material. Saddles shall meet the following requirements:
      a. Brass body to conform to the outside dimension of the main.
      b. O-ring, Buna N rubber gasket to provide watertight connection.
      c. Hinged, double bottom strap design.
      d. Threaded outlet to match threads on corporation valve.
   3. Corporation valve
      a. Stop size shall be the same as service line.
      b. Inlet thread shall be as per AWWA C800.
      c. Outlet thread shall be as required for the pipe material specified.

2.16 FIRE HYDRANTS

A. Fire hydrants shall conform to AWWA C502 and to the following requirements:
   1. Nozzles: Two (2) 2-1/2-inch hose and One (1) 4-1/2-inch pumper connections.
   2. Nozzle threads: Owner Standard.
   3. Main valve diameter: 5-1/4 inch.
   4. Minimum depth of bury: 42-inches.
   5. Inlet connection: 6-inch mechanical joint.
   6. Open counterclockwise.
   7. Close with water pressure.
   8. O-ring seals
   9. Traffic model with frangible sections near the ground line designed to break on impact.
   10. Provide extension for hydrant standpipe as required to set centerline of hydrant nozzle a minimum of 15-inches and a maximum of 24-inches.
   11. Exterior color above ground line shall match Owners.
   12. All hydrants of one manufacturer.

2.17 BACKFLOW PREVENTION ASSEMBLY

A. Backflow prevention assemblies shall conform to USC Foundation for Cross Connection Control and Hydraulic Research and to the following requirements:
   1. The size and type shall be as indicated on the Drawings.
   2. Double Check Valve (DCV) in conformance with AWWA C510 and ASSE 1015.

3. Reduced Pressure Zone (RPZ) in conformance with AWWA C511 and ASSE 1013.
4. Service shall be for cold water.
5. End connection shall be threaded or flanged as indicated on the Drawings.
6. Assembly shut-off valves shall be:
   a. 2-inch and under: 1/4 turn, full port, resilient seated, bronze ball valve.
   b. Over 2-inch: OS&Y resilient seated gate valves.
7. Valves shall be internally epoxy coated in accordance with AWWA C550.
8. Provide 120V 15 Amp GFI protected circuit for heat source with NEMA 3R receptacle mounted a minimum of 6-inches above the slab.

2.18 BACKFLOW PREVENTER ENCLOSURES

A. Enclosures for backflow preventers (BFP) shall meet the following requirements:
   1. Aluminum or fiberglass reinforced construction sized to totally enclose "wet" portion of BFP.
   2. Provide access through lockable doors or hinged lid for testing of BFP.
   3. Shall be totally removable for maintenance of BFP.
   4. Lined with unicellular, non-wicking, insulation.
   5. Provide thermostatically controlled heat source within enclosure to provide freeze protection to minus 30 degrees F.
   6. For enclosure of reduced pressure zone BFP provide drain openings at each end to accommodate full port discharge form device. Openings shall be protected against intrusion of wind, debris, and animals.
   7. Provide means of permanent anchor to concrete pad.

2.19 METERS

A. Displacement Type Meters: Displacement type meters shall conform to AWWA C700 and to the following requirements:
   1. Meter size shall be as indicated on the Drawings.
   2. Meter ends shall match pipe fittings.
   3. Provide magnetic drive with sealed gear housing.
   4. Totalizer shall have:
      a. 4-inch dial reading in gallons
      b. Six-digit totalizer

B. Compound Meters: Compound meters shall conform to AWWA C702 and to the following requirements:
   1. Meter size shall be as indicated on the Drawings.
   2. Meter ends shall match pipe fittings.
   3. Provide magnetic drive with sealed gear housing.
   4. Main casing shall be cast iron.
   5. Totalizer shall have:
      a. 4-inch dial reading in gallons
      b. Six-digit totalizer
      c. Circular test dial
      d. Must be capable of remote readout to match Owner's system.

2.20 THRUST BLOCKING

A. All buried pipe fittings shall be (MJ) mechanical joint type with thrust blocking per Detail 4/C094, unless otherwise noted.

B. Provide concrete thrust blocking in accordance with the detail on the Drawings.

C. Thrust blocking is not required where restrained joint fittings and equivalent length of restrained joint pipe are used unless shown otherwise on the Drawings.

2.21 DISINFECTANT

A. The following products may be used as the disinfectant:
   1. Chlorine, liquid: AWWA B301.
   2. Hypochlorite, calcium and sodium: AWWA B300.

PART 3 EXECUTION

3.01 GENERAL

A. Pipe installation shall meet the following general guidelines:
   1. Lay pipe in the presence of Engineer, unless specifically approved otherwise.
   2. Handle pipe and accessories in accordance with manufacturer's recommendations. Take particular care not to damage pipe coatings.
   3. Carefully inspect pipe immediately prior to laying. Do not use defective pipe. Replace pipe damaged during construction.
   4. Lay pipe to grade and alignment indicated on the Drawings.
   5. Provide proper equipment for lowering pipe into trench.
   6. Do not lay pipe in water or when the trench or weather conditions are unsuitable for the work.
   7. Provide tight closure pipe ends when work is not in progress.
   8. Keep pipe interior free of foreign materials.
   9. Clean bell and spigots before joining. Make joints and lubricate gasket in accordance with pipe manufacturer recommendation.
   10. Block fittings with concrete, or restrain as indicated on the Drawings or as required to prevent movement.

3.02 RELATION OF WATER MAINS TO SEWERS

A. Lateral Separation: Lay water mains at least 10 feet laterally from existing and proposed sewers. Where existing conditions prevent a 10-foot lateral separation, the following shall be followed with approval of the Engineer:
   1. Lay water main in a separate trench, with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.
   2. Lay water main in the same trench as the sewer with the water main located at one side on a bench of undisturbed earth, and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.

B. Crossing Separation: Lay bottom of water main at least 18-inches above the top of the sewer. Where existing conditions prevent an 18-inch vertical separation, construct both the water main and sewer of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.

C. Crossing a Water Main Under a Sewer: When it is necessary for a water main to cross under a sewer, construct both the water main and the sewer of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing.

3.03 DUCTILE IRON PIPE

A. Install pipe in conformance with AWWA C600 and the following:
   1. For laying pipe in a vertical or horizontal curve, each full length pipe may be deflected by the following offset distance:
      a. Push-on joint
         1) 3 to 12-inch pipe: 14-inch offset
         2) 14 to 36-inch pipe: 8-inch offset
      b. Mechanical joint
         1) 3 to 6-inch pipe: 20-inch offset
         2) 8 to 12-inch pipe: 15-inch offset
         3) 14 to 20-inch pipe: 8-inch offset
         4) 24 to 36-inch pipe: 6-inch offset
   2. For laying restrained joint pipe in a vertical or horizontal curve, except for horizontal directional drills (HDD), each full length pipe may be deflected by the following offset distance:
      a. 6 to 12-inch pipe: 11-inch offset
      b. 16 to 20-inch pipe: 7-inch offset
      c. 24 to 30-inch pipe: 5-inch offset
      d. 36-inch pipe: 4-inch offset
      e. 42 to 48-inch pipe: 1 ¼ -inch offset

3.04 PVC PRESSURE PIPE

A. Install PVC C900 pipe in conformance with AWWA C605.

B. Solvent Weld: Field cut ends shall be sanded to roughing the surface. Joints shall be cleaned of foreign material. Solvent shall be applied to the joint and joint made as recommended by the manufacturer. Excess solvent shall be wiped off. Joint should not be moved until sufficiently set up.

C. Bell and Spigot Joints: Clean bell and spigot ends prior to jointing. Ends of field cut pipe shall be beveled with file. Gasket shall be clean and lightly lubricated. Joint shall be made as recommended by the manufacturer.

3.05 VALVES AND FITTINGS

A. Install buried valves on top of an 18-inch square, 3-inch thick, solid concrete pad (minimum dimensions). The concrete pad may be provided by a pre-cast manufacturer or cast-in-place in the field above grade. Concrete used for the pads shall be a minimum 3,000 psi mix. The pads may not be cast-in-place in the pipe trench. Connection to pipe shall be such that there shall be no stress at the joint caused by misalignment or inadequate support of pipe or valve.

B. Valve Box: Set a valve box over each buried valve. Support box so that no stress shall be transmitted to the valve or pipe line. Install box plumb and set top flush with finished grade. Operating nut shall be centered in box. Provide a 24-inch x 24-inch wide by 6-inch thick concrete pad at top of valve boxes outside paved areas.

C. Valve operation nut shall be within 30 inches of the top of box. Provide stem extension if necessary to bring operating nut to within 30 inches of the top of box.

D. Install fittings as recommended by the manufacturer. Fittings shall be blocked or otherwise restrained from movement.

E. Install valves, gates, and accessories indicated on the Drawings and in complete accordance with the manufacturer's recommendations.

F. Install air / vacuum valve inside a manhole.

3.06 POST INDICATOR VALVE

A. Post indicator shall be installed plumb and such that the top of the post is 36" above finished grade.

B. The "OPEN" and "SHUT" targets shall be set for the appropriate valve size.

C. Coordinate installation of tamper switch with electrical contractor. Mount switches so not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position.

3.07 MANHOLES

A. Provide 12 inches of No. 67 stone base to extend a minimum of 6 inches beyond the manhole base.

B. Set base plumb and level. Align manhole invert with pipe invert.

C. Secure pipe connectors to pipe in accordance with manufacturer's recommendation.

D. Clean bells and spigots of foreign material that may prevent sealing. Unroll the butyl sealant rope directly against base of spigot. Do not stretch. Follow manufacturer's instructions when using O-ring seals.

E. Set precast components so that steps align.

F. Plug lift holes using a non-shrink grout. Cover with a butyl sealant sheet on the outside and seal on the inside with an application of an epoxy gel 1/8-inch thick extending 2 inches beyond the opening.

G. Set manhole frames to grade with grade rings. Seal joints between cone, adjusting rings, and manhole frame with butyl sealant rope and sheet.

H. Encase manhole rings in a concrete collar 18-inches wide by 6-inches thick of 3,000 psi concrete beneath paved surfaces.

I. Finish the interior by filling fractures greater than 1/2 inch in length, width or depth with a sand cement mortar. Do not fill the joints between the precast components.

J. Clean the interior of the manhole of foreign matter.

3.08 HYDRANT

A. Set hydrant in accordance with detail on Drawings.

3.09 PAINTING

A. Equipment shall receive the manufacturer's standard coating for the intended application. Coatings shall be suitable for the intended application.

B. Repaint damaged paint services.

C. Above ground piping and piping within vaults shall be painted in accordance with Section, Painting.

3.10 BACKFLOW PREVENTION TESTING

A. Install and test Backflow prevention devices in accordance with the requirements of the local authority having jurisdiction.

3.11 PRESSURE TESTING

A. Pressure test in accordance with AWWA C600 for ductile iron pipe and AWWA C605 and M23 for PVC pipe and as specified herein

B. General:
   1. The Engineer shall approve the source, quality, and method of disposal of water to be used in test procedures.
   2. Obtain Owner's permission 48 hours prior to filling or flushing of pipe system with water from Owner's water system. Owner shall operate valves connected to the existing water system. Where large quantities of water may be required for flushing, Owner reserves the right to require that flushing be done at periods of low demand.
   3. Clean and flush pipe system of foreign matter prior to testing.
   4. Provide air vents at the high points in the line section to be tested for releasing of air during filling. Service corporation stops may be used for air vent when located at a high point. Include cost of air vents in price of testing. Leave corporation stops in place after testing and note locations on As-Built Drawings.
   5. Allow concrete blocking to reach design strength prior to pressure testing.
   6. Test main prior to installation of service taps.
   7. Repair defects in the pipe system. Make repairs to the same standard as specified for the pipe system.
   8. Retest repaired sections until acceptance.
   9. Repair visible leaks regardless of the test results.
   10. Pipe sections shall not be accepted and placed into service until specified test limits have been met.

C. Testing
   1. Notify Owner and Engineer a minimum of 48 hours prior to testing.
   2. Perform tests in the presence of Engineer.
   3. Make pressure tests between valves. Furnish suitable test plugs where line ends in "free flow."
   4. Upon completing a section of pipe between valves, test pipe by maintaining for a two hour period a hydrostatic pressure of 150 psig.
   5. Test pressure shall not vary by more than +/- 5 psi for the duration of the test.
   6. No length of line shall be accepted if the leakage is greater than that determined by the following formula based on the appropriate test pressure:
      L = Allowable leakage per 1,000 feet of pipe in gallons per hour.
      D = Nominal diameter of the pipe in inches.
      100 psi: L = D x 0.07
      150 psi: L = D x 0.08
      200 psi: L = D x 0.09
      250 psi: L = D x 0.10

3.12 DISINFECTION

A. After satisfactory completion of the pressure test, disinfect new potable water mains and existing mains that have required repair in accordance with AWWA C651 and as specified herein. Disinfect water mains in a maximum length per day of 2,000 feet.

B. General:
   1. Provide a superintendent experienced in the required procedures for disinfecting with chlorine.

2. Obtain Owner's permission 48 hours prior to filling, flushing, and chlorinating of the water mains. Owner shall operate valves connected to the existing water system.
3. Do not allow highly chlorinated water into the existing distribution system.
4. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize the residual chlorine. Federal, state, or local environmental regulations may require special provisions or permits prior to disposal of highly chlorinated water.
5. Perform disinfection and testing in presence of Engineer.

C. Connection to Existing System: Notify Owner 48 hours prior to making connections to the existing system. Thoroughly clean the existing water main exterior prior to the installation of tapping sleeves and corporation stops. Lightly dust with calcium hypochlorite powder the water main exterior and the interior surface of the tapping sleeve, and corporation stops.

D. After satisfactory flushing of the main, disinfect by the injection of a chlorine solution. Induce chlorine in sufficient quantity to maintain a chlorine residual of at least 50 ppm throughout the system to be tested. Maintain the chlorine solution in the system for at least 24 hours.

E. Valves and Fire Hydrants: Open and close valves on the mains being disinfected a minimum of three times during the chlorine contact period and a minimum of three times during flushing. Fire hydrants and other appurtenances should receive special attention to insure proper disinfection.

F. Prior to flushing, the free chlorine residual shall be a minimum of 10 ppm. Flushing of the lines shall proceed until the lines contain the normal chlorine residual of the system.

G. Test in the field for free chlorine residual:
1. Sample location shall be the same as required for the bacteriological test samples.
2. Immediately after injection of the chlorine solution. Sample shall have a chlorine residual as specified.
3. Prior to flushing of the highly chlorinated water from the potable water system and a minimum of 24-hours after the initial injection of the chlorine. Sample shall have a minimum chlorine residual as specified.

3.13 BACTERIOLOGICAL TESTING

A. Required location for obtaining water samples:
1. Every 2,000 lf
2. End of each main.
3. A minimum of one from each branch.
4. Mains at cut-in locations: Each side of work area. Time between samples to be determined by Engineer in field.

B. A laboratory, certified for the required testing by the State of North Carolina, shall collect the sample and perform the testing. The laboratory shall be the same for both sampling and testing.

C. Obtain two water samples at each specified location for the bacteriological testing. Take the first sample immediately after flushing of the chlorinated water and again in 24-hours.

D. Recommended additional samples. During the required sampling of water from the new system, it is recommended that samples be taken from the existing potable water source to determine if coliforms are present.

E. Care in sampling. No hose or fire hydrant shall be used for the collection of samples. Take samples from an approved sample tap consisting of a corporation stop installed in the main with a copper tube gooseneck assembly. Operation shall be such as to ensure that the sample collected is actually from water that has been in the new system. Copper tube gooseneck assembly shall be removed and sample tap corporation stop shut off upon completion of testing bacteriological testing is requirements.

F. Test samples for the presence of coliform organisms in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater. Testing method used shall be the multiple-tube fermentation technique, the membrane-filter technique, or presence/absence.

G. Test for odor. The water in the new system should also be tested to assure that no offensive odor exists due to chlorine reactions or excess chlorine residual.

H. If samples show the presence of coliform, procedure 1 or 2 described below shall be followed, with the approval of the Owner, before placing the unit or facility in service.
   1. Take repeat samples at least 24 hours apart until consecutive samples do not show the presence of coliform.
   2. Again subject the system to chlorination and sampling as described in this section.

I. If samples are free of coliform, and with the approval of the Owner, the potable water system may be placed in service.

J. Contamination: If, in the opinion of the Engineer, possible contaminants have entered the existing water system, or water samples show the water in the existing system to be unsafe on completion of the work, the existing water system shall be disinfected as specified herein and shall include all contaminated components. Disinfection of the existing system shall be coordinated with the Owner.

3.14 VALVE OPERATION

A. Prior to final acceptance provide competent personnel to operate each valve in presence of Engineer. Verify that valves are left in the open position.

END OF SECTION

SECTION 02511

STAINLESS STEEL WATER PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes materials and installation of 316L stainless-steel raw water feed and permeate pipe and fittings 24 inches in diameter and smaller conforming to ASTM A 312 and having a maximum operating pressure up to 250 psi.

B. The Contractor shall furnish all materials, tools, equipment, transportation, labor, supervision and incidentals require to supply, store, install, clean, and test the shop fabricated stainless steel pipe and fittings as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Water Distribution System

1.03 REFERENCES

A. Publications are referred to in the text by basic designation only.
   1. American National Standards Institute (ANSI)
      a. B16.5 Pipe Flanges and Flanged Fittings 0.5 to 24 inch (Class 150)
      b. B16.9 Factory Made Wrought Steel Buttwelding Fittings
      c. B31.3 Plant and Process Piping
   2. American Society for Testing and Materials (ASTM)
      a. A-182 Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service
      b. A-193 Alloy Steel and Stainless Steel Bolting for High Temperature and Pressure
      c. A-240 Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications
      d. A-276 Stainless Steel Bars and Shapes
      e. A-312 Welded Austenitic Stainless Steel Pipes
      f. A 380 Cleaning, Descaling, and Passivation of Stainless Steel
      g. A-403 Wrought Austenitic Stainless Steel Pipe Fittings
      h. A-536 Ductile Iron Castings
      i. A 967 Chemical Passivation for Stainless Steel Parts
   3. American Welding Society (AWS)
      a. A5.9 Stainless Steel Welding Electrodes and Rods
   4. Manufacturers Standardization Society (MSS)
      a. SP-83 Class 3000 and 6000 Pipe Unions, Socket Welding and Treaded (Carbon Steel, Alloy Steel, Stainless Steel, and Nickol Alloys)
   5. National Sanitation Foundation (NSF) Standards
      a. 60 Drinking Water Treatment Chemicals – Health Effects
      b. 61 Drinking Water System Components - Health Effects
      c. 372 Drinking Water System Components – Lead Content

1.04 QUALIFICATIONS

A. All shop fabricated stainless steel pipe and fittings shall be furnished by a single manufacturer who is experienced, reputable and qualified in the manufacture and fabrication of the items to be furnished. The pipe and fittings shall be shop fabricated and field installed in accordance with common industry wide practices and methods and shall comply with these specifications. Shop fabricator shall have a minimum of 10 years of experience in fabrication of stainless steel pipe for the size shown on the Drawings.

1.05 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met.
   2. Show material of construction, with ASTM reference and grade. Submit manufacturer's certificates of compliance with referenced pipe standards, e.g., ASTM A 312, A 403. Show wall thickness of steel cylinder.
   3. Submit piping layout drawings showing location and dimensions of pipe and fittings. Include layout lengths of valves, meters, in-line pumps, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe.
   4. Shop fabrication drawings shall show alloys, diameters, pipe wall thicknesses, flanges and other joint preparation details, dimensions, fittings and other appurtenances to be supplied.
   5. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
      a. Pipe and Fittings
      b. Flanged gaskets.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide a suitable pipe hook or rope sling when handling the pipe with a crane. Lifting of the pipe shall be done in a vertical plane. Under no conditions shall the sling be allowed to pass through the pipe unless adequate measures are taken to prevent damage to both the tongue and groove ends.

B. Deliver pipe in the field as near as practicable to the place where it is to be installed. Distribute pipe along the side of the trench opposite to the spoil bank. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe or coating.

C. Shield pipe and fittings stored on site from outside elements as recommended by the pipe fabricator.

PART 2 PRODUCTS

2.01 GENERAL

A. Products with surfaces intended to be in contact with the drinking water shall be in accordance with NSF 61 for potable drinking water.

B. Stainless steel pipe sections, tees, and elbows with suitable end connections shall be shop fabricated shipped to the site for field assembly. Field welds shall be minimized to the greatest extent possible.

2.02 STAINLESS STEEL PIPE AND FITTINGS

A. Pipe
   1. Shall conform to ASTM A 312, Grade TP 316L as indicated in the drawings. Pipe sizes and wall thicknesses shall conform to ANSI B36.19, Table 2. All piping shall be Schedule 10S.
   2. The finish on the raw material, manufactured to ASTM A-240 will be No. 1, HRAP (hot rolled annealed and pickled) or better. The finish on the completed pipe and fittings shall be as specified in ASTM A778 and A774, respectively.
   3. Size shall be as indicated on the Drawings

B. Fittings
   1. Fittings for pipe shall be butt-welded, conforming to ASTM A 403, same material and wall thickness as the pipe, conforming to ANSI B16.9. Elbows shall be long radius, unless otherwise approved by the Engineer. Elbows up to 24" diameter shall be smoothflow; i.e. centerline to end of elbow equals 1.5 times the nominal pipe size. All short radius, special radius, and reducing elbows and long radius elbows greater than 24" diameter shall be smoothflow long or may be of mitered construction with at least (4) miter sections for 90 degree bends, (3) mitered sections for 45 and 60 degree bends, and (2) mitered sections for less than 45 degree bends. Reducers shall be straight tapered, cone type. Tees, crosses, laterals and wyes shall be shop fabricated from pipe.

C. Joints
   1. Flanges shall be provided as a minimum at all flanged valves, meters, couplings, wall pipe, or equipment.
   2. Pipe and fitting spools shall be shop fabricated to the fullest extent possible in 40'0" maximum lengths with 7'6" maximum widths for efficient commercial transport to the project site. Spools with fittings may exceed 40'0" so long as length allows commercial transport. Smaller pipe spools shall be provided with joints as shown on the Drawings for special handling, installation, and/or disassembly requirements.
   3. Joints in run of pipe shall be butt-welded.
   4. Joints between spools shall be grooved end or flanged when connecting to valves or meters. Grooved-end joints shall be of the roll-grooved type, for pipe up to 6" in diameter. Pipe size 8" and larger shall utilize a cut groove in a Schedule 40 end piece

D. Flanges
   1. Provide weld-neck flanges (conforming to ANSI B16.5) for piping 3 inches and smaller to connect to flanged valves, fittings, or equipment. Provide weld-neck or slip-on flanges for piping larger than 3 inches. Flanges shall be Class 150 or Class 300 per ANSI B16.5. Material for weld-neck and slip-on flanges shall be forged stainless steel. Use slip-on flanges for 12 or 24-inch Van Stone flanges.
   2. Bolts and Nuts for Flanges
      a. Bolts and nuts for flanges shall be Type 316L stainless steel conforming to ASTM A 193, Grade B8M, Class 2.
      b. Provide washer for each nut. Washers shall be of the same material as the bolts.

c. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.

3. Gaskets for Flanges
   a. 300# Flanges: Flexitalic "Style CG", spiral wound AISI Type 316 stainless steel, non-asbestos filler. 3/16" nominal thickness with compression ring 1/8" thick to match flange dimensions
   b. 150# Flanges: Full face, 1/8" thick, fabricated from EPDM.

E. Couplings
1. Used if indicated on the Drawings.
2. Sleeve type couplings shall be 316L stainless steel construction (specify gaskets, coating, etc). Pipe shall be plain end with external weld beads ground smooth to insure proper gasket seating. For pressure pipe lines, sleeve coupling joints will be restrained by the use of harness rods connecting across the joint to flange lugs on adjacent flange joints. Where no adjacent flange joints exist, stainless steel harness lugs shall be welded to the pipe to receive the harness rods. All sleeve couplings, flange lugs, harness rods and hardware will be provided.
3. Arched band type couplings shall be 316L stainless steel of equal or superior alloy and wall thickness as the pipe and will be Depend-O-Lok type as manufactured by Brico or equal. Couplings will be Fixed - FxF, Expansion - ExE, or Fixed by Expansion - FxE as noted on the drawings or as required. The pipe shall be plain end with external weld beads ground smooth and with S.S. restraining rings shop welded to the piping for fixed type couplings.
4. Split type couplings shall be 316L stainless steel. Gaskets shall be suitable for the service conditions. The pipe ends shall be roll grooved to the coupling manufacturer's specifications. Where roll grooving is impractical, the pipe shall have heavy wall machine grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper bored to the I.D. of the adjoining pipe to allow full weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.
5. Grooved-end couplings shall be 316L stainless steel. Gaskets shall be EPDM. Couplings shall be Victaulic Style 77-S or equal.

F. Unions
1. Unions shall be 3,000-pound forged stainless steel, with dimensions conforming to MSS SP-83. Ends shall be threaded per ANSI B1.20.1 or socket-welding type. Material shall be the same grade as the connecting pipe as shown in the drawings.

G. Tapping Sleeve
1. Tapping sleeves shall be 316L stainless steel, flanged for the tapping valve and manufactured for a working pressure of 150 psi. Sleeve shall have a full body 360-degree gasket. Sleeve shall have a 3/4-inch test plug. Bolts and nuts shall be stainless steel.

H. Threaded connections
1. Threaded pipe, gauge or instrument connections shall be made using stainless steel 3000-pound threaded half couplings conforming to ASTM A182 or ASTM A-276, shop welded to the pipe at the locations shown on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. Pipe installation shall meet the following general guidelines:
   1. Lay pipe in the presence of Engineer, unless specifically approved otherwise.
   2. Handle pipe and accessories in accordance with manufacturer's recommendations
   3. Carefully inspect pipe immediately prior to laying. Do not use defective pipe. Replace pipe damaged during construction.
   4. Lay pipe to grade and alignment indicated on the Drawings.
   5. Provide proper equipment for lowering pipe into trench.
   6. Do not lay pipe in water or when the trench or weather conditions are unsuitable for the work.
   7. Provide tight closure pipe ends when work is not in progress.
   8. Keep pipe interior free of foreign materials.
   9. Block fittings with concrete, or restrain as indicated on the Drawings or as required to prevent movement.

3.02 STAINLESS STEEL PIPE FABRICATION AND INSTALLATION

A. After the manufacture of individual stainless steel fittings and pipe lengths, they shall be pickled by immersion in a tank containing an ambient nitric hydrofluoric acid solution made up from Oakite Deoxidizer SS, or equal, and monitored to generally maintain a 25% or higher solution by volume of water. The duration of immersion shall be 15 to 20 minutes and may be supplemented by manually scrubbing or brushing with non metallic pads or stainless steel wire brushes. The acid treatment shall be followed by a spray rinse. The stainless steel products shall then be allowed to air dry to achieve passivation.

B. Welding
   1. Welding of pipe spools shall be performed using welders and procedures qualified in accordance with ASME Section IX. Piping with wall thicknesses up to and including 11 gauge (0.125") shall be welded with the TIG (GTAW) process. Heavier walls shall be beveled according to procedure, root pass welded with the TIG (GTAW), and have subsequent weld passes performed using the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler metal of equal or superior ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed; weld reinforcement shall be as follows:

Wall Thickness	Weld Reinforcement (Max)	
	I.D	O.D.
Up to 12 Ga. (0.109")	1/16"	3/32"
11 Ga (0.125") to 3/16" Plate	3/32"	1/8"
¼" Plate & Larger	1/8"	3/16"

   2. Concavity, undercut, cracks or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert argon gas shielding shall be provided to the interior and exterior of the joint. Angle face rings shall be continuously welded on both sides to pipe or fitting. Exterior welds, such as the back side of face rings or flanges and structural attachments, may be welded by the MIG (GMAW) or Metallic Arc (SMAW) process; however care must be taken to avoid melting through to the interior surface on very light walls.

Excessive weld deposits, slag, spatter and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.

C. Spools shall be fabricated to the "Pipe Fabrication Institute" fabricating tolerances ES-3 (1981).

D. After shop fabrication into pipe spools, exterior welds shall be manually scrubbed or brushed with non-metallic pads or stainless steel wire brushes to remove weld discoloration, rinsed with clean water and allowed to air dry.

E. Fabrication, Assembly, and Erection
   1. Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding.
   2. Fabrication shall comply with ANSI B31.3, Chapter V.
   3. The minimum number of passes for welded joints shall be as follows;

Steel Cylinder Thickness (inch)	Minimum Number of Passes for Welds
Less than 0.1875	1
0.1875 through 0.25	2
Greater than 0.25	3

Welds shall be full circumferential.

   4. Use the shielded metal arc welding (SMAW) or the tungsten inert gas (TIG) process for welding. Use the SMAW process for any pipe. Use the TIG process only on pipe having a maximum thickness of Schedule 10S.
   5. Welding preparation shall comply with ANSI B31.3, paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Tables 341.3.2A and 341.3.2B, and paragraph 341.4 for visual examination.
   6. Identify welds in accordance with ANSI B31.3, paragraph 328.5.
   7. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.
   8. Welding electrodes shall comply with AWS A5.4. Bare wire shall comply with AWS A5.9.

F. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece marked with identifying numbers or codes which correspond to the layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart.

G. Extreme care shall be used to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be non-ferrous or stainless steel or rubber lined. Nylon slings or straps or alloy chains or cable shall be used for handling stainless steel piping. After installation, all foreign matter shall wash and rinse from the piping surface. If rusting of embedded iron occurs, the affected surface shall be pickled with Oakite Deoxidizer SS or equal, scrubed with stainless steel brushes and rinsed clean.

H. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and rinsed clean. Final service marking of the pipeline will be suitable permanent sticker to be placed by Contractor

3.03 PRESSURE TESTING

A. Pressure test piping in accordance with Section 02315.

3.04 DISINFECTION

A. Disinfect piping in accordance with Section 02315.

3.05 BACTERIOLOGICAL TESTING

A. Perform bacteriological tests in accordance with Section 02315.

END OF SECTION

SECTION 02512

DISINFECTION OF POTABLE WATER SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Provide labor, material, and equipment required for the disinfection by chlorination of the potable water system installed on the water treatment plant site under this contract.

B. Raw water lines connecting the wells and the water treatment plant will be disinfected and tested under Contract 2. Contract 4 shall flush all raw water lines prior to start-up of the water treatment plant utilizing the new water supply wells.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 13206 Prestressed Composite Tank
   2. Water Treatment Facility and on-site water mains/piping.

1.03 REFERENCE STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. American Water Works Association (AWWA) Standards
      a. B300 Hypochlorites
      b. B301 Liquid Chlorine
      c. C652 Disinfection of Water Storage Facilities
      d. C653 Disinfection of Water Treatment Plants

1.04 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Test Report:
      a. Field test report indicating the measured chlorine residual.
      b. Bacteriological test.

PART 2 PRODUCTS

2.01 DISINFECTANT

A. The following products may be used as the disinfectant:
   1. Chlorine, liquid: AWWA B301.
   2. Hypochlorite, calcium and sodium: AWWA B300.

PART 3 EXECUTION

3.01 GENERAL

A. Provide a superintendent experienced in the required procedures for disinfecting with chlorine.

B. Obtain Owner's permission 48 hours prior to filling, flushing, and chlorinating of the potable water system. Owner shall operate valves connected to the existing water system.

C. Owner will provide water for initial chlorination of system. If bacteriological tests fail, Contractor shall pay for water for re-chlorination at Owner's standard water rate.

D. Do not allow highly chlorinated water into the existing distribution system.

E. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize the residual chlorine. Federal, state, or local environmental regulations may require special provisions or permits prior to disposal of highly chlorinated water.

F. Perform disinfection and testing in presence of Engineer.

G. Test in the field for free chlorine residual:
   1. Sample location shall be the same as required for the bacteriological test samples.
   2. Immediately after injection of the chlorine solution. Sample shall have a chlorine residual as specified.
   3. Prior to flushing of the highly chlorinated water from the potable water system and a minimum of 24-hours after the initial injection of the chlorine. Sample shall have a minimum chlorine residual as specified.

3.02 POTABLE WATER MAINS

A. After satisfactory completion of the pressure test, disinfect new potable water mains and existing mains that have required repair in accordance with AWWA C651 and as specified herein. Disinfect water mains in a maximum length per day of 2,000 feet.

B. Connection to Existing System: Notify Owner 48 hours prior to making connections to the existing system. Thoroughly clean the existing water main exterior prior to the installation of tapping sleeves and corporation stops. Lightly dust with calcium hypochlorite powder the water main exterior and the interior surface of the tapping sleeve, and corporation stops.

C. Keep the pipe interior clean during construction to minimize the amount of water required for flushing and disinfection.

D. After satisfactory flushing of the main, disinfect by the injection of a chlorine solution. Induce chlorine in sufficient quantity to maintain a chlorine residual of at least 50 ppm throughout the system to be tested. Maintain the chlorine solution in the system for at least 24 hours.

E. Valves and Fire Hydrants: Open and close valves on the mains being disinfected a minimum of three times during the chlorine contact period and a minimum of three times during flushing. Fire hydrants and other appurtenances should receive special attention to insure proper disinfection.

F. For Cut-In Construction: Use the following procedures for disinfecting of the new installation and the existing main at the cut-in point in accordance with AWWA C651, Section 9:
   1. Apply liberal quantities of hypochlorite, in the form of tablets, to the open trench.
   2. Interior of new pipe and fittings and the ends of the existing mains shall be swabbed or sprayed with a one percent hypochlorite solution before installation.

3. Install a 2-inch tap downstream of the work area. Tap shall be used for blowing off the main. Or use the next fire hydrant downstream of the work area for blowing off the main.
4. Install a 2-inch tap just upstream of the new installation. Control Water from the existing system so as to flow slowly into the work area during the application of chlorine. After the line is thoroughly flushed, add chlorine solution at a concentration of 100 ppm by the continuous feed method and hold in the main for one (1) hour.

G. Prior to flushing, the free chlorine residual shall be a minimum of 10 ppm. Flushing of the lines shall proceed until the lines contain the normal chlorine residual of the system.

3.03 POTABLE WATER STORAGE TANKS

A. Disinfect storage facilities prior to placing into service in accordance with AWWA C652 and as specified herein.

B. Allow for minimum paint system dry time as recommended by manufacturer prior to disinfection.

C. Remove material not part of the structural or operating facilities of the tank. Thoroughly clean interior surfaces and operating facilities of the storage tank using a high-pressure water jet, sweeping, scrubbing, or other means as approved by the Engineer. Remove foreign material accumulated in this cleaning operation from the storage facility.

D. Following cleaning operation, check screened openings and put in satisfactory condition to prevent birds, insects, and other possible contaminants from entering the facility.

E. Disinfection by Filling of Tank (AWWA C652, Method 1)
1. Add water and chlorine to the storage facility in amounts such that the solution will contain 50-ppm available chlorine and will fill the total storage volume.
2. Hold the solution in the storage facility for a period of not less than 24 hours.
3. After 24 hours, flush the concentrated solution from the tank and associated piping with water from an approved potable water source.

F. Disinfection by Spraying of Tank (AWWA C652, Method 2)
1. Apply a solution of 200-ppm available chlorine directly to surfaces of the storage facility that would be in contact with water when the storage facility is full to the overflow elevation.
2. Chlorine solution may be applied with suitable brushes or spray equipment. Solution shall thoroughly coat surfaces to be treated, including inlet and outlet piping, and shall be applied to any separate drain piping such that it will have available chlorine of not less than 10 ppm when filled with water. Overflow piping need not be disinfected.
3. Disinfected surfaces shall remain in contact with strong chlorine solution for a minimum of 30 min.
4. Purge highly chlorinated water form the tank and associated piping with water from an approved potable water source.

3.04 WATER TREATMENT FACILITIES

A. Disinfect new treatment facilities and existing treatment facilities taken out of service for inspection, repairing, painting, cleaning, or other activity that might lead to

contamination before they are placed into service in accordance with AWWA C653 and as specified herein.

B. Proper cleaning is necessary for the entire treatment facility, including treatment units not subject to disinfection by this standard.

C. Disinfect units that are downstream from the first point of application of disinfectant in the treatment process. Units must be chlorinated with a high dose of chlorine as described in this section. Retention of chlorinated product water containing low level free chlorine is not sufficient to ensure disinfection of water treatment units that may be contaminated during installation or maintenance operations.

D. Remove material not part of the structural or operating facilities of the treatment units. Once the materials are removed, the surfaces of the walls, floors, and attached structures shall be cleaned thoroughly by use of a high pressure water jet, sweeping, scrubbing, or equally effective means. Remove foreign material accumulated during this cleaning operation from the unit.

E. Filter Disinfection
   1. Prior to placement of filter material, clean filter basin as described above.
   2. A representative of the media manufacturer shall supervise disinfection of filter media.
   3. Subsequent to cleaning filter basin, place filter media in basin with reasonable precautions to maintain cleanliness. Following placement, backwash filter media and prepare for service in accordance with AWWA B100, Section 6, Preparation of Filter for Service and the media manufacturer.
   4. After other work is completed, and before filter is placed in service, add water and chlorine to the filter basin in amounts such that initially the solution will contain 50-ppm available chlorine and will fill the entire filter basin up to the maximum water level.
   5. Allow chlorinated water to stand in the filter for at least 24 hrs.
   6. At the end of the contact time, test chlorinated water to determine the free residual. If the free residual is less than 15 ppm, the chlorination process shall be repeated. Sufficient tests should be made both from the top and bottom of the unit (at intermediate points if feasible) to ensure that the residual readings measure the lowest chlorine level existing in the unit at the end of the contact time.
   7. After chlorine retention period, if satisfactory chlorine residuals are obtained, run filter to waste or backwash thoroughly to remove the highly chlorinated water.

F. Granular Activated Carbon
   1. Granular activated carbon (GAC) shall not be placed until all other media is placed and the filter basin and media has been disinfected as required above. GAC cannot be disinfected in the field. Special care must be taken in placing the GAC to protect it from contamination.

3.05 DISPOSAL OF CHLORINATED WATER

A. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize the residual chlorine. Federal, state, or local environmental regulations may require special provisions or permits prior to disposal of highly chlorinated water.

3.06 BACTERIOLOGICAL TESTING

A. Required location for obtaining water samples:
   1. Mains
      a. Every 2,000 lf
      b. End of each main.
      c. A minimum of one from each branch.
      d. Mains at cut-in locations
      e. Each side of work area. Time between samples to be determined by Engineer in field.
   2. Storage Tanks
      a. From outlet piping of each tank.
   3. Filters
      a. From outlet piping of each filter.
   4. Wells
      a. From the well head.

B. A laboratory, certified for the required testing by the State of North Carolina, shall collect the sample and perform the testing. The laboratory shall be the same for both sampling and testing.

C. Obtain two water samples at each specified location for the bacteriological testing. Take the first sample immediately after flushing of the chlorinated water and again in 24-hours.

D. Recommended additional samples. During the required sampling of water from the new system, it is recommended that samples be taken from the existing potable water source to determine if coliforms are present.

E. Care in sampling. No hose or fire hydrant shall be used for the collection of samples. Take samples from an approved sample tap consisting of a corporation stop installed in the main with a copper tube gooseneck assembly. Operation shall be such as to ensure that the sample collected is actually from water that has been in the new system.

F. Test samples for the presence of coliform organisms in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater. Testing method used shall be the multiple-tube fermentation technique, the membrane-filter technique, or presence/absence.

G. Test for odor. The water in the new system should also be tested to assure that no offensive odor exists due to chlorine reactions or excess chlorine residual.

H. If samples show the presence of coliform, procedure 1 or 2 described below shall be followed, with the approval of the Owner, before placing the unit or facility in service.
   1. Take repeat samples at least 24 hours apart until consecutive samples do not show the presence of coliform.
   2. Again subject the system to chlorination and sampling as described in this section.

I. If samples are free of coliform, and with the approval of the Owner, the potable water system may be placed in service.

3.07 CONTAMINATION

A. If, in the opinion of the Engineer, possible contaminants have entered the existing water system, or water samples show the water in the existing system to be unsafe

on completion of the work, the existing water system shall be disinfected as specified herein and shall include all contaminated components. Disinfection of the existing system shall be coordinated with the Owner.

END OF SECTION

SECTION 02513

WATER PIPE LINER SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes, but is not limited to, liner system for gray-iron and ductile iron water pipe and fittings.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02510 Water Distribution System

1.03 REFERENCES

A. Publications are referred to in the text by basic designation only.
   1. American Society for Testing and Materials (ASTM)
      a. B117 Operating Salt Spray (Fog) Apparatus
      b. C2794 Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
      c. D714 Evaluating Degree of Blistering of Paints
      d. D4060 Abrasion Resistance of Organic Coatings by the Taber Abraser
      e. D4541 Pull-Off Strength of Coatings Using Portable Adhesion Testers
      f. D4258 Surface Cleaning Concrete for Coating
      g. D4259 Abrading Concrete
      h. E96 Water Vapor Transmission of Materials
      i. G95 Cathodic Disbondment Test of Pipeline Coatings

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that tests set forth in each applicable referenced publication have been performed and that test requirements have been met. Submit for each of the following materials:
      a. Ceramapure PL 90 Ceramic Epoxy or approved equal.
   2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
      a. Ceramapure PL 90 Ceramic Epoxy or approved equal.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide a suitable pipe hook or rope sling when handling the pipe with a crane. Lifting of the pipe shall be done in a vertical plane. Under no conditions shall the sling be allowed to pass through the pipe or fittings with liner.

B. Deliver pipe with liner in the field as near as practicable to the place where it is to be installed. Distribute pipe along the side of the trench opposite to the spoil bank. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe or coating.

C. Any damage which does occur shall be repaired prior to the installation of the pipe in accordance with the manufacturer's recommendations, so the repair area is equal to the undamaged lining in all respects.

PART 2 PRODUCTS

2.01 CERAMAPURE PL 90 EPOXY LINING

A. Product shall be certified to meet the requirements of NSF/ANSI International Standard 61 for potable water use.

B. Pipe Condition
   1. All ductile iron pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface.
   2. The intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

C. General
   1. The interior wall of all ductile iron water pipe fittings shall be protected by the Ceramapure PL 90 Ceramic Epoxy lining material.
   2. The lining shall meet the manufacturer's recommendations and the following requirements as a minimum.
   3. The liner manufacturer shall have a minimum of five (5) years of successful experience and be able to demonstrate successful performance on comparable projects.

D. Lining Material
   1. The material shall be an amine cured epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining ductile iron pipe and fittings, a test report verifying the following properties, and a certification of the test results.
   2. The following tests must be run on coupons from factory lined ductile iron pipe:
      a. Immersion testing rated on using ASTM D-714
         1) 20% Sulfuric Acid Immersion – no effect after 5500 hrs.
         2) 5% Sodium Chloride Solution (Salt Water) Immersion – no effect after 2 years.
         3) 5% Sodium Chloride Solution (Salt Water) Immersion – Panel Scribed to Metal – no effect after 2 years
         4) 25% Sodium Hydroxide Immersion – no effect after 2 years
      b. Distilled Water Immersion-- per AWWA C-550--- passed
      c. ASTM B-117 Salt Fog (Scribed Panel)-- Passed one year no undercutting
      d. Undercutting Resistance: Alternate Wet /Dry Immersion(5% NaCl, flowing, aerated, 120°F, Wet 1 hour followed by dry one hour- 12 Cycles daily)-- Passed one year when rated using ASTM D-714--No undercutting at exposed edges.
      e. Weathering--Coupons with cut edges Exposure exposed to ambient weathering conditions in Birmingham, AL-- passed one year-- no undercutting at edges.

3. ASTM G-22 Standard practice for determining resistance of Synthetic Polymeric materials to bacteria. The test should determine the resistance to growth of Acidithiobacillus Bacteria and should be conducted at 30 degrees centigrade for a period of 7 days on a minimum of 4 panels. The growth must be limited only to trace amounts of bacteria.

4. An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

PART 3 EXECUTION

3.01 GENERAL

A. The lining compound shall be applied by a competent firm with a five (5) year history of lining ductile iron sewer pipe and fittings.
   1. The workmen employed by the applicator shall be experienced and competent in the application and inspection of the lining compound to be applied.
   2. The firm shall be financially responsible, having a net worth of at least the amount of the contract.

3.02 CERAMAPURE PL 90 EPOXY LINING

A. Application
   1. The entire surface shall be inspected prior to receiving protective compound to ensure that no oil, grease, etc. exists on the surface. If any surface contains any of these items shall be solvent cleaned to remove said substances.
   2. Once free of any oil, grease, etc., all surfaces shall be abrasive blasted using sand or grit abrasive media. No rust shall be present on surface at the time of application.
   3. After surface preparation, and within 12 hours of surface preparation, the pipe interior shall receive 40 mils nominal dry film thickness of Ceramapure PL90.
   4. No lining shall take place when the substrate or ambient temperature is below 40°F.
   5. The surface must be dry and dust free during application.
   6. Bell Sockets and Spigot Ends shall be coated with 6 mils nominal, 10 mils maximum with Ceramapure Joint Compound 6 inches back from the end of the spigot end.
   7. The joint compound shall be applied by brush to ensure full coverage.
   8. No excessive buildup shall be present in the gasket seat or on the spigot ends.
   9. Coating of the gasket seat and spigot ends shall be done after the application of the lining.
   10. The number of coats shall be as recommended by the lining manufacturer.
   11. No material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.
   12. Provide touch up, as necessary, using Ceramapure Joint Compound per manufacturer's recommendations.

B. Inspection and Certification
   1. A magnetic film thickness gauge shall be used to confirm the thickness on all ductile iron pipe and fittings. Thickness testing shall be done in accordance with SSPC-PA-2 Film Thickness Rating.

2. The interior lining shall be tested using a non-destructive 2,500 volt test to check for pinholes. Repair defects prior to shipment.
3. Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work. These records shall be made available to the Engineer upon request.
4. The pipe/fitting manufacturer shall provide a certificate attesting that the applicator meets the requirements of this specification, and that the material used was as specified and applied as specified.

END OF SECTION

SECTION 02530

SANITARY SEWER SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes, but is not limited to, piping, valves, and appurtenances for a complete sanitary sewer collection system.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Trenching for Utilities
   2. Section 02532 Sanitary Sewer Pipe Liner System

1.03 REFERENCES

A. Publications are referred to in the text by basic designation only.
   1. American Society for Testing and Materials (ASTM)
      a. A126 Gray iron Castings and Valves, Flanges and Pipe Fittings.
      b. C361 Reinforced Concrete Low-Head Pressure Pipe.
      c. C443 Flexible Watertight Joints for Precast Manhole Sections
      d. C478 Precast Reinforced Concrete Manhole Sections
      e. C828 Low-Pressure Air Test of Vitrified Clay Pipe Lines (4 to 12 inch)
      f. C890 Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
      g. C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
      h. C1244 Test Method for Concrete Sewer Manholes by the Negative Air Pressure
      i. D1248 Polyethylene Plastics Molding and Extrusion Materials
      j. D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
      k. D2241 Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
      l. D 2321 Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
      m. D3034 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
      n. D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
      o. D3350 Polyethylene Plastics Pipe and Fittings Materials
      p. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe
   2. American Water Works Association (AWWA)
      a. C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
      b. C105 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
      c. C110 Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids
      d. C115 Flanged Ductile-Iron Pipe with Threaded Flanges
      e. C151 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

f. C153 Ductile-Iron Compact Fittings, 3 inch through 16 inch, for Water and Other Liquids
g. C507 Ball Valves, 6 inch through 48 inch
h. C508 Swing-Check Valves for Waterworks Service, 2 inch Through 24 inch NPS
i. C509 Resilient-Seated Gate Valves for Water Supply Service
j. C512 Air-Release, Air / Vacuum, and Combination Air Valves for Waterworks Service
k. C550 Protective Epoxy Interior Coatings for Valves and Hydrants
l. C600 Standard for Installation of Ductile Iron Water Mains and Their Appurtenances
m. C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
n. C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch through 12 inch, for Water Distribution
o. C906 Polyethylene (PE) Pressure Pipe and Fittings 4 inch through 63 inch for Water Distribution
p. M23 PVC Pipe - Design Installation

3. National Sanitation Foundation (NSF) Standards
   a. 14 Plastic Piping Components and Related Materials
4. UNI-BELL Plastic Pipe Association (UNI)
   a. B-5 Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Sewer Pipe
   b. B-6 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.04 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that tests set forth in each applicable referenced publication have been performed and that test requirements have been met. Submit for each of the following materials:
      a. Pipe
         1) Ductile iron
         2) Polyvinyl Chloride (PVC) pressure pipe
            i) AWWA C900
            ii) Schedule 40 & 80
         3) Polyvinyl Chloride (PVC) gravity sewer pipe
            i) Schedule 40, drain, waste, and vent (DWV) pipe
      b. Pre-cast concrete manholes
      c. Valves
         1) Plug
         2) Check
         3) Air Release
   2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
      a. Pipe
         1) Ductile iron
         2) Polyvinyl Chloride (PVC) pressure pipe
            i) AWWA C900

ii) Schedule 40 & 80
3) Polyvinyl Chloride (PVC) gravity sewer pipe
i) Schedule 40, drain, waste, and vent (DWV) pipe

b. Pre-cast Concrete Manholes and the following appurtenances:
1) Manhole steps
2) Pipe connectors
3) Joint material
4) Castings

c. Valves
1) Plug
2) Check
3) Air Release

3. Reports:
a. Field test report for each section of pipe for the following:
1) Pressure test for force mains.
2) Low-pressure air test for gravity mains.
3) Vacuum test for manholes.

4. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the following:
a. Valves.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide a suitable pipe hook or rope sling when handling the pipe with a crane. Lifting of the pipe shall be done in a vertical plane. Under no conditions shall the sling be allowed to pass through the pipe unless adequate measures are taken to prevent damage to both tongue and groove ends.

B. Deliver pipe in the field as near as practicable to the place where it is to be installed. Distribute pipe along the side of the trench opposite to the spoil bank. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe or coating.

C. Shield PVC pipe and fittings stored on site from the sun's ultraviolet rays by suitable cover, or indoor storage.

PART 2 PRODUCTS

2.01 DUCTILE-IRON PIPE

A. Pipe and fittings shall conform to the following requirements:
1. Size shall be as indicated on the Drawings.
2. Suitable for a system working pressure of 150 psi.
3. Cement-mortar lined with seal coat in accordance with AWWA.
4. Interior lining for Concentrate Line ductile iron piping and fittings shall be Protecto 401 Ceramic Epoxy, or approved equal, designed for water containing high chloride concentrations. See Section 02532 Sanitary Sewer Pipe Liner System.

B. Ductile-iron pipe for below ground service shall have push-on or mechanical joints, unless noted otherwise on the Drawings, conform to AWWA C151, and to the following requirements:
1. Pipe shall be Pressure Class 350.
2. Provide mechanical joint fittings, unless noted otherwise on the Drawings.

C. Ductile-iron pipe for above ground service shall have flanged joints, unless noted otherwise on the Drawings, and conform to AWWA C115.
   1. Pipes to be painted shall have only a shop primer on the outside by the manufacturer. Verify that proposed manufacturer's primer is compatible with the proposed paint system.

D. Fittings for ductile-iron pipe shall conform to AWWA C110, or C153 and to the following requirements:
   1. Joint type shall be as specified above for the supplied ductile-iron pipe.
   2. Fittings shall be made of gray-iron or ductile-iron.

2.02 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

A. General
   1. Pipe and fitting size shall be as indicated on the Drawings.
   2. PVC materials shall comply with ASTM D1784 with a cell classification of 12454-B.
   3. Pipe used for potable water systems shall comply with NSF 61.

B. AWWA C900: C900 PVC pipe 4-inch to 48-inch shall conform to AWWA C900 and the following requirements:
   1. Outside diameter shall conform to ductile-iron pipe.
   2. Pipe shall be pressure class 235 with a standard dimension ratio of DR 18.
   3. Pipe shall have plain end and elastomeric-gasket bell ends.
   4. Fittings shall conform to AWWA C110, or C153 and have mechanical joints. Fittings shall be made of gray-iron or ductile-iron. Interior of fittings for the 16-inch concentrate line shall be lined with Protecto 401 Ceramic Epoxy or approved equal.
   5. Restraining mechanism for joint restraint must be approved by pipe manufacturer. Restraining system shall not result in a point load on the pipe.
   6. Gasketed-type restraint systems will not be allowed.
   7. Restraint for mechanical joint fittings shall be incorporated in the design of the follower gland and shall utilize multiple wedge segments that act against the pipe, increasing their resistance as the line pressure increases. The assembled joint shall maintain the maximum flexibility and deflection of all normal pipe sizes after burial. Restraining gland, wedge segments, and actuating bolts shall be manufactured of high strength ductile iron conforming to the requirements of ATSM A536, Grade 65-45-12. Mechanical joint restraining devices shall have a working pressure rating of 200 psi for 3-12" sizes and 235 psi for sizes 14-36" minimum and provide no less than a safety factor of 2:1.
   8. Restraint devices for bell and spigot joints of C900 PVC pipe shall consist of two split retainer rings. One clamping ring shall be installed on the spigot pipe, and with the necessary restraining rods and nuts, connected to a second clamping ring located on the pipe barrel immediately behind the gasket bell. Restraint devices shall incorporate a series of machined serrations that provide positive restraint, exact fit and full support of the pipe wall. Devices shall carry a minimum 2:1 safety factor. Clamping ring shall be manufactured of high strength ductile iron in accordance with ASTM A536, Grade 65-45-12. Side clamping bolt and hex nuts shall be high strength steel in accordance with ASTM A 449 and zinc plated to B6333, Type III Sc. 1 for corrosion resistance. Restraining rods and hex nuts shall be high strength, low alloy steel in accordance with AWWA/ANSI C111/A21.11 and provide a minimum 45,000 psi yield and 60,000 psi tensile strength.

C. Schedule 40 & 80: Schedule 40 & 80 PVC pipe ½-inch to 12-inch shall conform to ASTM D1785 and the following requirements:
   1. Outside diameter shall conform to iron pipe.
   2. Pipe shall be schedule 40 or 80.
   3. Pipe shall have an integral elastomeric-gasket bell end or solvent weld joints.
   4. Fittings for the pipe shall conform to ASTM D2466 or D2467 as appropriate for the pipe schedule.

2.03 POLYVINYL CHLORIDE (PVC) GRAVITY SEWER PIPE

A. General
   1. Pipe and fitting size shall be as indicated on the Drawings.
   2. PVC materials shall comply with ASTM D1784 with a cell classification of 12454-B.
   3. Pipe shall have an integral elastomeric-gasket bell end. Gaskets shall be in conformance with ASTM F477.
   4. See Section, Trenching for Utilities, for trench bedding and haunching requirements.

2.04 MANHOLES

A. Provide manholes made of precast concrete sections in conformance with ASTM C478, NC Department of Transportation, and the following requirements:
   1. General
      a. Provide manholes to the depth as indicated on the Drawings. Manhole inside diameter shall be 4 feet unless noted otherwise on the Drawings.
      b. Precast concrete manholes shall be as manufactured by Adams Concrete, Carolina Precast Concrete, Inc., D & M Concrete Specialties, Inc., N. C. Products Corp., Stay Right Tank, Tindall Concrete Products, Inc. or approved substitute.
   2. Precast Concrete Sections
      a. Minimum wall thickness shall be 5-inches.
      b. Base: Cast monolithically without construction joints or with an approved PVC waterstop in the cold joint between the base slab and the walls. The width of the base extensions on Extended Base Manholes shall be no less than the base slab thickness.
      c. Riser: Minimum lay length of 16 inches.
      d. Eccentric Cone: Top inside diameter shall be 24 inches. Width of the top ledge shall be no less than the wall thickness required for the cone section.
      e. Transition Cone: Provide an eccentric transition from 60-inch and larger manholes to 48-inch diameter risers, cones, and flat slab top sections. Minimum slope angle for the cone wall shall be 45 degrees.
      f. Transition Top: Provide an eccentric transition from 60-inch and larger manholes to 48-inch diameter risers, cones, and flat slab top sections. Transition Top sections shall be furnished with vents as shown on the manhole details. Tops shall not be used in areas subject to vehicle traffic.
      g. Flat Slab Top: Designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into Special Flat Slab Tops shall be sized to fit within the manhole ID and the top and bottom surfaces. Provide a float finish for exterior slab surface.
      h. Precast or core holes for pipe connections. Diameter of hole shall not exceed outside diameter of pipe by more than 3-inches.

i. Grade Rings: May be used to adjust frame and cover to finished grade. Grade Rings shall be no less than 4 inches in height.
j. Lifting Devices: Devices for handling precast components shall be provided by the precast manufacturer and comply with OSHA Standard 1926.704.

3. Joints
   a. Manufacturer in accordance with tolerance requirements of ASTM C 990 for butyl type joints.
   b. Minimize number of joints. Do not use riser section for manholes up to 6 feet tall and no more than one riser for each additional 4 feet in height.
   c. Flexible Joint Sealants: Preformed butyl rubber based sealant material conforming to Federal Specification SS-S-210A, Type B and ASTM C990.
   d. External Seal: Polyethylene backed flat butyl rubber sheet no less than 1/16-inch thick and 6-inches wide.
4. Inverts
   a. Brick and mortar or precast concrete invert.
   b. Form and finish invert channel to provide a consistent slope from inlet(s) to outlet up to 4-inches.
   c. Channel walls shall be formed to 3/4 of the height of the outlet pipe diameter.
   d. Finish benches with a minimum uniform 1.5:12 slope. Provide a 1/4-inch radius at the edge of bench and trough.
5. Flexible Pipe Connectors: Provide flexible connectors for pipe to manhole that conform to ASTM C923. Location of connectors shall vary from Project Drawings no more than 1/2-inch vertically and 5 degrees horizontally. Provide stainless steel pipe clamp type band around flexible connection to sewer pipe.
6. Manhole Steps:
   a. Steps shall be in accordance with ASTM C478 and made of 1/2-inch grade 60 steel encapsulated by co-polymer polypropylene and have serrated tread and tall end lugs.
   b. Secure steps to the wall with compression fit in tapered holes or cast-in-place. Align steps along a vertical wall and shall not be located over a pipe opening. First step shall be a maximum of 26 inches from the bottom.
   c. Steps shall be by American Step Co., Inc., Bowco Industries, Inc., M. A. Industries, Inc. or approved substitute.

2.05 CASTINGS

A. General
   1. Made of gray iron, ASTM A-48 - class 30, or ductile iron, ASTM A536, grade 65-45-12.
   2. Castings shall be free from imperfections not true to pattern. Casting tolerances shall be plus or minus 1/16-inch per foot of dimension. Top shall set neatly in frame, with edges machined for even bearing and proper fit to prevent rattling and flush with the edge of frame.
   3. Castings shall be as manufactured by Neenah Foundry Co., U.S. Foundry & Manufacturing Corp., or Vulcan Foundry

B. Manhole Frame and Cover:
   1. Minimum clear opening shall be 22 inches.
   2. Minimum weight for frame and cover shall be 300 pounds and suitable for Heavy Duty Highway Traffic Loads of H-20.
   3. Frame shall have four 3/8-inch anchor bolt holes equally spaced.

4. Cast "Sanitary Sewer" on the cover. Casting shall bear the name of the manufacturer and the part number.
5. Provide cover with two 1-inch perforated holes unless noted as watertight on the Drawings.
6. Provide the following where indicated on the Drawings:
   a. Ring and cover shall be watertight.
   b. Bolt down cover. Bolt down covers shall be provided with four (4) 3/8-inch stainless steel hex head bolts at 90 degrees.

2.06 VALVES

A. General: Valves shall meet the following requirements:
1. Size shall be as required for the pipe size and material as indicated on the Drawings and specified.
2. Open by counterclockwise rotation.
3. Standard system working pressure is 150 psi.
4. Equip valves with a suitable means of operation.
5. For buried valves over 5 feet deep, provide extension stems of cold rolled steel to bring the operating nut to within 2 feet of the ground surface.
6. Provide valve accessories as required for proper valve operation for valve locations as indicated on the Drawings and as recommended by valve manufacturer.
7. Valve accessories shall be compatible to proper valve operation.
8. Similar valve types shall be of one manufacturer.

B. Plug Valves: Plug valves shall conform to the following requirements:
1. Plug valves shall be of the non-lubricated, eccentric type designed for a working pressure of 175 psi for valves 12 inch and smaller, 150 psi for vales 14 inch and larger.
2. Valves shall provide tight shut-off at rated pressure.
3. The plug valve body shall be cast iron ASTM A126 Class B with a welded-in overlay of not less than 90% nickel alloy content on all the surfaces contacting the face of the plug.
4. The valve plug shall be constructed of cast iron conforming to ASTM A126 Class B, with Buna N resilient seating surface to mate with the body seat.
5. Valve flanges shall be in accordance with ANSI B16.1 Class 125.
6. Shaft bearings shall be sleeve-type, sintered, oil impregnated, and permanently lubricated stainless steel.
7. Plug valve shaft seals shall be of the multiple V-ring type and shall be adjustable. Sealing system shall conform to AWWA C504 and C507 standards. All packing shall be replaceable without removing the bonnet or actuator and while valve is in service.
8. Valves 6" and larger shall be provided with gear actuators.
9. Provide levers or hand wheels to operate the valve as recommended by the manufacturer.
10. Full ported (i.e,. 100% flow area) and piggable.

C. Swing Check Valves: Swing check valves from 2 to 24 inch shall conform to AWWA C508 and to the following requirements:
1. Provide lever and weight for swing check control.
2. Resilient material to Metal seat construction.
3. Ends shall be flanged.

2.07 AIR VALVES

A. Automatic air release valves shall be the combination type and allow both the release of air from the pipe (Air Release Mode) and the introduction of air into the pipe (Vacuum Break Mode).

B. Valves shall have a 2-inch threaded inlet.

C. The body of these valves shall be conical shaped and constructed of 316 stainless steel. The float shall be Delrin and the float spindle shall be of 316 stainless steel. The valve seat and all internal working parts shall be of corrosion resistant materials.

D. The ARV shall seal at 0 psi and have an overall operating range of 0-250 psi.

E. The ARV shall close watertight when liquid enters the valve and allow air to enter in the event of a vacuum. The ARV shall have a rolling cup seal diaphragm for indefinitely variable operation to provide a soft working behavior for water hammer inhibition.

F. All automatic air release valves shall be H-Tec model 986. All valves shall be installed in accordance with manufacturer's recommendations and shall have ISO 9001 certification.

2.08 VALVE BOX

A. Valve Box, Below Ground: Boxes shall be high strength cast iron of the screw or telescopic type. Box shall consist of a base section, center extension as required, and a top section with cover marked "SEWER."

2.09 THRUST BLOCKING

A. Provide concrete thrust blocking for pressure lines in accordance with the detail on the Drawings.

B. Thrust blocking is not required where restrained joint fittings and equivalent length of restrained joint pipe are used unless shown otherwise on the Drawings.

C. All products that are to be in contact with concrete shall be covered with 4 mil polyethylene sheets prior to pouring concrete.

PART 3 EXECUTION

3.01 GENERAL

A. Pipe installation shall meet the following general guidelines:
   1. Lay pipe in the presence of Engineer, unless specifically approved otherwise.
   2. Handle pipe and accessories in accordance with manufacturer's recommendations. Take particular care not to damage pipe coatings.
   3. Carefully inspect pipe immediately prior to laying. Do not use defective pipe. Replace pipe damaged during construction.
   4. Lay pipe to grade and alignment indicated on the Drawings.
   5. Provide proper equipment for lowering pipe into trench.
   6. Provide tight closure pipe ends when work is not in progress.
   7. Keep pipe interior free of foreign materials.
   8. Do not lay pipe in water or when the trench or weather conditions are unsuitable for the work.

9. Clean bell and spigots before joining. Make joints and lubricate gasket in accordance with pipe manufacturer recommendation.
10. Block fittings with concrete, or restrained as indicated on the Drawings or as required to prevent movement.

B. Gravity Pipe: Gravity pipe installation shall meet the following general guidelines:
1. Lay pipe upgrade from the lower end and at the grades and alignment indicated on the Drawings.

3.02 RELATION OF WATER MAINS TO SEWERS

A. Lateral Separation: Lay water mains at least 10 feet laterally from existing and proposed sewers. Where existing conditions prevent a 10-foot lateral separation, the following shall be followed with approval of the Engineer:
1. Lay water main in a separate trench, with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.
2. Lay water main in the same trench as the sewer with the water main located at one side on a bench of undisturbed earth, and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.

B. Crossing Separation: Lay bottom of water main at least 18 inches above the top of the sewer. Where existing conditions prevent an 18-inch vertical separation, construct both the water main and sewer of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.

C. Crossing a Water Main Under a Sewer: When it is necessary for a water main to cross under a sewer, construct both the water main and the sewer of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing.

3.03 SEWER PIPE

A. Lay sewer pipe to true lines and grades by use of laser beam equipment or other acceptable means.

B. Minimum Separation Distances:
1. 100-foot horizontal separation from wells or other water supplies.
2. 24-inch vertical separation from storm sewers or ferrous pipe shall be used.
3. For separation from water mains see paragraph 3.02 above.

3.04 DUCTILE IRON PIPE

A. Install pipe in conformance with AWWA C600 and the following:
1. For laying pipe in a vertical or horizontal curve, each full length pipe may be deflected by the following offset distance:
a. Push-on joint
1) 3 to 12-inch pipe: 14-inch offset
2) 14 to 36-inch pipe: 8-inch offset
b. Mechanical joint
1) 3 to 6-inch pipe: 20-inch offset
2) 8 to 12-inch pipe: 15-inch offset
3) 14 to 20-inch pipe: 8-inch offset
4) 24 to 36-inch pipe: 6-inch offset

2. For laying restrained joint pipe in a vertical or horizontal curve, except for horizontal directional drills (HDD), each full length pipe may be deflected by the following offset distance:
   a. 6 to 12-inch pipe: 11-inch offset
   b. 16 to 20-inch pipe: 7-inch offset
   c. 24 to 30-inch pipe: 5-inch offset
   d. 36-inch pipe: 4-inch offset
   e. 42 to 48-inch pipe: 1 ¼ -inch offset

3.05 PVC PRESSURE PIPE

A. Install PVC C900 pipe in conformance with AWWA C605.

B. Solvent Weld: Where indicated in these specifications or on the plans, solvent weld type joints shall be used. Field cut ends shall be sanded to roughing the surface. Joints shall be cleaned of foreign material. Solvent shall be applied to the joint and joint made as recommended by the manufacturer. Excess solvent shall be wiped off. The joint should not be moved until sufficiently set up.

C. Bell and Spigot Joints: Clean bell and spigot ends prior to jointing. Ends of field cut pipe shall be beveled with file. Gasket shall be clean and lightly lubricated. Joint shall be made as recommended by the manufacturer.

3.06 VALVES AND FITTINGS

A. Install buried valves on top of an 18-inch square, 3-inch thick, solid concrete pad (minimum dimensions). The concrete pad may be provided by a pre-cast manufacturer or cast-in-place in the field above grade. Concrete used for the pads shall be a minimum 3,000 psi mix. The pads may not be cast-in-place in the pipe trench. Connection to pipe shall be such that there shall be no stress at the joint caused by misalignment or inadequate support of pipe or valve.

B. Install fittings as recommended by the manufacturer. Fittings shall be blocked or otherwise restrained from movement.

C. Valve Boxes: Set valve boxes flush with finished grade. Box shall be supported so that no stress shall be transmitted to the valve. Operating nut shall be centered in box.

D. Install valves, gates, and accessories indicated on the Drawings and in complete accordance with the manufacturer's recommendations.

E. Valve boxes shall be set straight with the operating nut centered and supported on (2) 4" concrete blocks, to prevent load transfer onto valve body or pipe line. Set top of box at finished grade. Provide a 24-inch x 24-inch wide by 6-inch thick concrete pad at top of valve boxes outside paved areas.

3.07 AIR VALVES

A. Main shall be drilled for a two inch connection.

B. Valve shall be installed on the main line with a service saddle.

C. Install air valve in a flat top manhole.

3.08 MANHOLES

A. Set base plumb and level. Align manhole invert with pipe invert.

B. Secure pipe connectors to pipe in accordance with manufacturer's recommendation.

C. Clean bells and spigots of foreign material that may prevent sealing. Unroll the butyl sealant rope directly against base of spigot. Do not stretch. Follow manufacturer's instructions when using O-ring seals.

D. Set precast components so that steps align.

E. Plug lift holes using a non-shrink grout. Cover with a butyl sealant sheet on the outside and seal on the inside with an application of an epoxy gel 1/8-inch thick extending 2 inches beyond the opening.

F. Set manhole frames to grade with grade rings. Seal joints between cone, adjusting rings, and manhole frame with butyl sealant rope and sheet.

G. Apply external seal to the outside of joint.

H. Finish the interior by filling fractures greater than 1/2-inch in length, width or depth with a sand cement mortar.

I. Clean the interior of the manhole of foreign matter.

3.09 PAINTING

A. Equipment shall receive the manufacturer's standard coating for the intended application. Coatings shall be suitable for the intended application.

B. Repaint damaged paint services.

C. Above ground piping and piping within vaults shall be painted in accordance with Section, Painting.

3.10 TESTING

A. General
1. Clean and flush pipe system of foreign matter prior to testing.
2. Notify Owner and Engineer a minimum of 48 hours prior to testing.
3. Perform tests in the presence of Engineer.
4. Length of line to be tested at one time shall be subject to approval of Engineer.
5. Pipe sections shall not be accepted and placed into service until specified test limits have been met.
6. Repair defects in the pipe system. Make repairs to the same standard as specified for the pipe system.
7. Retest repaired sections until acceptance.
8. Repair visible leaks regardless of the test results.

B. Pressure Mains
1. The Engineer shall approve the source, quality, and method of disposal of water to be used in test procedures.
2. Obtain Owner's permission 48 hours prior to filling or flushing of pipe system with water from Owner's water system. Owner shall operate valves connected to the existing water system. Keep pipe interior clean during construction to minimize the amount of water required for flushing. Where large quantities of water may be required for flushing, Engineer reserves the right to require that flushing be done at periods of low demand.
3. Pressure test in accordance with AWWA C600 for ductile iron pipe and AWWA C605 and M23 for PVC pipe and the following.
4. Make pressure tests between valves. Furnish suitable test plugs where line ends in "free flow."

5. Provide air vents at the high points in the line section to be tested for releasing of air during filling. Service corporation stops may be used for air vent when located at a high point. Include cost of air vents in price of testing. Leave corporation stops in place after testing and note locations on As-Built Drawings.
6. Allow concrete blocking to reach design strength prior to pressure testing.
7. Force main shall be completely filled with water, all air expelled from the pipe, and the discharge end of the pipeline shall be plugged and adequately blocked before hydrostatic test begins.
8. Upon completing a section of pipe between valves, test pipe by maintaining for a two hour period the following hydrostatic pressure for each main:
   a. Force main: 100 psig
9. Test pressure shall not vary by more than +/- 5 psi for the duration of the test.
10. No length of line shall be accepted if the leakage is greater than that determined by the following formula based on the appropriate test pressure:
    L = Allowable leakage per 1,000 feet of pipe in gallons per hour.
    D = Nominal diameter of the pipe in inches.
    100 psi: L = D x 0.07
    150 psi: L = D x 0.08
    200 psi: L = D x 0.09
    250 psi: L = D x 0.10

C. Gravity Sewer Mains
   1. Test gravity lines between manholes.
   2. Light Testing: Engineer will check for displacement of pipe as follows:
      a. A light will be flashed between the ends of the pipe section being tested.
      b. If the illuminated interior shows misalignment, or other defects as designated by Engineer, defects shall be repaired.
   3. General
      a. Infiltration shall not exceed 100 gallons per inch of diameter, per mile of pipe, per 24 hours. Engineer may require flow measurement for verification of infiltration.
      b. Verify that maximum infiltration rate shall not be surpassed by air testing as follows.
   4. Low Pressure Air Test:
      a. Air testing of sewer mains shall conform to UNI-B-6 and the following requirements:
      b. Perform initial air test when each section of main is complete including services to right of way. Test as construction proceeds.
      c. Wet interior surfaces of porous pipe material prior to testing.
      d. Safety
         1) Provide a superintendent who has experience in low pressure air testing of gravity sewer mains.
         2) Follow safety recommendations of air testing equipment manufacturer.
         3) Properly brace sewer plugs during testing. Test plugs prior to use in air testing.
         4) No one shall be allowed in manhole or trench when pipe is under pressure.
         5) Pressurizing equipment shall include a regulator and a pressure relief valve, which are set no higher than 9 psig. Monitor gauges continuously to assure that the pressure does not exceed 9 psig.

e. Equipment
   1) Sewer plugs shall be specifically designed for low pressure air testing.
   2) Use two separate air hoses.
      i) One to connect the control panel to the sealed line for introducing the air.
      ii) One from the sealed line to the control panel to provide constant monitoring of the air pressure in the line.
      iii) If Pneumatic plugs are used a separate line shall be used to inflate the plugs.
   3) As a minimum the above ground air testing equipment shall include a shutoff valve, pressure regulating valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psig.
   4) Continuous monitoring pressure gauge shall be at least 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of +/- 0.04 psi.
   5) Monitoring gauges shall be subject to calibration as deemed necessary.
   6) Air used for testing shall pass through a single above ground control panel.

f. Testing
   1) Groundwater Determination: Immediately prior to each air test, determine groundwater level by a method acceptable to the Engineer. Adjust pressure used in air test in accordance with groundwater level.
   2) Apply air slowly to the test section until the pressure reached is 4.0 psi plus an adjustment of 0.433 psi for each foot of ground water above the crown of the pipe. Internal air pressure, including adjustment for ground water, should never exceed 9.0 psi.
   3) When the above required pressure is reached, throttle air supply to maintain internal pressure for at least two minutes to permit stabilization.
   4) When pressure has stabilized at required pressure, shut off air supply.
   5) While observing the continuous monitoring pressure gauge, decrease pressure approximately 0.5 psi from required pressure.
   6) At this reading timing shall commence with a stop watch and allowed to run until pressure has dropped 1.0 psi or allowable time has lapsed. Line shall be "Acceptable" if the pressure drop does not exceed 1 psig in the time prescribed for the test in Table 1, Low Pressure Air Testing for Gravity Sewer Mains, at the end of this section.

5. Hydrostatic Test for Gravity Sewers
   a. The source, quality, and method of disposal of water to be used in test procedures shall be approved by the Engineer.
   b. Obtain Owner's permission 48 hours prior to filling or flushing of pipe system with water from Owner's water system. Owner of water system shall operate valves connected to the existing water system.
   c. Air test line, as described above, prior to hydrostatic testing.
   d. Provide taps for filling and pressurizing the line. Service corporation stops may be used. Include cost of taps in price of testing. Leave corporation stops in place after testing and note locations on As-Built Drawings.
   e. Suitable means for thrust restraint shall be installed for testing.
   f. Test for each manhole reach.

g. Test pipe by maintaining for a two-hour period a hydrostatic pressure of 150 psig.
h. Test pressure shall not vary by more than +/- 5 psi for the duration of the test.
i. Pressure test in accordance with AWWA C600 for ductile iron pipe and as described above.
j. Hydrostatic testing for gravity sewers within 100 feet of a water supply well shall be paid for as described in Section, Basis for Payment.

D. Vacuum test each manhole in accordance with ASTM C1244 and the following:
1. No personnel shall be allowed in manhole during testing.
2. Test manhole after assembly and prior to backfilling.
3. Plug pipes with suitably sized and rated pneumatic or mechanical pipeline plugs. Brace plugs to prevent displacement.
4. Position vacuum test head assembly to seal against interior surface of the top of cone section in accordance with manufacturer's recommendation.
5. Draw vacuum of 10 inches of mercury on manhole. Shut off the vacuum pump and close valve on vacuum line.
6. Measure time for vacuum to drop to 9 inches of mercury. Manhole shall pass if time meets or exceeds the following:

Manhole I.D. (inches)	48	60	72	84	96	120
Seconds	60	75	90	105	120	150

7. If manhole fails test, remove head assembly, coat interior with a soap and water solution, and repeat vacuum test for approximately 30 seconds. Leaking areas will have soapy bubbles. Make necessary repairs to the satisfaction of Engineer and repeat test until manhole passes.

END OF SECTION

SECTION 02532

SANITARY SEWER PIPE LINER SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes, but is not limited to, liner system for sanitary sewer pipe.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02530 Sanitary Sewer System

1.03 REFERENCES

A. Publications are referred to in the text by basic designation only.
   1. American Society for Testing and Materials (ASTM)
      a. B117 Operating Salt Spray (Fog) Apparatus
      b. C2794 Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
      c. D714 Evaluating Degree of Blistering of Paints
      d. D4060 Abrasion Resistance of Organic Coatings by the Taber Abraser
      e. D4541 Pull-Off Strength of Coatings Using Portable Adhesion Testers
      f. D4258 Surface Cleaning Concrete for Coating
      g. D4259 Abrading Concrete
      h. E96 Water Vapor Transmission of Materials
      i. G95 Cathodic Disbondment Test of Pipeline Coatings

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that tests set forth in each applicable referenced publication have been performed and that test requirements have been met. Submit for each of the following materials:
      a. Protecto 401 Ductile Iron Pipe Liner
   2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
      a. Protecto 401 Ductile Iron Pipe Liner

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide a suitable pipe hook or rope sling when handling the pipe with a crane. Lifting of the pipe shall be done in a vertical plane. Under no conditions shall the sling be allowed to pass through the pipe or fittings with liner.

B. Deliver pipe with liner in the field as near as practicable to the place where it is to be installed. Distribute pipe along the side of the trench opposite to the spoil bank. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe or coating.

C. Any damage which does occur shall be repaired prior to the installation of the pipe in accordance with the manufacturer's recommendations, so the repair area is equal to the undamaged lining in all respects.

PART 2 PRODUCTS

2.01 PROTECTO 401 DUCTILE IRON PIPE LINER

A. Pipe Condition
   1. All ductile iron pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface.
   2. The intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

B. General
   1. The interior wall of ductile iron sewer pipe shall be protected by the Protecto 401 Ceramic Epoxy liner as indicated in Section 02530, Sanitary Sewer System.
   2. The lining shall meet the manufacturer's recommendations and the following requirements as a minimum.
   3. The liner manufacturer shall have a minimum of ten (10) years of successful experience and be able to demonstrate successful performance on comparable projects.

C. Lining Material
   1. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment.
   2. Permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
   3. The following tests must be run on coupons from factory lined ductile iron pipe:
      a. ASTM B-117 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two years.
      b. ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5mm undercutting after 30 days.
      c. Immersion testing rated on using ASTM D-714-87.
         1) 20% Sulfuric Acid – No effect after two years.
         2) 140°F 25% Sodium Hydroxide – No affect after two years.
         3) 160°F Distilled Water – No effect after two years.
         4) 120°F Tap Water (scribed panel) – 0.0 undercutting after two years with no effect.
      d. An abrasion resistance of no more than 3 mils (0.075mm) loss after one million cycles using European Standard EN 598: 1994 section 7.8 Abrasion resistance.

PART 3 EXECUTION

3.01 GENERAL

A. The lining compound shall be applied by a competent firm with a five (5) year history of lining ductile iron sewer pipe.

1. The workmen employed by the applicator shall be experienced and competent in the application and inspection of the lining compound to be applied.
2. The firm shall be financially responsible, having a net worth of at least the amount of the contract.

3.02 PROTECTO 401 DUCTILE IRON PIPE LINER

A. Application
1. The entire surface shall be inspected prior to receiving protective compound to ensure that no oil, grease, etc. exists on the surface. If any surface contains any of these items shall be solvent cleaned to remove said substances.
2. Once free of any oil, grease, etc., all surfaces shall be abrasive blasted using sand or grit abrasive media. No rust shall be present on surface at the time of application.
3. After surface preparation, and within 12 hours of surface preparation, the pipe interior shall receive 40 mils nominal dry film thickness of Protecto 401.
4. No lining shall take place when the substrate or ambient temperature is below 40°F.
5. The surface must be dry and dust free during application.
6. Bell Sockets and Spigot Ends shall be coated with 6 mils nominal, 10 mils maximum with Protecto Joint Compound 6 inches back from the end of the spigot end.
7. The joint compound shall be applied by brush to ensure full coverage.
8. No excessive buildup shall be present in the gasket seat or on the spigot ends.
9. Coating of the gasket seat and spigot ends shall be done after the application of the lining.
10. The number of coats shall be as recommended by the lining manufacturer.
11. No material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.
12. Provide touch up, as necessary, using Protecto Joint Compound per manufacturer's recommendations.

B. Inspection and Certification
1. A magnetic film thickness gauge shall be used to confirm the thickness on all ductile iron pipe and fittings. Thickness testing shall be done in accordance with SSPC-PA-2 Film Thickness Rating.
2. The interior lining shall be tested using a non-destructive 2,500 volt test to check for pinholes. Repair defects prior to shipment.
3. Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work. These records shall be made available to the Engineer upon request.
4. The pipe/fitting manufacturer shall provide a certificate attesting that the applicator meets the requirements of this specification, and that the material used was as specified and applied as specified.

END OF SECTION

SECTION 02606

PRECAST CONCRETE WATER STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Rectangular, monolithic, or sectional precast water and wastewater structures, pipe connectors, and accessories.

1.02 RELATED SECTIONS

A. Section 02300 – Earthwork.

B. Section 02315 – Trenching for Utilities.

1.03 REFERENCES

A. Prestressed Concrete Institute: Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

B. National Precast Concrete Association: Quality Control Manual for Precast Concrete Plants.

C. American Society for Testing and Materials (ASTM):
   a. C858 Standard Specification for Underground Precast Utility Structures
   b. C890 Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
   c. C891 Standard Practice for Installation of Underground Precast Concrete Utility Structures.
   d. C923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
   e. C913 Standard Specifications for Precast Concrete Water and Wastewater Structures.

D. American Association of State Highway and Transportation Officials: Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets (AASHTO M198).

E. American Concrete Institute: Building Code Requirements for Reinforced Concrete (ACI 318).

F. Occupational Safety and Health Administration: Standard 1926.704 - Requirements for Precast Concrete.

1.04 SUBMITTALS

A. Submit in accordance with Section, Submittal Procedures:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met.
   2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate items to be furnished for the project including options to be provided.
      a. Each type of precast concrete structure.

b. Hatches.
c. Joint Materials.
d. Connectors.

3. Sealed Calculations
   a. Structural analysis and design calculations for Precast Components, performed in accordance with applicable codes and standards, showing that allowable stresses will not be exceeded when installed as shown on the Drawings. All calculations must be sealed by a Professional Engineer registered in the State of North Carolina employed by the Precast Concrete Manufacturer.

1.05 QUALIFICATIONS

A. The Precast Manufacturer shall be a NCDOT approved manufacturer of Precast Concrete Structures and have a minimum of 5 years experience in manufacturing the required components.

B. The Precast Manufacturer shall have a recognized Quality Improvement Process installed at the manufacturing facility.

C. The Precast Manufacturer shall employ at least one Registered Professional Engineer at the manufacturing facility through the life of the project.

D. Concrete compressive strength testing shall be performed in a laboratory inspected by the CCRL of the National Bureau of Standards. Testing shall be performed by Grade I ACI Certified Laboratory Technicians or by Level I PCI Certified Technicians.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete shall conform to ASTM C858 and C913 as applicable and as follows:
   1. Compressive strength: 5000 psi minimum at 28 days.
   2. Air Content: 4 percent minimum.
   3. Cementitious Materials: Minimum of 564 pounds per c.y.
   4. Coarse Aggregates: ASTM C33. Sound, Crushed, Angular Granitic Stone only. Smooth or rounded stone shall not be used.
   5. Fine Aggregates: ASTM C33. Free from organic impurities.
   6. Chemical Admixtures: ASTM C494. Calcium Chloride or admixtures containing calcium chloride shall not be used.
   7. Air Entraining Admixtures: ASTM C260.

B. Reinforcing steel shall be ASTM A615 grade 60 deformed bar, ASTM A82 wire or ASTM A185 welded wire fabric.

C. Lift loops shall be ASTM A416 steel strand. Lifting loops made from deformed bars are not allowed.

D. Butyl Rubber Sealant shall conform to Federal Specification SS-S-210A, AASHTO M-198, Type B - Butyl Rubber and as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100 degrees F.

E. Butyl Rubber with Bentonite Sealant shall contain 99% solids with a maximum of 1% volatile matter and suitable for application temperatures between 5 and 125 degrees F.

F. Epoxy Gels used for interior patching of wall penetrations shall be a 2-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive meeting ASTM C-881, Type I and II, Grade 3, Class B and C, Epoxy Resin Adhesive.

2.02 COMPONENTS

A. Precast Component Fabrication and Manufacture shall be as described in this paragraph and as described in the paragraphs for the specific components.
   1. Precast concrete structure shall be watertight.
   2. Precast Manufacturing shall be in conformance with ASTM C858 or C913 as applicable. Wall and inside slab finishes resulting from casting against forms standard for the industry shall be acceptable, except form ties through the wall of the product are not allowed. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks, and minor depressions, chips and spalls will be tolerated. Dimensional tolerances shall be those set forth in the appropriate References and as specified below.
   3. Joint surfaces on joints between Precast Structure Components shall be keyways or tongue and grooves manufactured to the joint surface design and tolerance requirements of ASTM C858 or C913 as applicable.
   4. Lift Inserts and Holes shall be sized for a precision fit with the lift devices, shall conform to OSHA Standard 1926.704, and shall not penetrate through the precast structure wall.
   5. The structural design of Precast Components shall be in accordance with applicable codes and standards listed in Article 1.05 of this Specification Section. No less than 80 psf per foot of depth of Equivalent Fluid Pressure should be used for lateral earth design loads plus the lateral surcharge design loads possible from HS-20 Traffic. Vertical design loads shall include structure dead loads, earth loads, hydrostatic loads, and traffic live loads where applicable with no less than 300 psf live load. The empty and liquid full container conditions shall both be considered.

B. Precast Base Sections shall be cast monolithically without construction joints, or with an approved galvanized or PVC waterstop cast in the cold joint between the base slab and the walls. Where shown on the Project Plans, Base Section Slab Extensions shall be provided on the short sides of the section. The width of the extensions shall be the slab thickness unless shown differently.

C. The Minimum Lay Length of Precast Riser Sections shall be 36 inches.

D. Precast Top Sections shall be cast monolithically without construction joints, or with an approved PVC waterstop cast in the cold joint between the base slab and the walls. Joints cast on top sections for round manhole Transition Assemblies shall have ASTM C361 joint surfaces.

E. Pipe to Precast Structure Connectors shall conform to ASTM C923.

F. Joints between Precast Components shall be sealed with a polyethylene backed flat butyl rubber sheet no less than 1/16 inch thick and 6 inch wide applied to the outside perimeter of the joint. Joints shall also be sealed internally with a sealant having a cross-sectional area no less than the joint annular space times the joint height as follows:
   1. Butyl Rubber Sealant in joints with perimeters less than 18 feet.
   2. Bentonite impregnated Butyl Rubber Sealant in all other joints.

G. Access Hatch
   1. Provide access hatches in conformance to the following requirements:
      a. Size as indicated on the Drawings. The size on the Drawings is for the required minimum clear opening. Unless specifically indicated on the Drawings the doors can be single or double door as required for opening size.
      b. Frame shall be aluminum extrusion and aluminum checkered tread plate for the door(s). Frame shall be equipped with necessary anchors for setting in concrete. Hinges, nuts, bolts, and washers shall be stainless steel and tamper proof from outside.
      c. Design and construct hatches for a minimum 300 lb. live load unless an H20 load is indicated on the Drawings.
      d. Provide the following:
         1) Bituminous coating at locations, which will have contact with concrete.
         2) Waterproof hatch where indicated on the Drawings.
         3) Positive open door latch.
         4) Retractable lifting handle.
         5) Double doors shall be interlocked.
         6) Padlocking provision. Provide lock for each hatch and keyed alike for multiple hatches.
         7) Provide a stainless steel interior automatic slam lock with an interior operating handle. The lock shall be operated from the outside by a removable handle key.
         8) Provide doors requiring greater then a 50 lb lift with a stainless steel spring assist.
      e. Hatches shall be of one manufacturer.

H. Lifting Devices for handling Precast Components shall be provided by the Precast Manufacturer and shall comply with OSHA Standard 1926.704.

I. Coatings: Where shown on the Plans, the interior/exterior of the Precast Structure wall shall be coated with 21 mils of Coal Tar Epoxy, Kop-Coat Bitumastic No. 300-M or equal. The coating shall be spray applied according to the manufacturer's recommendations by an applicator with a minimum of 5 years experience.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect Precast Components prior to unloading from the delivery truck.

3.02 PREPARATION

A. Product Delivery, Storage, and Handling: Coordinate delivery with the manufacturer, handle and store the Precast Components in accordance with ASTM C891 and the manufacturer's recommendations using methods that will prevent damage to the components and their joint surfaces.

3.03 PLACING PRECAST CONCRETE SECTIONS

A. Excavate to the required depth and remove materials that are unstable or unsuitable for a good foundation. Prepare a level, compacted foundation extending 6" beyond the precast base and follow ASTM C891 excavation standards.

B. Set base plumb and level, aligning pipe opening with pipe invert.

C. Thoroughly clean joint tongue and grooves to remove dirt and other foreign materials that may prevent sealing. Unroll the Butyl Sealant rope directly against bottom groove. Leave protective wrapper attached until sealant is entirely unrolled against groove. Do not stretch. Overlap from side to side not top to bottom.

D. Set risers and tops, aligning internal wall surfaces, so that proper alignment is achieved, taking particular care to clean, prepare and seal joints.

E. When recommended by the manufacturer, fill the void between horizontal joint surfaces with a sand cement grout around the outside perimeter as risers are set.

F. After joining precast sections, apply the butyl sealant sheet around the outside perimeter of the joints below grade.

G. Secure Pipe Connectors to Pipe according to the Connector Manufacturer Instructions. When pipe stub outs are installed, provide restraint from longitudinal movement before backfill.

H. Lift Holes leaving less than 2" of wall thickness shall be plugged from the outside using a sand cement mortar and then covered with butyl sealant sheet. Lift Holes penetrating the wall shall be additionally sealed with an interior application of an epoxy gel 1/8" thick extending 2" beyond the penetration.

I. Test structure after installation in accordance with ACI 350.IR "Testing Reinforced Concrete Structures for Water-tightness." Plug pipe connections and fill tanks to the overflow elevation. There shall be no loss of water over a 24 hour period. If test fails, a second test shall be run for an additional 24 hours. If the test fails a second time, Contractor shall coat interior of tank with NSF approved water proofing compound. The tank shall be retested and the process repeated until the tank passes the test. A report of the test process and results shall be signed by Contractor and submitted to Owner.

J. Perform the final finishing to the Structure interior by filling all chips or fractures greater than 1/2" in length, width or depth and depressions more than 1/2" deep in inverts with a sand cement mortar. Clean the interior of the Structure, removing all dirt, spills or other foreign matter.

END OF SECTION

SECTION 02630

STORM DRAINAGE SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes, but is not limited to, piping and appurtenances for a complete storm drainage system.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Trenching for Utilities

1.03 REFERENCES

A. Publications are referred to in the text by basic designation only.
   1. American Society for Testing and Materials (ASTM)
      a. A126 (latest)
      b. C361 (latest)
      c. C76 Reinforced Concrete Culverts, Storm Drain and Sewer Pipe (latest)
      d. C443 Flexible Watertight Joints for Circular Concrete Pipe and Precast Manhole Sections (latest)
      e. C478 Precast Reinforced Concrete Manhole Sections (latest)
      f. C858 Underground Precast Concrete Utility Structures (latest)
      g. C890 Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures (latest)
      h. C913 Precast Concrete Water and Wastewater Structures (latest)
      i. C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (latest)
      j. C990 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (latest)
      k. D1248 Polyethylene Plastics Molding and Extrusion Materials (latest)
   2. American Association of State Highway and Transportation Officials (AASHTO)
      a. M 170 Standard Specifications for Reinforced Concrete Culverts, Storm Drain, and Sewer Pipe (latest)
   3. UNI-BELL Plastic Pipe Association (UNI)
      a. B-6 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe (latest)
   4. NCDOT Standard Specifications for Roadway and Structure and Standard Details.

1.04 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met. Submit for each of the following materials:
      a. Pipe
         1) Reinforced Concrete Pipe

2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
    a. Pipe
        1) Reinforced Concrete Pipe
3. Reports:
    a. Field test report for each section of pipe for the following:
        1) Low-pressure air test for storm drain piping.
4. Calculations:
    a. Provide calculations/certifications sealed by a North Carolina Professional Engineer as specified herein or on the Drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide a suitable pipe hook or rope sling when handling the pipe with a crane. Lifting of the pipe shall be done in a vertical plane. Under no conditions shall the sling be allowed to pass through the pipe unless adequate measures are taken to prevent damage to both tongue and groove ends.

B. Deliver pipe in the field as near as practicable to the place where it is to be installed. Distribute pipe along the side of the trench opposite to the spoil bank. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe or coating.

C. Shield PVC pipe and fittings stored on site from the sun's ultraviolet rays by suitable cover, or indoor storage.

PART 2 PRODUCTS

2.01 REINFORCED CONCRETE PIPE

A. Pipe shall conform to the following requirements:
    1. Size shall be as indicated on the Drawings.
    2. Suitable for pressures as specified ASTM C76

B. Reinforced Concrete Pipe shall conform to ASTM C76, AASHTO M170, and to the following requirements:
    1. Pipe lengths shall be not less than 8 feet.
    2. Pipe shall be Class III minimum per ASTM C76.
    3. Pipe shall be designed for a Type 2 laying condition at the depth of cover indicated on the Drawings.
    4. Joints shall have O-ring rubber gaskets in accordance with ASTM C443.
    5. Storm Sewer Mains:
        a. Joint shall be modified tongue and groove.
        b. Use flexible plastic joint material

C. Concrete Flared End Sections shall meet all applicable requirements of ASTM C76. Concrete Flared End Sections shall be reinforced.

PART 3 EXECUTION

3.01 GENERAL

A. Pipe installation shall meet the following general guidelines:
    1. Lay pipe in the presence of Engineer, unless specifically approved otherwise.

2. Handle pipe and accessories in accordance with manufacturer's recommendations.
3. Carefully inspect pipe immediately prior to laying. Do not use defective pipe. Replace pipe damaged during construction.
4. Lay pipe to grade and alignment indicated on the Drawings.
5. Provide proper equipment for lowering pipe into trench.
6. Provide tight closure pipe ends when work is not in progress.
7. Keep pipe interior free of foreign materials.
8. Do not lay pipe in water or when the trench or weather conditions are unsuitable for the work.
9. Clean bell and spigots before joining. Make joints and lubricate gasket in accordance with pipe manufacturer recommendation.
10. Provide pneumatic plug at each entrance into the new storm drain system and maintain plugged until the project is complete.

B. Storm Drainage Pipe: Gravity pipe installation shall meet the following general guidelines:
1. Lay pipe upgrade from the lower end and at the grades and alignment indicated on the Drawings.
2. Lay storm drainage pipe to true lines and grades by use laser beam equipment or other acceptable means.

3.02 TESTING

A. General
1. Clean and flush pipe system of foreign matter prior to testing.
2. Notify Owner and Engineer a minimum of 48 hours prior to testing.
3. Perform tests in the presence of Engineer.
4. Length of line to be tested at one time shall be subject to approval of Engineer.
5. Pipe sections shall not be accepted and placed into service until specified test limits have been met.
6. Repair defects in the pipe system. Make repairs to the same standard as specified for the pipe system.
7. Retest repaired sections until acceptance.
8. Repair visible leaks regardless of the test results.

B. Storm Drainage
1. Test gravity lines between manholes or junction boxes.
2. Light Testing: Mains will be checked by Engineer for displacement after the trench has been filled to two feet above the pipe and tamped as specified, and upon completion of the project. Test will be as follows:
   a. A light will be flashed between the ends of the pipe section being tested.
   b. If the illuminated interior shows any misalignment, or other defects as designated by Engineer, defects shall be repaired.
3. General
   a. Infiltration shall not exceed 100 gallons per inch of diameter, per mile of pipe, per 24 hours. Engineer may require flow measurement for verification of infiltration.
   b. Verify that maximum infiltration rate shall not be surpassed by air testing as follows.
4. Low Pressure Air Test:
   a. Air testing of sewer mains shall conform to UNI-B-6 and the following requirements:

b. Perform initial air test when each section of main is complete, but prior to installation of service wyes. Test as construction proceeds.
c. Wet interior surfaces of porous pipe material prior to testing.
d. Safety
    1) Provide a superintendent who has experience in low-pressure air testing of gravity sewer mains.
    2) Follow safety recommendations of air testing equipment manufacturer.
    3) Properly brace sewer plugs during testing. Test plugs prior to use in air testing.
    4) No one shall be allowed in manhole or trench when pipe is under pressure.
    5) Pressurizing equipment shall include a regulator and a pressure relief valve, which are set no higher than 9 psig. Monitor gauges continuously to assure that the pressure does not exceed 9 psig.
e. Equipment
    1) Sewer plugs shall be specifically designed for low pressure air testing.
    2) Use two separate air hoses.
        i) One to connect the control panel to the sealed line for introducing the air.
        ii) One from the sealed line to the control panel to provide constant monitoring of the air pressure in the line.
        iii) If Pneumatic plugs are used a separate line shall be used to inflate the plugs.
    3) As a minimum the above ground air testing equipment shall include a shutoff valve, pressure regulating valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psig.
    4) Continuous monitoring pressure gauge shall be at least 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of +/- 0.04 psi.
    5) Monitoring gauges shall be subject to calibration as deemed necessary.
    6) Air used for testing shall pass through a single above ground control panel.
f. Testing
    1) Groundwater Determination: Immediately prior to each air test, determine groundwater level by a method acceptable to the Engineer. Adjust pressure used in air test in accordance with groundwater level.
    2) Apply air slowly to the test section until the pressure reached is 4.0 psi plus an adjustment of 0.433 psi for each foot of ground water above the crown of the pipe. Internal air pressure, including adjustment for ground water, should never exceed 9.0 psi.
    3) When the above-required pressure is reached, throttle air supply to maintain internal pressure for at least two minutes to permit stabilization.
    4) When pressure has stabilized at required pressure, shut off air supply.
    5) While observing the continuous monitoring pressure gauge, decrease pressure approximately 0.5 psi from required pressure.
    6) At this reading timing shall commence with a stopwatch and allowed to run until pressure has dropped 1.0 psi or allowable time has lapsed. Line shall be "Acceptable" if the pressure drop does not exceed 1 psig

in the time prescribed for the test in Table 1, Low Pressure Air Testing for Gravity Sewer Mains, at the end of this section.

END OF SECTION

SECTION 02700

PAVEMENT AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE

A. Provide pavement, curb and gutter, and sidewalk sections as indicated on the Drawings and specified herein. Construction shall conform with the lines, grades, thickness, and typical cross-section indicated on the Drawings.

B. Provide for the milling of the existing pavement, if necessary.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02300 Earthwork

1.03 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. N.C. Department of Transportation – Standard Specifications for Roads and Structures (NCDOT).

B. Paragraphs in the NCDOT standard regarding measurement and payment do not apply to this Project.

1.04 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Certificates of Compliance: Certificates shall attest that supplied products conform to the referenced standard and this specification, that all tests set forth in each applicable referenced publication have been performed, and that all test requirements have been met. Submit for each of the following materials:
      a. Asphalt Concrete
      b. Aggregate Base Course
      c. Pavement Marking Material

1.05 PROTECTION OF EXISTING PAVEMENT, CURB AND GUTTER, AND SIDEWALK

A. Existing pavement, curb and gutter, and sidewalks at the site are in good condition. Contractor, Owner, and Engineer shall inspect the entire site prior to the start of construction and mark existing damaged areas and note areas on Contractor's plan set to be used for the Record Drawings.

B. Protect existing pavement, curb and gutter, and sidewalks during construction.

C. Remove areas of existing curb and gutter, and sidewalks damaged during construction. Removal shall include to the nearest existing joint. Replace damaged areas with new curb and gutter, and sidewalks to match the existing section.

D. Remove areas of existing pavement damaged during construction. New pavement patch shall consist of re-stabilizing the subgrade, and providing 8 inches of ABC and 2 inches of SF9.5A asphalt to match existing pavement surface.

E. Repair damage to existing pavement, curb and gutter, and sidewalks.

PART 2 PRODUCTS

2.01 MATERIALS AND MIXES

A. Aggregate Base Course: Stone meeting the requirements under Section 520, pages 5-10 through 5-15 and Section 1010, pages 10-30 through 10-40.

B. Asphalt Concrete Surface Course - Type S-9.5B: Conforming to materials and composition required in NCDOT Section 610, Asphalt Concrete Plant Mix Pavements, pages 6-27 through 6-51.

C. Concrete for Curb and Gutter, and Sidewalks: Conforming to materials and composition required in NCDOT Section 846, Concrete Curb, Curb and Gutter, Concrete Gutter, Shoulder Berm Gutter, Concrete Expressway Gutter, Concrete Valley Gutter and Concrete Flumes, and Section 848, Concrete Sidewalks and Driveways and Wheelchair Ramps.

D. Pavement Markings and Symbols: Conforming to materials and composition required in NCDOT Section 1205, Pavement Marking General Requirements.

PART 3 EXECUTION

3.01 PREPARATION OF SUBGRADE

A. Refer to applicable portions of Section, Earthwork.

B. Compaction shall be to at least 95 percent maximum density Standard Proctor Method.

C. Remove unsuitable material to a depth of one foot and replace with an approved material. Loosen exceptionally hard spots and re-compact. Finish subgrade to provide uniform bearing surface.

D. Maintain subgrade in satisfactory condition and properly drain until surface courses are placed.

E. Preparation, shaping, and compaction shall be in accordance with NCDOT Section 500, Fine Grading Subgrade, Shoulders, and Ditches.

3.02 MILLING ASPHALT PAVEMENT

A. Milling of existing asphalt pavement shall be in accordance with applicable paragraphs of NC DOT Section 612.

B. Milled asphalt shall be properly disposed by the Contractor.

C. Minimize heavy construction equipment traffic within areas of reduced pavement sections .

3.03 AGGREGATE BASE COURSE

A. This applies to both the aggregate base course as indicated on the Drawings for paved and unpaved roads.

B. The stone base shall be constructed in accordance with the applicable paragraphs of NCDOT Section 520.

C. Compacted base shall be of the thickness indicated on the Drawings.

D. The base course stone shall be compacted to ate least 100 percent of the maximum dry density as determined by the modified Proctor compaction test, AASHTO T-180 as modified by NCDOT.

3.04 ASPHALT CONCRETE SURFACE COURSE

A. Spreading, compaction, and finishing shall comply with the requirements of NCDOT Section 610 Asphalt Concrete Plant Mix Pavements.

B. The asphalt concrete surface course shall be placed in tow lifts. Compacted thickness shall be as indicated on the drawings.

3.05 TACK COAT

A. Application rates, method of application, and curing shall be in accordance with the requirements of NCDOT Section 605.

3.06 CONCRETE CURB & GUTTER

A. Provide concrete curb and gutter where indicated on the Drawings. Curb and Gutter shall conform to the section indicated on the Drawings.

B. Construct Curb and Gutter in accordance with NCDOT Section 846.

3.07 CONCRETE DITCHES

A. Provide concrete ditches where indicated on the Drawings. Cross section shall be as indicated on the Drawings.

B. Construct ditches in accordance with NCDOT Section 850, Concrete Paved Ditch.

3.08 CONCRETE SIDEWALKS

A. Provide concrete sidewalks where indicated on the Drawings. Construction shall be in conformity with the materials, lines, grades, thickness, and typical section as indicated on the Drawings.

B. Construct sidewalks in accordance with NCDOT, Section 848, and the following specifications.

C. Space contraction joints equal to the width.

D. Place a 1/2 inch wide expansion joint at all intersections and wherever walks abut structures and other walks.

E. Place additional expansion joints at each fifth contraction joint.

F. Walks shall receive a light broom finish.

3.09 PAVEMENT MARKINGS AND SYMBOLS

A. Mark parking spaces in paved areas with 4 inch white paint stripe the length of the parking space.

B. Stripe roads maintained by the NCDOT or the local municipality in accordance with the agency requirements.

C. Provide painted pavement symbols as indicated on the Drawings.

END OF SECTION

SECTION 02820

FENCING
(CHAIN LINK)

PART 1 GENERAL

1.01 SCOPE

A. Provide chain link fencing where indicated on the Drawings and specified herein.

B. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational system:
   1. Clearing as necessary for installation of fence.
   2. Fence post, frame, and concrete foundation.
   3. Chain link fabric and barbed wire.
   4. Gates.

1.02 SYSTEM DESCRIPTION

A. Fencing Location
   1. Function: Perimeter security.
   2. Fence Height: 6'-0" fabric height and 1'-0" barbed wire height.
   3. Provide posts, bottom intermediate and top rails as indicated. Provide corner and brace assemblies.
   4. Provide fabric gauges as indicated and install fabric on outside of fence and anchor to framework such that fabric remains in tension after pulling force is released.

1.03 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
      a. Individual components of the fencing system.
   2. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Layout drawing showing spacing of posts and location of gate, corner, end, and pull posts.
   3. Manufacturer's Installation Procedures.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Engage an installer who has at least three years' experience and has completed at least five chain link fence projects with the same material and of similar scope to that indicated for this project with a successful construction record of in-service performance.

PART 2 PRODUCTS

2.01 FABRIC

A. Selvage: Fabric shall be twisted and barbed at both selvages. Both selvages of meshes less than 2 inches shall be knuckled. Bottom tension wire shall be 7 gauge and shall terminate at posts.

B. Galvanized Steel Chain-Link Fence Fabric: Fabricated in one-piece widths for fencing 12 feet and less in height to comply with Chain Link Fence Manufactures Institute (CLFMI) "Product Manual" and with requirements indicated below:
   1. Mesh and Wire Size: 2-inch mesh, 0.148-inch diameter (9 gauge-coated size).
   2. Coating: ASTM A 392-74, Class 2, galvanized.

2.02 FRAMING

A. Round member sizes are given in actual outside diameter (OD) to the nearest thousandth of inches. Round fence posts are often referred to in ASTM standard specifications by Nominal pipe sizes (NPS) or the equivalent trade sized inches. The following indicates these equivalents all measured in inches:

Actual OD Size (in)	NPS Size	Trade
1.660	1 1/4	1 5/8
1.900	1 1/2	2
2.375	2	2 1/2
2.875	2 1/2	3
4.000	3 1/2	4

B. Type I Round Posts: Standard weight (schedule 40) galvanized-steel pipe conforming to ASTMF 1083, according to heavy industrial requirements of ASTM F 669. Group IA, with minimum yield strength of 25,000 psi, not less than 1.8 oz. of zinc per square foot. Type coating inside and outside according to ASTM F 1234, as determined by ASTM A 90, and weights per foot as follows:

Actual OD Size (in)	Weight (lb/ft)	NPS Size
1.660	2.27	1-1/4
1.900	2.72	1-1/2
2.375	3.65	2
2.875	5.79	2 1/2
4.000	9.11	3 1/2

C. Top Rail: Manufacturer's longest lengths (21 feet) with expansion-type coupling, approximately 6 inches long for joining. Provide rail ends of other means for attaching top rail securely to each gate, corner, pull, and end post.
   1. Round Steel: 1.660-inch OD Type.

D. Steel posts for fabric heights up to 6 feet:
   1. Round Line or Intermediate Posts: 2.375-inch OD Type I steel pipe.
   2. Round End, Corner, and Pull Posts: 2.875-inch OD Type I steel pipe.

E. Steel posts for fabric heights over 6 feet:
   1. Round Line or Intermediate Posts: 2.375-inch OD Type I steel pipe.
   2. Round End, Corner, and Pull Posts: 2.875-inch OD Type I steel pipe.

F. Swing Gate Posts: Furnish post to support single gate leaf, or one leaf of a double-gate installation, according to ASTM F 900, sized as follows.
   1. Steel posts for fabric height of 8 feet or less and gate leaf width:
      a. Up to and including 4 feet: 2.875-inch OD pipe weighing at least 5.79 lb per feet.
      b. Over 4 to 10 feet: 4.000-inch OD pipe weighing at least 9.11 lb per ft.

2.03 FITTINGS AND ACCESSORIES

A. Material: Comply with ASTM F 626. Galvanized iron or steel to suit manufacturer's standards.
   1. Steel and Iron: Unless specified otherwise, hot-dip galvanize steel or cast-iron fence fittings and accessories with at least 1.2 oz. Zinc per sq. ft. as determined by ASTM A 90.

B. Post and Line Caps: Provide weather-tight closure cap for each post. Provide line post caps with loop to receive top rail.

C. Post Brace Assembly: Manufacturer's standard adjustable brace. Use material specified below for brace, and truss to line posts with 3/8-inch-diameter rod and adjustable tightener. Provide manufacturer's standard galvanized-steel, cast iron or cast-aluminum cap for each end.
   1. Round Steel: 1.6600-inch OD Type I steel pipe.

D. Bottom and Center Rail: (Where indicated on drawings). Same material as top rail unless indicated otherwise. Provide manufacturer's standard galvanized-steel, cast-iron or cast-aluminum cap for each end.

E. Tension or Stretcher Bars: Hot-dip galvanized steel with a minimum length 2 inches less than the full height of fabric, a minimum cross section of 3/16 inch by 3/4, and a minimum of 1.2 oz of zinc coating per sq. ft. Provide one bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into the post.

F. Tension and Brace Bands: 3/4 –inch-wide minimum hot-dip galvanized steel with a minimum of 1.2 oz. of Zinc coating per sq. ft.
   1. Tension Bands: 0.074-inch thick (14 gauge) minimum.
   2. Brace Bands: 0.105 inch thick (gauge) minimum

G. Tension Wire: 0.177-inch-diameter metallic-coated steel marcelled tension wire conforming to ASTM A 824 with finish to match fabric.
   1. Coating Type II zinc in the following class as determined by ASTM A 90.
      a. Class 2, with a minimum coating weight of 1.20 oz. per sq. ft. of uncoated wire surface.

H. Tie Wire: (9-gauge) aluminum wire alloy 1350-H19 or equal.

2.04 BARB WIRE

A. Provide three lines of 4 point pattern barbed wire. Barb wire shall be double strand 12-1/2 gauge twisted wire with 14 gauge, 4 point round aluminum barbs spaced on approximately 5 inch centers conforming to the requirements of ASTM A121. Extension arms to accommodate barbwire shall withstand a 250-pound pulldown load from end of arm and have a 3-inch apron around post. The top most barbed wire shall be approximately 18 inch above the fabric and approximately 18 inch out from fence line. Barbed wire shall be securely fastened in slots by heavy wire pins. Arms having projections to bend down over barbed wire will not be acceptable.

2.05 CONCRETE

A. Concrete: Provide concrete consisting of Portland cement per ASTM C150, aggregates per ASTM C 33, and potable water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 3000 psi. Use at least four sacks of cement per cu. yd., 1-inch maximum size aggregate, 3-inch maximum slump.

B. Package Concrete Mix: Mix dry-packaged normal-weight concrete conforming to ASTM C 387 with clean water to obtain a 2- to 3- slump.

2.06 GATES

A. General: Fabricate perimeter frames of gates from same material and finish as fence framework. Assemble gate frames by welding. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware, and accessories. Space frame members a maximum of 8 feet apart unless otherwise indicated.
   1. Fabric: Same as for fence unless otherwise indicated. Secure fabric at vertical edges with tension bars and bands and to top and bottom of frame with tie wires.
   2. Bracing: Install an adjustable truss rod diagonally on gates six foot wide and greater to prevent sagging.

B. Swing Gates: Comply with ASTM F 900.
   1. Framework: Fabricate using 1.660-inch minimum OD Type I steel pipe or 1-inch-square galvanized steel tubing weighing 1.84 lb per sq. ft.
   2. Gate Hardware: Provide galvanized hardware and accessories for each gate according to the following:
      a. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180 degree gate opening. Provide 1-1/2 pair of hinges for each leaf over 6-foot nominal height.
      b. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as an integral part of latch.
      c. Keeper: Provide a keeper for vehicle gates that automatically engages gate leaf and holds it in the open position until manually released.
      d. Gate stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete, and designed to engage a center drop rod or plunger bar. Include a locking device and padlock eyes as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install fence to comply with ASTM F 567. Do not begin installation and erection before final grading is completed, unless otherwise permitted.

B. Excavation: Drill or hand-excavate (using post-hole digger) holes for posts to diameter and spacings indicated, in firm, undisturbed or compacted soil.
   1. If not indicated on Drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than four times the largest cross section of post.
   2. Unless otherwise indicated, excavate hole depths approximately 3 inches lower than post bottom, with bottom of posts set not less than 36 inches below finish grade surface.

C. Setting Posts: Center and align posts in holes 3 inches above bottom of excavation. Space a maximum of 10 feet o.c., unless otherwise indicated.
   1. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and hold in position during placement and finishing operations.
      a. Crown concrete footings at top to shed water.

D. Top Rails: Run rail continuously through line post caps, bending to radius for curved runs and at other posts terminating into rail end attached to posts or post caps fabricated to receive rail. Provide expansion couplings as recommended by fencing manufacturer.

E. Center Rails: Install center rails in one piece between posts and flush with post on fabric side, using rail ends and special offset fittings where indicated.

F. Brace Assemblies: Install braces at end and gateposts and at both sides of corner and pull posts. Locate horizontal braces at midheight of fabric. Install so posts are plumb when diagonal rod is under proper tension.

G. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric before stretching fabric and tie to each post with not less than same gage and type of wire. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter (11-gage) hog rings of same material and finish as fabric wire, spaced a maximum or 24 inches o.c.

H. Fabric: Pull fabric taut and tie to post, rails, and tension wires.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and Gateposts with tension bands spaced not over 15 inches o.c.

J. Tie Wires: Use wire of proper length to secure fabric firmly to posts and rails. Bend ends of wire to minimize hazard to persons or clothing.
   1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to rails and braces 24 inches o.c.

K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

L. Netting Ties: Fasten safety netting to tension cable and fence top rail with cable ties at 12" o.c.

M. Barbed Wire: Install three parallel wires on each extension arm on security side of fence, unless otherwise indicated. Pull wires taut.

N. Gates: Install gates plumb, level and secure for full opening without interference. Install ground set items in concrete for anchorage as recommended by the manufacturer.

END OF SECTION

SECTION 02831

CANTILEVER SLIDE GATE
(CHAIN LINK, ELECTRICALLY OPERATED)

PART 1 GENERAL

1.01 SCOPE

A. Provide complete electrically operated chain link cantilever slide gate with enclosed aluminum track and hardware as indicated on the Drawings and specified herein.

B. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational system:
   1. One (1) cantilever slide gate.
   2. Electric motor.
      a. Horsepower: 1 Hp
      b. Power: 220 V, 3 phase, 60 cycle
   3. Card reader controlled access and telephone communications for visitor access.
   4. Automatic vehicle exit gate opener.
   5. Safety features:
      a. Time delay for gate closure.
      b. Detector for vehicle not clearing the gate.
      c. Safety edge.
      d. Manual exit button.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02830 Fencing (Chain Link)

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:
   1. Catalog Data: Submit manufacturer's standard drawings and catalog cuts for the following. Equipment to be furnished for the Project shall be clearly indicated including options to be provided.
      a. Individual components of the gate system as specified herein.
   2. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.
      b. Mounting details indicating position of equipment with respect to each other.
      c. Electrical diagram(s) for complete operating system.
   3. Manufacturer's Installation Procedures.
      a. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the total system as supplied for the Project.
   4. Warranties:
   5. Spare Parts and Maintenance Materials: Provide a price list for one set of spare parts normally required for one-year's operation for the equipment.

1.04 QUALITY ASSURANCE

A. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.
   1. Product manufacturer shall have a minimum of five (5) years of experience.
   2. The equipment shall be as manufactured by Anchor Fence, Inc. or equal.
   3. Substitutions shall be as specified in Section 01600, Material and Equipment.

B. Gates and accessories shall be supplied by one supplier to provide one system responsibility.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Product shall be handled in accordance with Section 01600, Material and Equipment.

1.06 WARRANTY

A. Provide manufacturer's standard limited warranty covering cantilever slide gate and truck assembly against failure resulting from normal use for period of 5 years from date of purchase. Failure is defined as any defect in manufacturing that prevents the gate from operating in a normal manner.

PART 2 PRODUCTS

2.01 CHAIN LINK CANTILEVER SLIDE GATES

A. Gate frames: Fabricate chain link cantilever slide gates in accordance with ASTM F1184, Class 2, using 2-inch square aluminum members, ASTM B 221, alloy and temper 6063-T6, weighing 0.94 lb / ft. Weld members together forming rigid one-piece frame integral with top track. Provide 2 truck assemblies for each gate leaf, except as indicated for gates larger than 30 feet.

B. Internal uprights: 2-inch x 2-inch aluminum members welded in gate frames, at approximately 8 feet on center, subdividing frame into panels.

Gate leaf sizes	Cantilever Support (overhang)
20 feet	10'-0"

C. Chain link fence fabric shall be in accordance with Section 02830, Fencing (Chain Link). Install fabric with hook bolts and tension bars at all 4 sides. Attach to gate frame at not more than 15-inches on center.

D. Bracing: Provide diagonal adjustable length truss rods, of 3/8 inch galvanized steel, in each panel of gate frames.

E. Top track/rail: Enclosed, combination one-piece track and rail, aluminum extrusion with weight of 3.72 lb/ft. Track to withstand reaction load of 2,000 lb.

F. Truck assembly: Swivel type, zinc die cast, with 4 sealed lubricant ballbearing rollers, 2-inches in diameter by 9/16-inch in width, and 2 side rolling wheels to ensure truck alignment in track. Mount trucks on post brackets using 7/8-inch diameter ball bolts with 1/2-inch shank. Design truck assembly to withstand same reaction load as track.

G. Gate hangers, latches, brackets, guide assemblies, and stops: Malleable iron or steel, galvanized after fabrication. Provide positive latch with provisions for padlocking.

H. Bottom guide wheel assemblies: Each assembly shall consist of two 4-inch diameter rubber wheels, straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb and in proper alignment. Attach one assembly to each guide post.

I. Gate posts: Galvanized steel 4-inch OD schedule 40 pipe, weighing 9.1 lb/ft. Provide 1 latch post and 2 support posts for single slide gates and 4 support posts for double slide gates.

2.02 GATE OPERATOR

A. Gate operator shall be a high starting torque reversible motor. Limit switches shall be readily adjustable and securely locked in place after adjustment. 4L cogged belt, chain and sprocket motor speed reduction, with adjustable twin disc friction clutch for mechanical overload protection. Unit shall have and adjustable solenoid activated disc-type brake, and a quick disconnect for manual operation. Operator shall have open override circuitry to provide complete control of gate (from external controls) while closing. Internal timer limits run time of the unit to maximum 90 seconds in any one direction and delays reversal of gate 1.5 seconds when signaled by an open button, or safety device, to extend operator life. Operator shall have an audible warning alarm system which provides a 3 to 5 second advance warning that the gate operator is about to begin operation and will continue until the gate comes to a complete stop. Operator shall have full system capabilities so additional control systems can easily be added in the field. Housing shall be of 16-gauge painted galvanized steel. Provide power disconnect switch. Complete unit shall be UL listed.

2.03 AUTOMATIC AND SAFETY CONTROLS

A. Gate shall have the following automatic and safety controls:
   1. Entrance gate shall have a card access control unit. The unit shall be weatherproof and protected against vandalism. Unit shall be easily programmable for validating and voiding of a minimum of fifty (50) cards.
   2. Entrance gate location shall have communications through the plant phone system to allow visitor access.
   3. Vehicle and pedestrian detectors: Each gate shall have a photo electric cell to reverse the gate operator when the beam is broken by a vehicle or pedestrian crossing the path of the gate closure.
   4. Exit gate shall have a vehicle loop detector in the pavement to automatically open the gate when a vehicle is approaching to exit.
   5. Exit gate shall have a manual push-button inside the gate to allow pedestrian exit from inside the plant.

2.04 SETTING MATERIALS

A. Concrete: Minimum 28 day compressive strength of 3,000 psi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify areas to receive fencing are completed to final grades and elevations.

B. Ensure property lines and legal boundaries of work are clearly established.

3.02 CHAIN LINK GATE FRAMING INSTALLATION

A. Install gate posts in accordance with manufacturers instructions.

B. Concrete set gate posts: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter 4 times greater than outside dimension of post, and depths approximately 6-inches deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils and for posts with heavy lateral loads. Set post bottom 36-inches below surface when in firm, undisturbed soil. Place concrete around posts in continuous pour, tamp for consolidation. Trowel finish around post and slope to direct water away from posts.

C. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

3.03 GATE INSTALLATION

A. Install gates plumb, level, and secure for full opening without interference.

B. Attach hardware by means which will prevent unauthorized removal.

C. Adjust hardware for smooth operation.

3.04 START-UP SERVICES

A. Provide the services of the manufacturer's representative to check the equipment installation, supervise initial start-up, and instruct the Owner's personnel in the proper operation and maintenance of the equipment. A minimum of one separate trip to the site will be required, consisting of a minimum of one 8-hour working day.

B. Regardless of the time spent at the site, the services will not be considered complete until the system operates as intended for a minimum of one (1) week of plant operation.

C. A copy of all tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Engineer.

3.05 CLEANING

A. Clean up debris and unused material, and remove from the site.

END OF SECTION

SECTION 02920

LAWNS AND GRASSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work shall include, but not be limited to, the following:
   1. Surface preparation of subsoil.
   2. Placing topsoil.
   3. Addition of lime and fertilizer.
   4. Seeding.
   5. Maintenance to produce a permanent stand of grass.

1.02 PAYMENT PROCEDURES

A. Base bid for the work on the specified quantities of lime, fertilizer, and seed. After the specified soil tests have been made, Engineer may vary specified quantities. Should the actual quantities applied in the field vary appreciably from those specified, an adjustment in the contract price may be made.

1.03 REFERENCES

A. N.C. Department of Agriculture - NCDA

B. U.S. Department of Agriculture - USDA

1.04 PERFORMANCE REQUIREMENT

A. Grassed area shall be considered established when it presents a green appearance from eye level 50 feet away and the grass is vigorous and growing well in each square foot of seeded area. It is not required that the seeded area be thick and heavy as an old established lawn.

B. Should the permanent seed not germinate and produce a strand of grass, reseed affected areas until a permanent stand is established.

1.05 SUBMITTALS

A. Not less than 6 weeks prior to seeding, obtain representative soil samples from areas to be seeded and deliver the properly packaged samples with an information sheet for each sample properly filled out to the Soils Division of the NC Department of Agriculture or a private laboratory. Based on the test results, submit to the Engineer a recommendation as to the quantity and type of lime, fertilizer and seed for the area covered by the test.

1.06 QUALITY ASSURANCE

A. Quality of fertilizer, lime, and seed, and operations in connection with the furnishing of this material, shall comply with the requirements of the N.C. Fertilizer, Lime and Seed Law; and with the requirements of the rules and, regulations adopted by the NC Department of Agriculture in accordance with the provisions of the said law.

B. Seed containers shall bear an official "Certified Seed" label as inspected by the N.C. Crop Improvement Association.

C. Packages for soil conditioners and fertilizer shall bear manufacturer's guaranteed analysis.

D. Do not apply lime, fertilizer or seed in strong wind, when the soil is extremely wet, or otherwise unworkable. No rolling shall be done if precipitation after seeding would make the operation detrimental to the seed bed.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Deliver grass seed mixture in sealed containers showing percentage of seed mix, year of production, net production, net weight, date of packaging, and location of packaging.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.08 MAINTENANCE SERVICE

A. Maintain seeded areas until grass is well established and exhibits a vigorous growing condition for a minimum of two cuttings. Mow grass at regular intervals to a maximum height of 3 inches. Hand clip where necessary.

B. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions.

C. Water areas seeded between May 1 and July 15 at such intervals as to maintain the seeded area in a moist condition until the grass is established and accepted by the Engineer. Provide equipment to transport and distribute the water to the seeded areas. Areas seeded between September 1 and November 1 need not be irrigated beyond the initial watering specified above except that the Contractor may apply water at his own discretion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds, and roots; pH value of minimum 5.4 and maximum of 7.0.

B. Lime: Ground Dolomitic agricultural limestone, not less than 85 percent total carbonates, ground so that 50 percent passes 100 mesh sieve and 90 percent passes 30 mesh sieve. Coarser material will be acceptable, provided the specified rates of application are increased proportionately on the basis of quantities passing No. 100 mesh sieve.

C. Fertilizer: Mixed, commercial, fertilizer containing 10-10-10 percentages of available nitrogen, phosphoric acid, and potash respectively, plus superphosphate with 20 percent P2O5 content. Fertilizer shall be dry, in granular (pellet) form, shall be delivered to the site in the manufacturer's original bag or container which shall be plainly marked as to formula.

D. Seed: Fresh seed guaranteed 95 percent pure with a minimum germination rate of 85 percent within one year of tests. Provide the following seed mixtures with lime and fertilizer in disturbed areas including NCDOT Rights-of-Way:

1. Temporary Seeding

Planting Dates	Grass Type	Pounds/Acre
Dec. 1 - Apr. 15	Rye (Grain)	120
	Kobe Lespedeza	50
Apr. 15 - Aug. 15	German Millet	40
Aug.15 - Dec. 1	Rye (Grain)	120
Lime		3,000
Fertilizer	10-10-10	800
Mulch	Straw	4,000

2. Permanent Seeding

Planting Dates	Grass Type	Pounds/Acre
Feb. 15 - Apr. 30	Tall Fescue	100
&	Pensacola Bahiagrass	50
Sept. 1 - Oct. 31	Kobe Lespedeza	40
	Tall Fescue	100
	Pensacola Bahiagrass	50
Lime		4,000
Fertilizer	10-10-10	1,000
Mulch	Straw	4,000

E. Matting / Erosion Control Fabric (ECF): Matting and ECF shall be heavy jute mesh over mulch held in place by staples. Commercially available ECFs may be used upon approval of the engineer. Approval of fabrics will require manufacturer's design data regarding velocity, ditch slopes, method of installation, decay cycle, repair techniques, and grass growth enhancement characteristics.

F. Wire Staples: 16 gauge steel wire, with minimum of 3" top and 4" long legs.

G. Mulch: Threshed straw of oats, wheat, or rye; free from seed of obnoxious weeds; or clean salt hay. Straw which is fresh and excessively brittle or straw which is in such an advanced stage of decomposition as to smother or retard growth of grass will not be acceptable.

H. Water: Water shall be free from substances harmful to growth of grass.

PART 3 EXECUTION

3.01 PREPARATION OF SUBSOIL

A. Complete operations in the area to be seeded and prepare subsoil to eliminate uneven areas and low spots. Bring surface to the approximate design contours.

B. Scarify subsoil to a depth of 3 inches. Remove weeds, roots, stones and foreign materials 1-1/2 inches in diameter and larger.

3.02 PLACING TOPSOIL

A. Place topsoil during dry weather and on dry unfrozen subsoil.

B. Spread topsoil to a minimum depth of 4 inches. Remove vegetable matter and foreign non-organic material from topsoil while spreading. Grade surface to provide positive drainage and prevent water ponding. Lightly compact topsoil with at least one pass of a cultipacker or similar equipment

C. Maintain the finished surfaces by protecting, and replacing topsoil and subsoil as necessary until the area is accepted under the contract.

3.03 APPLICATION OF LIME

A. Liming shall be done immediately after grading has reached the fine grading stage, even though actual seeding may not be done until several months later.

B. Spread lime evenly by means of a mechanical distributor.

C. When lime is distributed by commercial liming dealers, sales slips showing the tonnage delivered shall be filed with the Engineer and shall show the full tonnage required for the acres treated.

D. Incorporate lime in the top 2 to 3 inches of soil by harrowing, disking, or other approved means.

3.04 APPLICATION OF FERTILIZER

A. Spread fertilizer not more than 2 weeks in advance of seeding.

B. To verify application rate, determine acreage to be fertilized and provide Engineer with total weight of fertilizer applied to the area.

C. Provide mechanical spreader for even distribution and spread half of the rate in one direction, and the other half at right angles to the first. Mix thoroughly into upper 2 to 3 inches of soil by disking, harrowing or other approved methods.

3.05 SEEDING

A. Accomplish seeding by means of an approved power-drawn seed drill, combination corrugated roller-seeder, approved hand operated mechanical seeder, or other approved methods to provide even distribution of seed.

B. Do not seed when ground is excessively wet or excessively dry. After seeding, roll area with a roller, not less than 18 inches in diameter and weighing not more than 210 pounds per foot of width. Upon completion of rolling, water area with a fine spray.

C. Immediately following seeding apply mulch or matting. Do not seed areas in excess of that which can be mulched on same day.

D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil depth

3.06 MULCHING AND MATTING

A. Apply mulch or matting as required to retain soil and grass, but no less then the following:
   1. Slopes from 0 to 20 percent by spreading a light cover of mulch over seeded area at the rate of not less than 85 lbs. per 1000 sq. ft.
   2. Slopes greater than 20 percent mulch with matting. Pin matting to the ground with wire staples at 5 foot intervals, immediately after seeding.

3. Use tack to prevent disruption of mulch.

B. For tack use an asphalt tie-down of emulsified asphalt grade AE-3 or cut-back asphalt grade RC-2 or other approved equal. The application rate shall be 0.10 gal/sy (11 gal / 1000 sq ft). An approved jute mesh or net may be used in lieu of tacking straw mulch.

C. Other types of mulch and anchoring methods may be used upon approval by the Engineer.

3.07 PROTECTION

A. Protect seeded areas from damage by barricades, signs, and other appropriate means. Maintain and protect slopes from weather damage.

END OF SECTION

SECTION 03100

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE

A. Provide labor, materials, and equipment required for placement of cast-in-place concrete.

B. Work included under this section includes, but is not limited to, the following:

1. Concrete materials
2. Concrete
3. Reinforcement
4. Form work
5. Grout
6. Mixing, placing and curing
7. Concrete finishing

1.02 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Concrete Institute (ACI)
   a. 301
   a. 318
2. American Society of Testing Materials (ASTM)
   a. A307 Carbon Steel Externally Threaded Standard Fasteners.
   b. C39 Test for Compressive Strength of Cylindrical Concrete Test Specimens.
   c. C94 Ready Mixed Concrete
   d. C143 Test for Slump of Portland Cement Concrete.
   e. C171 Sheet Materials for Curing Concrete.
   f. C192 Making and Curing Concrete Test Specimen.
   g. C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   h. C309 Liquid Membrane-Forming Compounds for Curing.
   i. C920 Elastomeric Joint Sealants.
   j. D1751 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
3. N. C.. Department of Transportation - Standard Specifications for Roads and Structures (NC DOT).
4. Concrete Reinforcing Steel Institute (CRSI)

1.03 QUALITY ASSURANCE

A. Concrete work shall conform to the requirements of ACI 318, ACI 301 and CRSI "Manual of Standard Practice" as a minimum.

B. Methods and materials of work shall conform to the requirements of the standards and codes and recommended practices as referred to within this section.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:

1. Test Reports:
   a. Laboratory Mix Design: Mix design shall be in accordance with ACI 318, Section 5.3 (Field Experience and / or Trial Mixtures). Design mixes shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce specified concrete.
   b. Concrete Tests: Reports for 7-day and 28-day concrete compressive strengths.
2. Catalog Data: Manufacturer standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided for the following.
   a. Water stops.
   b. Forming accessories
   c. Admixtures
   d. Patching compounds
   e. Joint systems
   f. Curing compounds
   g. Dry-shake finish materials.
3. Shop Drawings: Project specific shop drawings for the following:
   a. Reinforcing Steel: Shop drawings shall comply with ACI SP-66 "ACI Detailing Manual". Shop drawings shall be drawn to a scale of 1/4" = 1' - 0" or larger. Where necessary for clear delineation, complicated wall steel shall be shown on inside and outside elevations. Bars shall be clearly shown, accurately located, and dimension on the plans, elevations, and sections.
4. Delivery Tickets: Submit copy of delivery tickets to the Engineer for each batch of ready mixed concrete in accordance with ASTM C-94. Indicate total water content.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Reinforcement Steel: Store reinforcement in a manner that will avoid excessive rusting or coating by grease, oil, dirt, and other objectionable materials. Store in separate piles so as to avoid confusion or loss of identification after bundles are broken.

B. Protect cement from contamination or damage during handling. Do not use cement which has been damaged, is partially set, lumpy or caked. If the damaged cement is in bags, the entire contents of the bag shall be rejected. Do not use cement salvaged from used bags or reclaimed from cleaning bags.

PART 2 MATERIALS

2.01 CEMENT

A. Portland cement shall comply with ASTM C-150, Type I unless otherwise specified.

1. Different brands of cement, different types of cement, or the same brand of cement from different mills shall not be mixed, nor shall they be used alternately, except when authorized by the Engineer.
2. Measure cement by the bag as packaged by the manufacturer, or by weight; one bag of cement shall be considered to contain 94 pounds net. A barrel is equivalent to 4 bags or 376 pounds net.
3. When bulk cement is used, the weighing and handling shall be inspected by the Engineer prior to use.
4. Pozzolans or fly ash conforming to ASTM C618 may be blended with the cement. The maximum pozzolan or fly ash content shall not exceed 25 percent by weight of the total cement material.

B. A concrete mix design utilizing expansive or shrinkage compensating concrete may be proposed for use in large concrete structures.

2.02 ADMIXTURES

A. Air-entraining admixtures shall conform to ASTM C-260. Testing in accordance with ASTM C-233 will be waived provided the admixture has been tested and accepted by the Bureau of Public Roads, U.S. Department of Transportation, or provided a statement is submitted by the manufacturer that the admixture to be furnished for the project has been tested and conforms to ASTM C-260.

B. Water-reducing admixture shall conform to ASTM C-494, Type A or Type D and shall be chloride free.

C. Non-corrosive accelerator admixture shall conform to ASTM C-494, Type C or E, and have long term test data proving its non-corrosive effect on metal deck and reinforcing steel. Admixture shall be "Accelguard" by the Euclid Chemical Company, "Daraccel" by GCP Applied Technologies, or equal.

D. Shrinkage reducing admixture shall be “eclipse shrinkage reducing admixture” by GCP Applied Technologies or equal.

2.03 AGGREGATES

A. Fine aggregate for use in classes of concrete (except lightweight concrete) and Portland cement mortars, except mortars for masonry work, shall conform with ASTM C33 and as specified in accordance with NCDOT Section 1014, "Aggregate for Portland Cement Concrete", Para. 1014-1, "Fine Aggregate", and graded as

specified in Table 1005-2 of Section 1005. Fine aggregate for lightweight concrete shall be as specified above or lightweight sand as necessary to meet the required density and compressive strength.

B. Coarse aggregate for normal concrete, except as specified otherwise herein, shall be in accordance with ASTM C33 and graded as specified in NCDOT Table 1005-1 of Section 1005. Coarse aggregate for lightweight concrete shall be as specified in ASTM C-330 as required to meet the density and compressive strength requirements.

2.04 HIGH EARLY STRENGTH CONCRETE

A. High early cement (Type III), the non-corrosive accelerator added to the normal cement (Type I) or high strength concrete shall be used only where specified or in an emergency when approved by Engineer. In such cases, the requirements for proportioning and mixing shall be as specified herein.

2.05 REINFORCEMENT

A. Metal reinforcement shall be Grade 60 and conform to ASTM A615. Bars shall be deformed except 1/4 inch round bars which may be plain. Bars shall be formed to the dimensions indicated and approved on the shop drawings. Fabrication and details on reinforcement shall conform to the requirements of the ACI 318, Chapter 7, "Details of Reinforcement". Heating for bending shall be employed only when approved by Engineer.

B. Welded wire fabric shall conform to ASTM A1064. Where the size and weight of welded wire fabric is not indicated or specified, it shall be 6 x 6 inch mesh of 0.192 inch nominal-diameter wire and shall weigh approximately 42 pounds per 100 square feet.

C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.06 FORMS

A. Forms except as otherwise specified shall be of plywood, steel or other approved material. Plywood shall be concrete form plywood, not less than 5/8 inch thick. Surfaces of steel forms shall be free from irregularities, dents, and sags.

2.07 MISCELLANEOUS PRODUCTS

A. Bonding and patching compounds: Compounds for bonding, patching, and structural repairs, shall be "Euco Weld" by Euclid Chemical Company, "Colma Dur Mortar", "Sikadur Hi-Mod" by Sika Chemical Corporation, or equal.

B. Non-shrink Grout: Factory premixed non-shrink, non-metallic grout with minimum compressive strength of 4,500 PSI at 3 days and 8,500 PSI at 28 days. Grout shall be NS Grout by The Euclid Chemical Company, "Masterflow 713" by Master Builders, Sonogrout by Sonneborn Company, or equal.

C. Waterstops: Vinyl meeting U.S. Corps of Engineers' Specification CRD-C572-74, 6 inch minimum width and 3/8 inch thickness, of the rib-center bulb or dumbbell type.

D. Expansion Joint Filler: Bituminous impregnated, preformed type conforming to ASTM D 1751.

E. Concrete curing paper: Conform to ASTM C 171, Type 1, Waterproof Paper, shall be used. Polyethylene or similar plastic sheets shall not be used for concrete curing. Sisalkraft "Orange Label" or equal.

F. Joint sealer: Shall conform to ASTM C 920, Type M, Grade P, Class 25, Use T. Joint sealer for water containment structures shall be Polysulfide Type. Provide concrete primer as recommended by sealant manufacturer and compatible with the substrate.

G. Anchor bolts: Shall conform to ASTM F1554, Grade 36 or Grade 55.

H. Plain washers for anchor bolts: Shall conform to "Plain Washers," ANSI B18.22.l-1965 (R1998), Type A. Furnish one washer with each anchor bolt, unless otherwise noted on the Drawings.

I. Membrane forming curing compound: Liquid membrane forming curing compounds shall be wax free resin-type capable of retaining 95 percent of the moisture for the specified curing period and shall conform to ASTM C309, Type 1D, and shall contain a red fugitive dye. Curing compound applied to surfaces to be left permanently exposed to view shall not cause permanent discoloration or otherwise adversely affect the appearance of surface.

J. Curing compound: Shall be "Super Floor Coat" by Euclid Chemical Company, "Masterseal" by Master Builders, Kure-N-Seal by Sonneborn, or equal. Compound shall conform to Federal Specification TT-C-800A, 30% solids content minimum.

K. Abrasive aggregate for non-slip finish: Crushed ceramically bonded aluminum oxide grits as abrasive aggregate for non-slip finish. Material shall be factory-graded, packaged, rust-proof and non-glazing, and unaffected by freezing moisture and cleaning materials and equal to "MasterTop 120SR" by Sonneborn Building Products, Inc., "Non-Slip" by Euclid Chemical Company, or equal.

L. Liquid chemical floor hardener: Colorless, aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent,

containing not less than 2 pounds of fluosilicate per gallon. Material shall be "Hornolith" by Tamms, or "Lapidolith" by Sonnebom Building Products, Inc or equal.

M. Stone under slab: Clean NC DOT size No.67 coarse aggregate.

N. Vapor barrier under slabs: "Moistop," by the Henry Company or equal.

O. Structural steel shapes and plates to be embedded in or anchored to the concrete shall conform to ASTM A 36-19.

PART 3 EXECUTION

3.01 GENERAL

A. Provide a minimum of 4 inches of stone under concrete slabs on grade unless noted otherwise on Drawings.

B. Provide a vapor barrier under interior concrete slabs on grade unless noted otherwise on drawings.

C. Provide a two coat treatment of a liquid chemical floor hardener to interior concrete floor surfaces to be left permanently exposed to view.

D. Provide a "dry shake" application of abrasive aggregate for non-slip finish on exterior concrete platforms, steps and landings, and interior and exterior concrete ramps shall receive a Ceramically bonded aluminum oxide grits as abrasive aggregate for non-slip finish.

E. Provide joint sealing compound at locations indicated on the Drawings and at joints in interior and exterior floor slabs to be left permanently exposed to view. Color of joint sealing compound for exposed joints shall match concrete color.

F. Install waterstops in accordance with manufacturer's instruction and securely anchor to reinforcing bars or forms to prevent displacement during placing of concrete.

G. Provide joint sealer locations indicated on the Drawings and between points of contact between slabs and vertical surfaces. Provide joint filler between horizontal concrete surfaces at expansion and isolation joints, unless otherwise noted on the Drawings.

3.02 CONCRETE MIX

A. General: Provide normal weight, air-entrained concrete except where specified or indicated on the Drawings to be lightweight concrete. Interior slabs, subject to abrasion, shall have a maximum air content of 3 percent. Concrete shall contain the specified water-reducing admixture. Thin slabs (less than 8 inches thick) placed below 50 degrees F shall contain a non-corrosive accelerator. Each mix shall be proportioned as specified by weight and use the aggregate and cement proposed for the project. Mix designs shall be in accordance with ACI specifications.

B. Design of Concrete: Provide concrete mix designs and engage an independent testing laboratory, approved by the Engineer, to prepare the mix designs for the classes of concrete specified in the "Properties and Location of Concrete" table which follows. Materials and proportioning shall be in accordance with the ACI Specifications, unless otherwise specified.

1. Submit mix designs, test data, laboratory strength tests and certificates of analysis for cement and aggregates prior to the placement of concrete.
2. Proportion concrete mixes to be placed by pumping for the type of equipment to be used so as to have a continuous flow of concrete through the pumping system.

Properties and Location of Concrete:

Concrete Class (Location)	Min 28-day Compressive Strength (6"x 12" Cylinders)	Maximum Allowable Course Aggregate Size & Type	Slump	Total Air Content By Volume	*Max W/C Ratio
Liquid Retaining Structures	4,500 psi	1-1/2" Stone	2"-4"	4-1/2% ± 1 1/2%	0.35
Exterior Slabs	3,500 psi	3/4" Stone	2"-5"	6% ± 2%	0.40
Interior Slabs	3,500 psi	3/4" Stone	2"-5"	N/R	0.40
Footings - Building	3,000 psi	1-1/2" Stone	2"-4"	Not Reqd	0.58
All Other Concrete	3,000 psi	3/4" Stone	2"-4"	5% ± 1 1/2%	0.46

* Including free surface moisture on aggregates and liquid admixtures. W/C ratio is maximum permissible ratio for concrete when strength data from field experience or trial mixtures are not available. Higher ratios may be acceptable provided documentation is submitted in accordance with ACI Specifications. The maximum permissible W/C ratio for liquid retaining structures shall be 0.45.

3. If expansive or shrinkage compensating concrete or shrinkage reducing admixtures are proposed for use in concrete for liquid retaining structures, increased spacing of construction joints may be proposed. Submit request for modification along with recommendation from material supplier for review along with mix design.

3.03 MEASUREMENT OF MATERIALS, MIXING AND EQUIPMENT

A. Concrete shall be machine mixed except in emergencies mixing may be by hand as directed. Except when ready-mixed concrete is used, provide an approved type of batch mixer at the site equipped with an accurate water measuring and control device and capable of producing a homogeneous concrete mixture of uniform color. Apparatus provided for weighing aggregate and cement shall be designed especially for this purpose. Weigh fine and coarse aggregate and cement separately. Cement in standard packages need not be weighed, but bulk cement or fractional packages shall be weighed. Accuracy of measuring devices shall be such that successive quantities can be measured to within one percent of required amount. Measuring devices shall be subject to verification. Do not exceed rated capacity of mixer. Time

of mixing after cement and aggregates are in the mixer drum shall not be less than one minute for one cubic yard or less and increased 15 seconds for each additional cubic yard or fraction thereof in capacity. The total required water shall be in the drum before one-fourth of the mixing time has elapsed. Mixer drum shall rotate at a peripheral speed of about 200 feet per minute throughout the mixing period. Discharge entire contents of mixer drum before recharging. Provide necessary equipment and establish accurate procedures subject to Engineer's approval for determining the quantity of free moisture in the aggregates. Moisture determination shall be made at intervals as directed by Engineer. The retempering of concrete which has partially hardened, i.e., mixing with or without additional cement, aggregate, or water, will not be permitted.

3.04 READY-MIXED CONCRETE

A. Ready-mixed concrete plant shall be properly equipped for the accurate proportioning and proper mixing and delivery of the concrete, including the proper water measurements and controls, as specified above. Plant shall have sufficient capacity and transportation equipment to deliver the concrete at the required rate. Plant shall be subject to inspection and approval of the Engineer.

B. Mix and handle ready-mixed concrete in accordance with ASTM C-94.

3.05 CONVEYING

A. Convey concrete from mixer to its final position as rapidly as practicable by approved methods which will not cause segregation or loss of ingredients. Deposit concrete as nearly as practicable in its final position to avoid rehandling. Free vertical drop of concrete shall not exceed 3 feet. Chuting will be permitted only where the concrete is deposited into a hopper before it is placed in the forms. Clean conveying equipment before each run. Deposit concrete as soon as practicable after the forms have been coated and the reinforcement placed. Place concrete before the initial set and not later than 30 minutes after mixing or agitating. Concrete which has segregated in conveying shall not be used.

3.06 PLACING

A. Place concrete in accordance with ACI 301.

B. Accomplish compaction by use of a mechanical vibrator having a frequency of not less than 8000 cps. Vibration shall not be used to flow concrete horizontally more than 2 feet.

3.07 PLACEMENT IN EXTREME WEATHER

A. Placing Concrete in Cold Weather: Do not place concrete when the atmospheric temperature is below 40 degrees F, or when the concrete is likely to be subjected to freezing temperatures within 24 hours after placement. Heat concrete as necessary to maintain a concrete temperature of between 60 and 80 degrees F when placed. Remove frozen material from aggregates before placing in the mixer.

B. Placing Concrete in Hot Weather: When the outdoor ambient temperature is over 90 degrees F or as directed by the Engineer, provide methods so the temperature of the concrete as placed shall not exceed 90 degrees F. Shade concrete after placing and start curing as soon as the surface of the fresh concrete is sufficiently hard to permit it without damage. Unless specified otherwise, the control of hot weather concreting and the methods employed to control the temperature of the material both during placing and curing operation shall be in accordance with ACI 305R, Hot Weather Concreting.

3.08 CURING AND PROTECTION

A. General: Protect concrete, including areas to be given a special finish, from damage by the sun, rain, flowing water, frost, and mechanical injury. Do not allow concrete to dry out for a minimum of seven days from the time it is placed. Provide water curing by keeping the surface of the concrete continuously wet by covering with water, with an approved water saturated covering, or by spraying. Water used for curing shall be fresh water. Where water curing is not used, provide curing by sealing the water in the concrete so that it cannot evaporate. This may be done by leaving the forms in place, covering with a waterproof curing paper laid with airtight joints, use of a curing compound, or by other approved means.

B. Do not use liquid membrane-forming curing compounds where terrazzo, hard tile or cementitious floor finish materials are to be installed. See finish schedule.

C. Apply curing compound immediately after final finishing.

D. Keep wood forms sufficiently damp to prevent drying out of the concrete.

E. Portions of the time during which either moisture or warmth is lacking shall not be counted effective for curing. When concrete is placed in cold weather, make provisions for maintaining the temperature of the air in contact with the concrete at not less than 50 degrees F for a period of not less than 7 days after placing, or at not less than 70 degrees F for a period of not less than 3 days after placing. Heating of the concrete in place shall be affected by salamanders or steam coils under canvas covers or by other approved means. Temperature within enclosures shall not exceed 100 degrees F, and apply adequate moisture during the heating period to prevent concrete from drying out. Rate of cooling after the protection period shall be approximately 1 degree F per hour for the first 23 hours and 2 degrees F per hour thereafter.

3.09 REMOVAL OF FORMS AND PROTECTION

A. General: Remove forms in a manner which will not damage the concrete. Do not remove forms for the following minimum times:

	Days after Placing
1. Side forms on beams, girders, columns, and walls (lifts 15 ft and under)	24 hours provided patching and finishing may be completed in 8 hours and the work immediately recovered with approved curing media.

2. Columns and walls (lifts over 15 ft)	5
3. Supporting forms for arches, beams, girders, and slabs	14

B. Provide sufficient shoring members to support dead load plus construction loads on beams, girders, slabs, and arches until concrete has reached the full specified strength.

C. Special Requirements for High-Early Strength Concrete: The curing periods, minimum periods during which supporting forms and shores shall be left in place, and minimum periods for maintaining curing temperatures shall be not less than one-quarter of those specified for concrete using Type 1 cement, but in no case less than 24 hours.

3.10 CONSTRUCTION JOINTS

A. General: Provide construction joints where indicated on the Drawings or as otherwise approved.

B. Prepare construction joint surfaces for placement of concrete by cleaning with compressed air and water. Remove stains and foreign material from the surface and coat with a bonding compound. Place new concrete after bonding compound has dried.

C. Where new concrete is to be bonded to existing concrete, clean existing surface and roughened thoroughly, remove loose particles, dampen surface, and apply bonding compound. Place new concrete after bonding compound has dried.

D. Where construction joints are indicated on the Drawings for slabs on grade, control joint indicated on the Drawings may be used instead. This provision does not apply when the construction joint occurs directly under CMU walls.

1. Control Joints: Saw cut slab after concrete has hardened sufficiently to prevent dislodging of aggregate and while the temperature of the fresh concrete is still rising. Complete cutting of slabs within twenty four hours of concrete placement. Flush out joints immediately after cutting with air or water under pressure to remove sawing residue.
2. Keep joints clean and protected from debris, grease, and oil. No earlier than thirty days after concrete placement, fill joints with a flexible epoxy joint filler and compatible back up material intended for this purpose. Prepare joint and apply filler in accordance with manufacturer's recommendations.

3.11 FINISHING CONCRETE

A. General: As soon as forms are removed, patch defective areas and fill tie holes with cement mortar of the same composition as that used in the concrete. Cut out defective areas to solid concrete but to a depth of not less than 1 inch. Edges of the cut shall be perpendicular to the surface of the concrete. Area to be patched and at least 6 inches adjacent thereto shall be dampened and apply bonding compound. Place patching mortar after bonding compound has dried. Mix mortar approximately

one-half hour before placing and remix occasionally during this period with trowel without the addition of water. Compact mix into place and screed slightly higher than the surrounding surface. Finish patches on exposed surfaces to match the adjoining surfaces after they have set for a period of an hour or more. Cure patches as specified for concrete. Wet tie holes with water and fill solid with mortar. Fill holes extending through the concrete by means of a plunger type gun or other suitable device from the exposed face. Wipe excess mortar off the exposed face with a cloth. Protect finish surfaces from stains and abrasions.

B. Surface Finishes: Exposed concrete surfaces, except floors, bottom slabs, and walking surfaces, shall receive the following finish.

1. As soon as the pointing and patching has set sufficiently to permit it, thoroughly wet surface with a brush and rub with a No. 16 carborundum stone or other equally good abrasive, bringing the surface to a paste. Continue rubbing sufficiently to remove form marks and projections, producing a smooth dense surface without pits or irregularities.
2. Carefully spread or brush material, which in the above process has been ground to a paste, uniformly over the entire surface and allowed to reset. After the rubbing is complete, thoroughly drench and keep surface wet for a period of 7 days, unless otherwise directed. Obtain final finish by a thorough rubbing with a No. 30 carborundum stone or other equally good abrasive. Continue rubbing until entire surface is a smooth texture and uniform in color.
3. Adjoining or adjacent work which has been disfigured by the above specified work shall be thoroughly cleaned by approved methods so that the complete unit presents the same appearance.
4. In lieu of the procedure described in items 1, 2, and 3 above, grind all fins smooth and use a cementious type concrete coating, color as selected by the Owner. Apply cementious type concrete coating in strict accordance with the manufacturer's recommendation. Acceptable manufacturers shall be MasterSeal 581 by MasterBuilders, Euclid Company, UGL or equal.

C. Floor and Roof Slab Finishes:

1. Finished floor and roof slab surfaces shall be true plane surfaces, with a tolerance of 1/8 inch in 10 feet unless otherwise indicated. Pitch surfaces to drains. Dusting of finish surfaces with dry materials will not be permitted.
2. Monolithic Finish: Floor and roof slabs shall be placed, consolidated, struck off and leveled to the required elevation. When the concrete has stiffened sufficiently to bear a man's weight without deep imprint, float surface, at least twice, to a uniform sandy texture. Steel trowel surface to a smooth, even, impervious finish, free from trowel marks.
3. Surface of slabs, except roof slabs, shall be given a second steel-troweling to a burnished finish.

D. Sidewalk, platform, and wearing surfaces not otherwise specified shall receive a broom finish. Slab shall receive a float finish, as indicated above, and then lightly brush surface with a hair broom to leave a slightly rough, non-slip surface. Brooming shall be done in one direction and leave a uniform neat pattern.

E. Concrete bottom slabs in channels, clarifiers, wet wells, and chlorine contact chamber shall receive a steel troweled finish. Surface shall be smooth, true to established planes and conforming to lines and slopes as indicated on the Drawings. Care shall be taken to produce a surface of maximum smoothness, and care shall be taken to protect surface from damage during later work.

3.12 FORMS

A. General: Form concrete unless specified or directed otherwise. Set forms true to line and grade within the allowable tolerances specified for finishes and shall be mortar-tight. Arrange bolts and rods used for internal ties so that when forms are removed, metal will have the minimum specified cover.

B. Where water-tightness is required, do not use bolts or rods which are withdrawn when the forms are removed. Do not use wire ties where the concrete surface will be exposed to weathering and where discoloration will be objectionable. Provide form work with adequate clean-out openings to permit inspection and easy cleaning after reinforcement has been placed. In columns, walls, and similar members of small dimensions, the height of forms for each vertical lift shall not exceed 6 feet unless suitable openings are provided at not more than 6 foot vertical intervals to permit proper placing of the concrete. Where forms for continuous surfaces are placed in successive units, fit forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Install panel forms to provide tight joints between panels. Install forms so they can be removed without damaging the concrete. Chamfer exposed joints, edges, and external corners. Forms for heavy girders and similar members shall be constructed with a camber, as directed. When placing concrete in excavations, forms shall be not less than 3 inches outside the concrete lines indicated.

C. Coating: Before placing the concrete, coat contact surfaces of forms with a non-staining mineral oil or two coats of nitrocellulose lacquer, except for unexposed surfaces when the temperature is above 40 degrees F sheathing may be wetted thoroughly with clean water. Remove excess oil by wiping with cloths. Clean contact surfaces of forms for reuse.

3.13 REINFORCING STEEL

A. General: Provide reinforcement bars, stirrups, hanger bars, wire fabric, and other reinforcing materials as indicated on the Drawings or required by the specifications together with necessary wire ties, chairs, spacers, supports, and other devices to properly install and secure the reinforcing. Reinforcement shall be free from foreign substances. Reinforcement which has bands not shown on the project drawings or on approved shop drawings or which is reduced in section by rusting shall not be used.

B. Fabricate bar mats from bars conforming to specifications for reinforcement bars and intersections shall be fastened securely by approved mechanical ties.

C. Placing: Place reinforcement accurately and thoroughly secure. Support with concrete or metal chairs, spacers, or metal hangers. Metal chairs, clips, or supports, the ends of which will be exposed on the concrete surface, will be permitted only

where the surface will not be exposed to weathering and where discoloration will not be objectionable; elsewhere concrete or other approved non-corrodible material or other approved means shall be used for support.

D. Splicing: Where splices in addition to those shown on the project Drawings are necessary, lap bars as scheduled below.

BAR SIZE	LAP, INCHES	BAR SIZE	LAP, INCHES
#3	16 (18)	#7	33 (42)
#4	19 (24)	#8	39 (51)
#5	23 (30)	#9	69 (90)
#6	28 (36)	#10	88 (114)

Figures in parentheses are for top bars (horizontal reinforcement placed such that more than twelve inches of fresh concrete is cast in the member below the reinforcement). Other figures are for all other bars.

Stagger splices in alternate bars. Splices shall be in accordance with ACI 318 and ACI 301.

E. Protection of Reinforcement: Reinforcement of footings and other principal structural members in which the concrete is deposited on the ground shall have not less than 3 inches of concrete between the reinforcement and the ground contact surface. If concrete surfaces after removal of the forms are to be exposed to the weather or water or be in contact with the ground, the reinforcement shall be protected with not less than 2 inches of concrete for bars greater than 5/8-inch in diameter and 1-1/2 inches for bars 5/8-inch or less in diameter. Measure protective cover from the outside edge of the steel.

F. Concrete protective covering for reinforcement of surfaces not exposed directly to the ground, water, or weather shall be not less than 3/4 inch for slabs and walls and not less than 1-1/2 inch for beams, girders, and columns.

G. Do not use heat to field bend bars.

H. When required and approved in writing by the Engineer, welding of reinforcing shall conform to "Recommended Practice for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction (AWS D12.1)". No tack welding will be permitted.

3.14 SETTING MISCELLANEOUS MATERIALS

A. Pipe sleeves, wall castings, anchors and bolts, including those for machine and equipment bases, angle frames or edgings, hangers and inserts, pipe supports, conduits and other materials in connection with concrete construction, shall, where practicable, be placed and secure in position when the concrete is placed. Anchor bolts for machines and equipment shall be set according to templates, shall be carefully plumbed, checked for location and elevation with an instrument, and be held in position rigidly to prevent displacement while concrete is being placed.

3.15 TESTING

A. Field Poured Specimens:

1. Provide one set of specimens for compressive strength tests for each 100 cubic yards, or fraction thereof, of each class of concrete, placed each day. Not less than four specimens shall be made for each test. Specimens shall be made and cured in accordance with ASTM C31. When in the opinion of the Engineer there is a possibility of the air temperature falling below 40 degrees F, additional specimens shall be taken and cured in the field under conditions similar to those of the concrete in the structure. Test specimens in accordance with ASTM C39.
   a. The standard age of specimens at test shall be 28 days. Of the four specimens made for each test, two shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. The fourth specimen shall be a reserve.
   b. The strength level of the concrete will be considered satisfactory so long as the averages of all sets of three consecutive strength test results (average of two cylinders tested at 28 days) equals or exceeds the specified strength f'c and no individual strength test result falls below the specified strength f'c by more than 500 psi. When the test results do not conform to these requirements, the Engineer shall have the right to require changes in the mix design and conditions of temperature and moisture necessary to secure the required strength.
   c. Tests shall be performed by an independent laboratory as specified in Section 01450, Quality Control.
   d. Test reports shall be submitted in accordance with Section 01450, Quality Control.

B. Drilled Cores:

1. Where there is a question as to the quality of the concrete in the structure, the Engineer may require additional testing in accordance with ASTM C42 for that portion of the structure where the questionable concrete has been found. If the results of these additional tests meet the requirements of the specifications, the Owner shall pay for the costs of the tests. If the results of the additional tests fail to meet the requirements of the specifications, the Contractor shall pay for the tests. Concrete failing to meet the specifications shall be removed and replaced at no additional cost to the Owner.

C. Air Entrainment shall be as specified. Test air content in accordance with AASHTO T152, T121, or T156. Test shall be at the frequency required by the Engineer.

D. Test slump plus or minus 1 inch as determined by AASHTO T119. Make test from each delivery before placing concrete. Slump tests shall be made in the presence of the Engineer's representative. Concrete not meeting the slump standards specified shall be modified, if possible, to meet the standards or shall be rejected by the Engineer's representative and removed from the project.

E. Water-bearing structures shall be watertight against water pressure which may come upon them prior to backfill. Repair imperfections. On completion of water-bearing

structures, fill with water to the high water line and allow to remain filled for forty-eight (48) hours before testing for water-tightness. Repair leaks to make structures water-tight.

END OF SECTION

SECTION 03335

CONCRETE FINISHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finishing concrete slabs and formed surfaces.
   2. Floor sealer/hardener.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 03100 - Cast-In-Place Concrete.

1.2 REFERENCES

A. American Concrete Institute (ACI):
   1. 301 - Structural Concrete for Buildings.

B. ASTM International (ASTM):
   1. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   2. E1155 - Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System (Inch-Pound Units).

1.3 DEFINITIONS

A. Specified Overall Value (SOV): Describes the flatness or levelness value which must be achieved when all measured values of that type on a given Test Surface are combined.

B. Minimum Local Value (MLV): Describes the flatness or levelness value below which repair or replacement is required and applies to Minimum Local Area.

C. Minimum Local Area (MLA): An area bounded by construction or contraction joints or by column lines or half-column lines, whichever is smaller; no boundary crosses a construction joint or expansion joint.

D. Level: Horizontal, normal to the direction of gravity. An envelope is defined by 2 level lines which are separated by stated distances.

1.4 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Descriptive data for sealer/hardener.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 3 years documented experience in work of this Section.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Concrete Sealers:
   1. Euco Diamond Hard by Euclid Chemical. (http://www.euclidchemical.com)
   2. Ashford. (http://ashfordformula.com)
   3. BASF Corporation. (www.buildingsystems.basf.com)
   4. Dayton Superior Corporation. (www.daytonsuperior.com)
   5. W. R. Meadows, Inc. (www.wrmeadows.com)
   6. Nox-Crete Products Group. (www.nox-crete.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Concrete Materials: Specified in Division 3.

B. Floor Sealer/Hardener:
   1. Type: blend of silicate and siliconate polymers.
   2. Compliance:
      a. Abrasion Resistance to Revolving Disks: At least a 32.5% improvement over untreated samples when tested in accordance with ASTM C779.
      b. Surface Adhesion: At least a 22% increase in adhesion for epoxy when tested in accordance with ASTM D3359.
      c. Hardening after 7 days: An increase of at least 40% over untreated samples.
      d. Hardening after 28 days: An increase of at least 38% over untreated samples.
      e. Coefficient of Friction: 0.86 dry, 0.69 wet when tested in accordance with ASTM C1028.
      f. Rebound Number: An increase of at least 13.3% over untreated samples when tested in accordance with ASTM C805.
      g. Light Exposure Degradation: No evidence of adverse effects on treated samples when tested in accordance with ASTM G23.
      h. Minimum solids: 15%
      i. Minimum siliconate: 50% of solids

2.3 MIXES

A. Patching Mortar:
   1. Use same proportions as concrete except omit coarse aggregate.
   2. Add minimum water required for handling and placing.

B. Mortar Slurry: 1 part portland cement and 1-1/2 part damp, loose sand, by volume.

PART 3 EXECUTION

3.1 FINISHING FORMED SURFACES

A. Concealed Surfaces: Leave texture imparted by forms.

B. Exposed Surfaces:
   1. While concrete is still green, patch voids over 1/2 inch in diameter or depth.
   2. Chip away defective concrete; form edges perpendicular to surface. Wet area to be patched with clean water.
   3. Apply bonding agent in accordance with manufacturer's instructions.

4. Press mortar into place; strike off slightly higher than surrounding surface. Allow initial shrinkage to occur before finishing.
5. Finish to match texture and color of adjacent surfaces.
6. Remove fins and other protrusions by rubbing with carborundum stone while concrete is still green.

3.2 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

C. Smooth-Rubbed Finish: Provide smooth-rubbed finish on scheduled concrete surfaces that have received smooth-formed finish treatment not later than 1 day after form removal.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.3 MONOLITHIC SLAB FINISHES

A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile and other bonded applied cementitious finish flooring material, and where indicated.

B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.

D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

E. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

F. Chemical-Hardener Finish: On concrete floors which remain exposed and as directed apply chemical-hardener finish to interior concrete floors. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water (parts of hardener/water as follows), and apply in 3 coats; first coat, 1/3-strength; second coat, 1/2-strength; third coat, 2/3-strength. Evenly apply each coat, and allow 24 hours for drying between coats.

3.4 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and trowel-finish concrete surfaces.

END OF SECTION

SECTION 03354

POLISHED CONCRETE FINISH

PART 1GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Polished concrete finish.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. American National Standards Institute (ANSI) B101.3 -Test Method for Measuring Wet DCOF of Common Hard Surface Floor Materials.

B. ASTM International:
   1. E430 - Standard Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry.
   2. F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
   3. F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   4. F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes.

C. Concrete Polishing Association of America (CPAA):
   1. Accreditation Program.
   2. D100.0 - Polished Concrete Definition.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Manufacturer's descriptive data and application instructions for concrete treatment products.

B. Quality Control Submittals:
   1. Applicator qualifications, including list of previous projects and certification issued by flooring system manufacturer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Minimum 2 years documented experience in work of this Section.
   2. Certified by concrete treatment manufacturer.
   3. Supervisor certified as Craftsman or Master Craftsman by CPAA.

B. Concrete:
   1. Mix Design: Free from admixtures and additives not specifically approved by concrete surface treatment manufacturer.
   2. Curing compound acceptable to concrete treatment manufacturer.

C. Mockup:
   1. Size: Minimum 25 square feet.
   2. Show polished finish.
   3. Locate where directed.
   4. Approved mockup may not remain as part of the Work.

D. Pre-Installation Conference:
   1. Convene 2 weeks prior to beginning work of this section.
   2. Attendance: Owner, Architect, Contractor, and Subcontractor.
   3. Review and discuss:
      a. Staging and sequencing.
      b. Protection of completed work.

E. Coefficient of Friction: Minimum 0.43, tested to ANSI B101.3 after polishing.

1.5 PROJECT CONDITIONS

A. Protect concrete surfaces scheduled to receive polished finish prior to finishing; prevent damage and staining:
   1. Prohibit vehicular traffic on surfaces to be polished.
   2. Prohibit pipe cutting operations on surfaces to be polished.
   3. Prohibit storage on surfaces to be polished for minimum 28 days after concrete placement.
   4. Prohibit ferrous metals storage on surfaces to be polished.
   5. Prevent liquid drippings from equipment on surfaces to be polished.
   6. Prevent acids and acidic detergents from contacting surfaces to be polished.
   7. Prevent painting over surfaces to be polished.

B. Apply concrete treatment when ambient and surface temperatures are between 35 and 90 degrees F.

C. Close areas to traffic during finishing and for minimum time period after finishing as recommended by concrete treatment manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Advanced Floor Products. (www.retroplatesystem.com)
   2. Ameripolish. (www.ameripolish.com)
   3. Endurable Concrete Products. (www.endurableproducts.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Densifier:
   1. Per 03335, Concrete Finishing

B. Sealer:
   1. Type: Non-film forming, stain resistant, food resistant, chemical stain resistant, impregnating sealant designed for use on concrete surfaces previously densified.

2. Source: Flexmar's Polyaspartic, Rhino Pro Flooring's Polyaspartic, or HP Spartacote's Polyaspartic, or approved substitute.
3. Maximum volatile organic compound (VOC) content: 50 grams per liter.

2.3 ACCESSORIES

A. Cleaning Products: Non-corrosive, neutral pH, of type recommended by concrete treatment manufacturer.

B. Patching Compound: 40 percent Portland cement, 45 percent limestone, and 15 percent vinyl acetate copolymer, mixed with dust salvaged from grinding process to form paste.

C. Grout: Clear modified silicate sealant, free from latexes, mixed with dust salvaged from grinding process to form paste that reacts with calcium hydroxide in concrete.

2.4 EQUIPMENT

A. Field Grinding and Polishing Equipment:
1. Variable speed, multiple head, counter-rotating, walk-behind machine with minimum 600 pounds of down pressure on grinding or diamond polishing pads.
2. If dry grinding, honing, or polishing, use dust extraction equipment with flow rate suitable for dust generated, with squeegee attachments.

B. Edge Grinding and Polishing Equipment: Hand-held or walk-behind machines producing same results as field grinding and polishing equipment without noticeable differences.

C. Burnishing Equipment: High speed walk-behind or ride-on machines capable of generating 1000 to 2000 revolutions per minute and with minimum head pressure of 20 pounds.

D. Metal Bonded Pads: Grinding pads with embedded industrial grade diamonds of varying grits.

E. Resin Bonded Pads: Polishing pads with embedded industrial grade diamonds of varying grits.

F. Burnishing Pads: Maintenance pads for use with high speed burnishing equipment.

PART 3 EXECUTION

3.1 PREPARATION

A. Testing Concrete Floors:
1. Alkalinity:
   a. Test method: Measure pH according to ASTM F710.
   b. Acceptable results: pH between 8 and 10.
2. Moisture Vapor Transmission:
   a. Test method: Perform anhydrous calcium chloride test to ASTM F1869.
   b. Acceptable results: Maximum 5 pounds per 1000 square feet in 24 hours.
3. Relative humidity:
   a. Test method: Perform relative humidity test using in situ probes to ASTM F2170.
   b. Acceptable results: Maximum 75 percent.

3.2 POLISHING

A. Initial Grinding:
   1. Use grinding equipment with metal bonded grinding pads.
   2. Begin grinding in one direction using sufficient size grit pad.
   3. Make sequential passes with each pass perpendicular to previous pass using finer grit pad with each pass, up to 150 grit.
   4. Achieve maximum refinement with each pass before proceeding to finer grit pads.
   5. Vacuum floor using squeegee vacuum attachment after each pass.
   6. Continue grinding until aggregate exposure matches approved mockup.

B. Treating Surface Imperfections:
   1. Mix patching compound and grout material with dust created by grinding operations to match color of adjacent concrete surface.
   2. Fill surface imperfections. Work compound and treatment until color differences between concrete surface and filled surface imperfections are not noticeable when viewed from 10 feet away under lighting conditions that will be present after construction.

C. Liquid Densifier Application: Apply undiluted solution to point of rejection, remove excess liquid, and allow to cure according to manufacturers' instructions.

D. Grout Grinding:
   1. Use grinding equipment and appropriate grit grinding pads.
   2. While applying fresh grout material prior to, grind concrete in direction perpendicular to initial grinding to remove scratches.
   3. Vacuum floor using squeegee vacuum attachment after each pass.

E. Honing:
   1. Use grinding equipment with resin bonded grinding pads.
   2. Grind concrete in one direction starting with 50 grit pad; make as many sequential passes as required to remove scratches, each pass perpendicular to previous pass, up to 400 grit pad reaching maximum refinement with each pass before proceeding to finer grit pads.
   3. Auto scrub or vacuum floor using squeegee vacuum attachment after each pass.

F. Polishing:
   1. Use polishing equipment with resin bonded polishing and burnishing pads.
   2. Begin polishing in one direction starting with 800 grit pad.
   3. Make sequential passes with each pass perpendicular to previous pass using finer grit pad with each pass.
   4. Achieve maximum refinement with each pass before proceeding to finer grit pads.
   5. Auto scrub or vacuum floor using squeegee vacuum attachment after each pass.
   6. Continue polishing until gloss appearance, as measured according to ASTM E430, matches approved mockup.

G. Final Polished Concrete Floor Finish: Class A - Cream Finish: Polish Portland cement paste resulting in little or no aggregate exposure.

H. Final Concrete Floor Gloss: Level 2 - Medium Gloss Appearance:
   1. Procedure: Minimum five step process with full refinement of each diamond pad up to 800 grit resin bonded pad with one application of densifier.
   2. Gloss reading: Minimum 55, tested to ASTM E430 before sealer application.

3.3 SEALING

A. Apply sealer to manufacturer's recommend coverage.

B. Remove excessive sealer.

C. Using burnishing equipment and finest grit burnishing pads, burnish to uniform sheen matching approved mockup.

3.4 FIELD QUALITY CONTROL

A. Measure slip resistance using BOT-3000 slip-tester; ensure compliance with specified slip resistance rating.

3.5 PROTECTION

A. Close areas to traffic until concrete treatment has cured.

B. Protect completed work with nonstaining sheet coverings.

END OF SECTION

SECTION 04010

MASONRY MORTARING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mortar for masonry.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 04 2000 - Unit Masonry.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. C144 - Standard Specification for Aggregate for Masonry Mortar.
   2. C150 - Standard Specification for Portland Cement.
   3. C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
   4. C270 - Standard Specification for Mortar for Unit Masonry.

B. The Masonry Society (TMS):
   1. 402 - Building Code for Masonry Structures.
   2. 602 - Specification for Masonry Structures.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Samples: 1/2 x 1/2 inch x 3 inch long colored mortar samples.

B. Quality Control Submittals:
   1. Test reports: Indicating mortar compliance with ASTM C270.
   2. Delivery tickets: If mortar is delivered to site dry and pre-blended, furnish delivery tickets indicating quantity, mortar type, and date of manufacture.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with TMS 402 and 602.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver cement and lime in manufacturer's original, unopened packages or containers.

B. Protect materials from moisture absorption and damage; reject damaged containers.

C. Store aggregate to prevent inclusion of foreign matter.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Cement (Subject to compliance with requirements):
   1. Essroc Cement Corp. (www.essroc.com)
   2. LaFarge North America, Inc. (www.lafarge-na.com)
   3. Lehigh Cement Co. (www.lehighcement.com)
   4. Texas Industries, Inc. (www.txi.com)

B. Acceptable Manufacturers - Lime (Subject to compliance with requirements):
   1. Graymont Dolime (OH) Inc. (www.graymont-oh.com)
   2. Lhoist North America. (www.lhoist.us)

C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Portland Cement:
   1. ASTM C150, Type I.
   2. For exposed surfaces, provide cement from one source throughout project.

B. Aggregate:
   1. ASTM C144, standard masonry type.
   2. For exposed surfaces, provide aggregate from one source throughout project.

C. Lime: ASTM C207, Type S.

D. Colorant: Pure mineral oxide type manufactured by Quickrete or approved substitute; color to be selected from manufacturer's full color range.

E. Water: Clean and free from oils, acids, alkalies, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.

F. Integral water-repellent admixture: Dry-Block, Spec-Mix, MasterPel, or approved equal.

2.3 MIXES

A. Mortar Mixes: To ASTM C270 using the Property Method.
   1. Veneer concrete unit masonry: Type N, white color.
   2. Concrete unit masonry: Type S, gray color.

2.4 MIXING

A. Mix mortar in accordance with ASTM C270.

B. Jobsite Proportioning of Mortar:
   1. Mix using mechanical mixer. Hand mixing not permitted.
   2. Mix approximately three-quarters of required water, all of cement and lime, and one-half of aggregate for minimum of 2 minutes.
   3. Add remainder of water and aggregate; mix for minimum of 3 minutes.

C. Dry Preblended Mortar:
   1. Mix using continuous, self-cleaning mixer mounted at apex of silo cone.
   2. Set water flow valve to provide workable consistency.

D. Provide uniformity of color in exposed mortar.

E. Colorant may not exceed 9 pounds per 94 pound bag of cement for mineral oxides.

F. Thoroughly mix ingredients in quantities needed for immediate use.

G. Discard lumpy, caked, frozen, and hardened mixes.

H. Mortar may be retempered by adding water as required. Use mortar within 2-1/2 hours after initial mixing at ambient temperatures below 80 degrees F and within 1-1/2 hours after initial mixing at ambient temperatures over 80 degrees F.

I. Do not add accelerators, retarders, water repellents, antifreeze compounds, or other additives without Architect's approval.

PART 3 EXECUTION

3.1 INSTALLATION

A. Follow requirements specified in referenced sections.

END OF SECTION

SECTION 04100

MASONRY GROUTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grout for masonry.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 04 2000 - Unit Masonry.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. C91 - Standard Specification for Masonry Cement.
   2. C150 - Standard Specification for Portland Cement.
   3. C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
   4. C404 - Standard Specification for Aggregates for Masonry Grout.
   5. C476 - Standard Specification for Mortar and Grout for Reinforced Masonry.

B. The Masonry Society (TMS):
   1. 402 - Building Code for Masonry Structures.
   2. 602 - Specification for Masonry Structures.

1.3 SUBMITTALS

A. Quality Control Submittals:
   1. Test reports: Indicating grout compliance with ASTM C476.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with TMS 402 and 602.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver cement and lime in manufacturer's original, unopened packages or containers.

B. Protect materials from moisture absorption and damage; reject damaged containers.

C. Store aggregate to prevent inclusion of foreign matter.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Cement:
   1. Essroc Cement Corp. (www.essroc.com)

2. LaFarge North America, Inc. (www.lafarge-na.com)
3. Lehigh Cement Co. (www.lehighcement.com)
4. Texas Industries, Inc. (www.txi.com)

B. Acceptable Manufacturers - Lime:
1. Graymont Dolime (OH) Inc. (www.graymont-oh.com)
2. Lhoist North America. (www.lhoist.us).

C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Portland Cement: ASTM C150, Type I.

B. Aggregate: ASTM C404.

C. Lime: ASTM C207, Type S.

D. Water: Clean and free from oils, acids, alkalies, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.

2.3 MIXES

A. Grout Mix:
1. ASTM C476, fine grout, unless otherwise noted on plans.
2. Compressive strength: Minimum 2500 psi at 28 days, unless otherwise noted on plans.
3. Slump: 7 to 8 inches.

2.4 MIXING

A. Mix grout in accordance with ASTM C476.

B. Thoroughly mix ingredients in quantities needed for immediate use.

C. Mix dry ingredients mechanically until uniformly distributed; add water to achieve workable consistency.

D. Discard lumpy, caked, frozen, and hardened mixes.

E. Use grout within 2 hours after initial mixing at ambient temperatures below 80 degrees F and within 1-1/2 hours after initial mixing at ambient temperatures over 80 degrees F.

F. Do not add accelerators, retarders, water repellents, antifreeze compounds, or other additives without Architect's approval.

PART 3 EXECUTION

3.1 INSTALLATION

A. Follow requirements specified in referenced sections.

END OF SECTION

SECTION 04200

UNIT MASONRY

GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Concrete unit masonry.

2. Clay unit masonry in the form of brick.

3. Cavity wall construction.

4. Reinforced masonry walls.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 8 Section "Aluminum Windows".

C. Products installed but not furnished under this Section include the following:

1. Steel lintels in unit masonry are specified in Division 5 Section "Metal Fabrications."

2. Wood nailers and blocking built into unit masonry are specified in Division 6 Section "Wood Blocking and Curbing."

3. Hollow metal frames in unit masonry openings are specified in Division 8 Section "Steel Doors and Frames."

4. Plastic windows in unit masonry openings in Division 8.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops the following installed compressive strengths (f'm):

1. For clay unit masonry: As follows:

a. fm= 1500 psi.

b. Compressive strength 2,500 psi minimum.

2. For concrete unit masonry: As follows:

c. f'm = 1500 psi.

d. Compressive strength 1,900 psi minimum.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each different masonry unit, accessory, and other manufactured product indicated.

C. Shop drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315 "Details and Detailing of Concrete Reinforcing" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement.

D. Samples for initial selection purposes of the following:

1. Unit masonry samples in small-scale form showing full extent of colors and textures available for each different exposed masonry unit required.

E. Samples for verification purposes of the following:

1. Full-size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction.

2. Include size variation data verifying that actual range of sizes for brick falls within ASTM C 216 dimension tolerances for brick where modular dimensioning is indicated.

3. Accessories embedded in the masonry.

4. Material certificates for the following signed by manufacturer and Contractor certifying that each material complies with requirements.

5. Each different cement product required for mortar and grout including name of manufacturer, brand, type, and weight slips at time of delivery.

6. Each material and grade indicated for reinforcing bars.

7. Each type and size of joint reinforcement.

8. Each type and size of anchors, ties, and metal accessories.

F. Material test reports from a qualified independent testing laboratory employed and paid by Contractor indicating and interpreting test results relative to compliance of the following proposed masonry materials with requirements indicated:

1. Mortar complying with property requirements of ASTM C 270.

2. Grout mixes. Include description of type and proportions of grout ingredients.

3. Masonry units.

4. Cold-weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.

5. Hot-weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.

6. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, telephone numbers, names of Architects and Owners, and other information specified.

7. Results from tests and inspections performed by Owner's representatives will be reported promptly and in writing to Architect and Contractor.

1.05 QUALITY ASSURANCE

A. Unit Masonry Standard: Comply with ACI 530.1/ASCE 6 "Specifications for Masonry Structures," except as otherwise indicated.

B. Revise ACI 530.1/ASCE 6 to exclude, as they pertain to Work of Division 4 Section "Unit Masonry", Sections 1.4 and 1.7; Parts 2.1.2, 3.1.2, and 4.1.2; and Articles 1.5.1.2, 1.5.1.3, 2.1.1.1, 2.1.1.2, and 2.3.3.9 and to modify Article 2.1.1.4 by deleting requirement for installing vent pipes and conduits built into masonry. The Contractor shall have full responsibility for the above excluded sections as they pertain to the General Conditions of the Contract, the Division 1 Sections of the General Requirements, and the corresponding related technical sections of these Specifications. In no way, do the minimum criteria of the above referenced masonry standard relieve the Contractor of meeting or exceeding more restrictive criteria specified in the General Conditions of the Contract, the Division 1 Sections of the General Requirements, and the corresponding related technical sections of these Specifications.

C. Inspecting Laboratory Qualifications: To qualify for employment in performing tests and inspection specified in this Section, an independent testing laboratory must demonstrate to Architect's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM C 1093, that it has the experience and capability to conduct satisfactorily the testing indicated without delaying the progress of the Work.

D. Preconstruction Testing: The Contractor shall employ and pay a qualified independent testing laboratory to perform the following preconstruction testing indicated and other inspecting and testing services required by referenced unit masonry standard:

E. Clay unit masonry tests: For each different clay masonry unit indicated, units will be tested per ASTM C 67.

F. Concrete Masonry Unit Tests: For each different concrete masonry unit indicated, units will be tested for strength, absorption, and moisture content per ASTM C 140.

G. Prism Tests: For each type of wall construction indicated, masonry prisms will be tested per ASTM E 447, Method B.

H. Mortar properties will be tested per property specification of ASTM C 270.

I. Mortar composition and properties will be evaluated per ASTM C 780.

J. Grout compressive strength will be tested per ASTM C 1019.

K. Fire Performance Characteristics: Where indicated, provide materials and construction identical to those of assemblies whose fire resistance has been determined per ASTM E 119 by a testing and inspecting organization, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

L. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces. Different color units may come from different sources.

M. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

N. Field-Constructed Mock-Ups: Prior to installation of unit masonry, erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated for final unit of Work:

O. Locate mock-ups on site in locations indicated or, if not indicated, as directed by Architect.

P. Build mock-ups for the following types of masonry in sizes of approximately 4 feet long by 4 feet high by full thickness, including face wythes and backup construction as well as accessories.

Q. Each type of exposed unit masonry construction.

R. Notify Architect one week in advance of the dates and times when mock-ups will be erected.

S. Protect mock-ups from the elements with weather-resistant membrane.

T. Retain and maintain mock-ups during construction in undisturbed condition as standard for judging completed unit masonry construction.

U. When directed, demolish and remove mock-ups from Project site.

V. Accepted mock-ups in undisturbed condition at time of Substantial Completion may become part of completed unit of Work.

W. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.

C. Store cementitious materials off the ground, under cover, and in dry location.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

1.07 PROJECT CONDITIONS

A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

B. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

C. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

D. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls.

E. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that come in contact with such masonry.

F. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

G. Protect sills, ledges, and projections from mortar droppings.

H. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes from mortar droppings.

I. Cold-Weather Construction: Comply with referenced unit masonry standard for cold-weather construction and the following:

1. Do not lay masonry units that are wet or frozen.

2. Remove masonry damaged by freezing conditions.

J. Hot-Weather Construction: Comply with referenced unit masonry standard.

PRODUCTS

1.08 MATERIALS, GENERAL

A. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.

1.09 CONCRETE MASONRY UNITS

A. General: Comply with requirements indicated below applicable to each form of concrete masonry unit required.

B. Concrete Masonry Units: Manufactured to specified dimensions of 3/8 inch less score exposed face than nominal widths by nominal heights by nominal lengths indicated on drawings.

C. Concrete Block: Specified dimensions as follows:

1. Size: Manufacturer's standard units with nominal face dimensions of 16" long x 8" high (15-5/8" x 7-5/8" actual) x thicknesses indicated.

2. Special shapes: Lintels, bond beams, solid units, sill block.

3. Surface finishes: Split.

4. Integral water-repellent admixture: Dry-Block

5. Colors: To be selected from manufacturer's mid color range for face block.

D. Hollow Load-Bearing Concrete Masonry Units: ASTM C 90, Type I and II and as follows:

1. Unit Compressive Strength: Provide units with minimum average net area compressive strength indicated below:

e. 1900 psi.

f. Not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

2. Weight Classification: Lightweight for regular and fire rated block. Provide lightweight units with lightweight aggregates conforming to ASTM C331. Bottom ash shall meet all requirements in ASTM C140, C90 and C331.

Test	C331 Specifications
Organic Impurities-Color C40	≤3 (Standard)
Clay Lumps C142	2.0 Max
Loss on Ignition C618	5.0 Max
Pop Outs C151	None
Stain Index C641	<20 (no stain)

3. Unprocessed and unapproved waste products are prohibited.

E. Solid Load-Bearing Concrete Masonry Units: ASTM C 145, Grade N and as follows:

1. Unit Compressive Strength: Provide units with minimum average net area compressive strength indicated below:

g. 1900 psi.

h. Not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

2. Weight Classification: Lightweight.

F. Concrete Building Brick: ASTM C 55 and as follows:

1. Unit Compressive Strength: Provide units with minimum average net area compressive strength indicated below:

i. 3500 psi.

j. Not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

2. Weight Classification: Lightweight.

1.10 MORTAR AND GROUT MATERIALS

1. Specified in Division 4

1.11 MASONRY CEMENT SHALL NOT BE USED.

1.12 AIR ENTRAINMENT ADMIXTURES SHALL NOT BE USED.

1.13 ANTIFREEZING ADMIXTURES SHALL NOT BE USED.

1.14 REINFORCING STEEL

A. General: Provide reinforcing steel complying with requirements of referenced unit masonry standard and this article.

B. Steel Reinforcing Bars: Material and grade as follows:

1. Billet steel complying with ASTM A 615.

2. Grade 60.

3. Deformed Reinforcing Wire: ASTM A 496.

4. Plain Welded Wire Fabric: ASTM A 185.

5. Deformed Welded Wire Fabric: ASTM A 497.

1.15 JOINT REINFORCEMENT

A. General: Provide joint reinforcement complying with requirements of referenced unit masonry standard and this article, formed from the following:

1. Galvanized carbon steel wire, coating class as required by referenced unit masonry standard for application indicated.

B. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with prefabricated corner and tee units, and complying with requirements indicated below:

1. Wire Diameter for Side Rods: 0.1875 inch.

2. Wire Diameter for Cross Rods: 0.1483 inch (9 gage).

3. Hook and Eyes: 0.1875 inch.

4. For single-wythe masonry provide type as follows with single pair of side rods:

5. Truss design with continuous diagonal cross rods spaced not more than 16 inches o.c.

C. For multiwythe masonry provide type as follows:

1. Hook and eye with double eyes welded at 15 inches o.c. number of side rods as follows:

k. Number of Side Rods for Composite Construction: One side rod for each face shell of concrete masonry back-up.

l. Number of Side Rods for Multiple-Wythe Concrete Masonry: One side rod for each face shell of concrete masonry back-up.

m. Number of Side Rods for Multiple-Wythe Brick Masonry: One side rod for each face of brick back up.

D. Manufacturers: Subject to compliance with requirements, provide joint reinforcement by one of the following:

1. AA Wire Products Co.

2. Dur-O-Wal, Inc.

3. Heckman Building Products, Inc.

4. Hohmann & Barnard, Inc.

5. Masonry Reinforcing Corp. of America.

6. National Wire Products Industries.

7. Southern Construction Products, Inc.

1.16 TIES AND ANCHORS, GENERAL

A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standard and of this article.

B. Galvanized Carbon Steel Wire: Galvanize in accordance with ASTM 153-82 (1.50 oz. per sq. ft.) hot dipped galvanized after fabrication.

C. Wire Diameter: 0.1875 inch.

D. Galvanized Steel Sheet: As follows:

1. ASTM A 526 (commercial quality), Coating Designation G60, steel sheet zinc-coated by hot-dip process on continuous lines prior to fabrication, for sheet metal ties and anchors completely embedded in mortar.

2. ASTM A 366 (commercial quality) cold-rolled carbon steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153, Class B2 (for unit lengths over 15 inches) and Class B3 (for unit lengths under 15 inches), for sheet metal ties and anchors exposed to the weather and not completely embedded in mortar and grout.

E. Galvanized Steel Sheet Thickness: For steel sheet hot-dip galvanized by continuous process prior to fabrication:

1. 0.0785 inch (14 gage).

F. Thickness of Steel Sheet Galvanized After Fabrication: Uncoated thickness of steel sheet hot-dip galvanized after fabrication:

1. 0.0747 inch (14 gage).

G. Galvanized Heavy-Thickness Steel Sheet: ASTM A 635 (commercial quality) hot-rolled carbon steel sheet hot-dip galvanized after fabrication to comply with ASTM A 525, Class B3, for rigid anchors fabricated from steel sheet or strip with a thickness of 0.180 inch and greater.

H. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AA Wire Products Co.

2. Dur-O-Wal, Inc.

3. Heckman Building Products, Inc.

4. Hohmann & Barnard, Inc.

5. Masonry Reinforcing Corp. of America.

6. National Wire Products Industries.

7. Southern Construction Products, Inc.

1.17 BENT WIRE TIES

A. Individual units prefabricated from bent wire to comply with requirements indicated below:

1. Tie Shape for Hollow Masonry Units Laid with Cells Vertical: Rectangular with closed ends and not less than 4 inches wide.

2. Tie Shape for Solid Masonry Unit Construction: Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long.

3. Type for Masonry Where Coursing Between Wythes Align: Unit ties bent from one piece of wire.

4. Type for Masonry Where Coursing Between Wythes Does Not Align: Adjustable ties composed of two parts, one with pintles, the other with eyes, maximum misalignment 1-1/4 inches.

1.18 RIGID ANCHORS

A. Provide straps of form and length indicated, fabricated from metal strips of following width and thickness.

1. 1-1/2 inches wide by 1/4 inch thick.

1.19 ADJUSTABLE MASONRY VENEER ANCHORS

A. General: Provide two-piece assemblies allowing vertical or horizontal differential movement between wall and framework parallel to plane of wall, but resisting tension and compression forces perpendicular to it; for attachment over sheathing to studs; and with the following structural performance characteristics:

1. Structural Performance Characteristics: Capable of withstanding a 100 lbf load in either tension or compression without deforming over, or developing play in excess of, 0.05 inch.

2. Wire Ties For Cold-Formed Metal Frame Stud Assemblies:

n. Wire Size: 0.1875" diameter.

o. Wire Tie Shape: Triangular.

p. Wire Tie Length: As required to extend within 1" of masonry veneer face.

3. Wire Ties For Cold-Formed Metal Frame Furring Channel Assemblies: Mill galvanized finish.

q. Wire Size: 5 gauge.

r. Wire Tie Shape: J shaped with vertical loop-back leg as manufactured by Heckman Building Products, Inc.

s. Wire Tie Length: As required to extend within 1" of masonry veneer face.

4. Anchor Section (For Cold-Formed Metal Frame Stud Assemblies): Sheet metal plate, with screw holes top and bottom and with raised, rib-stiffened strap stamped into center to provide slot between strap and plate for connection of wire tie and pronged-leg construction; of overall size and thickness indicated below:

t. Size: Plate and strap size: 1-1/4" wide for plate, 5/8" for strap x lengths indicated below; slot clearance formed between face of plate and back of strap at maximum rib projection: 1/32" + diameter of wire tie.

u. Plate and Strap Lengths: 5" and 3-1/2"; with both sides of plate stiffened by ribs.

v. Pronged-Leg length: 1/2"

w. Thickness: 0.0747" (14 gage).

5. Available Products: Subject to compliance with requirements, masonry veneer anchors which may be incorporated in the work includes, but is not limited to, the following:

x. "DW-10-X"; Hohmann & Barnard, Inc.

6. Anchor Section (For Cold-Formed Metal Frame Furring Channel Assemblies): Provide POS-I-TIE by Heckman Building Products, Inc. with a self-drilling steel fastener with 3/8" x 3/4" galvanized steel washer with a permaseal backing for 1/2: gypsum sheathing. Fastener section shall be coated twice with Stalgard, by Elco Industries, after initial galvanizing. The barrel casting shall be of Zamak-2 (92% zinc) with an eye at the outer end that fits over the end of the self-drilling steel fastener.

7. Steel Drill Screws for Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, #10 diameter by length required to penetrate stud by not less than 6 exposed threads, and with the following corrosion protective coating:

   y. Organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

8. Neoprene Gaskets: Screw-attached masonry veneer anchor manufacturer's standard closed cell neoprene gaskets manufactured to fit behind anchor plate and to prevent moisture from penetrating through screw holes to steel studs behind sheathing.

9. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

   z. Organic-Polymer-Coated Steel Drill Screws:

10. "Traxx," ITW Buildex.

11. "Dril-Flex," Elco Industries, Inc.

1.20 POSTINSTALLED ANCHORS

A. Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing laboratory.

1. Type: Chemical anchors.

2. Type: Expansion anchors.

3. Corrosion Protection: Carbon steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild) at interior conditions.

4. Corrosion Protection: Stainless steel components complying with ASTM F 593 and ASTM F 594, Group 1 alloy 304 or 316 for bolts and nuts; alloy 304 or 316 for anchor at exterior conditions.

5. For cast-in-place and postinstalled anchors in concrete: Capability to sustain, without failure, a load equal to 4 times loads imposed by masonry.

6. For postinstalled anchors in grouted concrete masonry units: Capability to sustain, without failure, a load equal to 6 times loads imposed by masonry.

1.21 EMBEDDED FLASHING MATERIALS

A. Sheet Metal Flashing: Fabricate from the following metal complying with requirements specified in Division 7 Section "Flashing and Sheet Metal" and below:

1. Stainless steel drip edge .015" thick (15 mil.).

B. Coated Copper Flashing: Copper sheet coated on both sides with a polymer modified asphalt compound weighing approximately 6 oz per square foot.

1. Copper weight 3 oz per square foot.

2. Application: Where flashing is fully concealed in Masonry.

3. Adhesive for flashing: Type recommended by Manufacturer.

4. Products:

aa. Coated copper flashing by Polytite.

bb. Coated copper flashing by Sandell.

cc. Copper Aqua-Flash by Wire-Bond.

1.22 MISCELLANEOUS MASONRY ACCESSORIES

A. Nonmetallic Expansion Joint Strips: Premolded filler strips complying with ASTM D 1056, Type 2 (closed cell), Class A (cellular rubber and rubber-like materials with specific resistance to petroleum base oils), Grade 1 (compression-deflection range of 2-5 psi), compressible up to 35 percent, of width and thickness indicated, formulated from the following material:

1. Neoprene.

2. Urethane.

3. Polyvinyl chloride.

B. Preformed Control Joint Gaskets: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

1. Styrene-Butadiene Rubber Compound: ASTM D 2000, Designation 2AA-805.

2. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

3. Pea Gravel: Provide river-run aggregate, 3/8" to 1/4" size, free from fines and other deleterious material.

4. Manufactured Weepholes: Plastic 3/8 inch O.D. x 4 inch long. Provide with cotton wick attached.

1.23 MASONRY CLEANERS

A. Job-Mixed Detergent Solution: Solution of trisodium phosphate (1/2 cup dry measure) and laundry detergent (1/2 cup dry measure) dissolved in one gallon of water.

EXECUTION

1.24 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.

B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of unit masonry.

C. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

D. Do not proceed until unsatisfactory conditions have been corrected.

1.25 INSTALLATION, GENERAL

A. Comply with referenced unit masonry standard and other requirements indicated applicable to each type of installation included in Project.

B. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

C. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 8 inches of masonry between chase or recess and jamb of openings and between adjacent chases and recesses.

D. Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.

E. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

F. Dampproofing: Coordinate installation of cavity wall dampproofing with cavity wall construction.

1.26 CONSTRUCTION TOLERANCES

A. Comply with construction tolerances of referenced unit masonry standard.

1.27 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.

B. Lay up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less that nominal 4-inch horizontal face dimensions at corners or jambs.

D. One-half running bond with vertical joint in each course centered on units in courses above and below.

E. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

F. Stopping and Resuming Work: In each course, rack back 1/2-unit length for one-half running bond or 1/3-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.

G. Built-In Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.

H. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

I. At exterior frames insert extruded polystyrene board insulation around perimeter of frame in thickness indicated but not less than 3/4 inch to act as a thermal break between frame and masonry.

J. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

K. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

1.28 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units as follows:

1. With full mortar coverage on horizontal and vertical face shells.

2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.

3. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

4. Cut joints flush for masonry walls to be concealed or to be covered by other materials, unless otherwise indicated. At exterior conditions tool joint first, then re-fill and cut joint flush.

1.29 STRUCTURAL BONDING OF MULTIWYTHE MASONRY

A. Use individual metal ties installed in horizontal joints to bond wythes together.

B. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes.

C. Use either of the structural bonding systems specified above that is appropriate for the conditions and/or as indicated on the drawings.

D. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.

E. Provide continuity with horizontal joint reinforcement at corners using prefabricated "L" units, in addition to masonry bonding.

F. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:

1. Provide individual metal ties.

2. Provide continuity with horizontal joint reinforcement using prefabricated "T" units.

3. Nonbearing Interior Partitions: Build full height of story to underside of solid floor or roof structure above and as follows:

4. Install pressure-relieving joint filler in joint between top of partition and underside of structure above.

1.30 CAVITIES/AIR SPACES

A. Ensure dampproofing membrane is properly cured prior to exterior wythe installation.

B. Keep cavities/air spaces and weeps clean of mortar droppings and other materials during construction. Strike joints facing cavities/air spaces flush.

1. Pull a 2 x 4 mortar shelf up through the work to catch falling mortar.

C. Tie exterior wythe to backup with continuous horizontal joint reinforcing.

D. Provide weep holes in exterior wythe of cavity wall located immediately above ledges and flashing, spaced 2'-0" o.c., for brick and 2'-8" o.c. for concrete masonry units unless otherwise indicated.

1.31 HORIZONTAL JOINT REINFORCEMENT

A. General: Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" exterior side of walls, 1/2" elsewhere. Lap reinforcing a minimum of 6".

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Reinforce walls with continuous horizontal joint reinforcing.

D. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.

E. Space continuous horizontal reinforcement as follows:

1. For multi-wythe walls (solid or cavity) where continuous horizontal reinforcement acts as structural bond or tie between wythes, space reinforcement as required by code but not more than 16" o.c. vertically.

2. For single-wythe walls, space reinforcement at 16" o.c. vertically, unless otherwise indicated.

3. For parapets, space reinforcement at 8" o.c. vertically, unless otherwise indicated.

F. Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcement placed in 2 horizontal joints approximately 8" apart, immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints.

G. In addition to wall reinforcement, provide additional reinforcement at openings as required to comply with the above.

1.32 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.

2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 16" o.c. vertically and 16" o.c. horizontally.

1.33 ANCHORING SINGLE-WYTHE MASONRY VENEER

A. Anchor single-wythe masonry veneer to studs with masonry veneer anchors to comply with the following requirements:

1. Fasten each anchor section through sheathing to metal studs with metal fasteners of type indicated.

2. Embed tie section in masonry joints. Provide not less than 2-inch air space between back of masonry veneer wythe and face of sheathing.

3. Locate anchor section relative to course in which tie section is embedded to allow maximum vertical differential movement of tie up and down.

4. Space anchors as indicated but not more than 16" o.c. vertically and 16" o.c. horizontally. Install additional anchors within 1'-0" of openings and at intervals around perimeter not exceeding 3'-0".

1.34 MOVEMENT (CONTROL AND EXPANSION) JOINTS

A. General: Provide vertical and horizontal expansion, control and isolation joints in masonry where shown; and if not shown, provide control and isolation joints as recommended by BIA and NCMA and as follows:

1. Interior Partitions: Provide vertical expansion joints 30'-0" o.c. horizontally (maximum).

2. Exterior Cavity Walls: Provide vertical expansion joints 20'-0" o.c. horizontally (maximum) or as noted.

3. Steel Lintels: Provide horizontal bond breaks at the end bearing to allow for thermal expansion and contraction.

4. Openings in Exterior and Interior Walls: At masonry with steel lintels, provide control joints on each side of the opening continuing to the top and bottom of the brick wythe and as specified above. At CMU lintels, provide control joints in alignment with the outside ends of the lintel continuing to the bed joint and then with horizontal bond breaks at the end bearing.

5. At exterior windows only, at CMU sills and lintels, provide control joints in alignment with the outside ends of the sill/lintel continuous vertically.

6. Veneer Construction: Provide horizontal pressure relieving joints at each story as recommended by BIA Technical Note 28B current edition. Verify locations of steel shelf angles with Architect/Engineer.

B. Form control joints in concrete masonry as follows:

1. Install preformed control joint gaskets designed to fit standard sash block.

C. Form expansion joints in brick made from clay or shale as follows:

1. Form open joint of width indicated but not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealers." Maintain joint free and clear of mortar.

1.35 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and wherever openings of more than 1'-0" for brick size units and 2'-0" for block size units are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

C. For hollow concrete masonry unit walls, use specially formed bond beam units with reinforcement bars placed as indicated and filled with coarse grout.

D. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

1.36 FLASHING/WEEP HOLES

A. General: Provide concealed flashing in masonry work at, or above, shelf angles, lintels, ledges and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Form flashing dams at ends. Prepare masonry surfaces smooth and free from projections which could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with mastic before covering with mortar. Extend flashings through exterior face of masonry and extend 1" minimum. After observed by Architect and directed by Architect, cut off flush with face of masonry.

B. Extend flashing (NOTE : ALL THROUGH WALL FLASHINGS MUST HAVE ALL JOINTS SOLDERED) the full length of lintels and shelf angles and minimum of 4" into masonry each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4", and through the inner wythe to within 1/2" of the interior face of the wall in exposed work. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2". At heads and sills turn up ends not less than 2" to form an end dam as recommended by BIA and illustrated in BIA Technical Note 7, Figure 21, current edition.

C. Install flashing to comply with manufacturer's installation.

D. Provide weep holes in the head joints of the first course of masonry immediately above concealed flashings. Space 24" o.c..

E. Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

1.37 INSTALLATION OF REINFORCED UNIT MASONRY

A. General: Install reinforced unit masonry to comply with requirements of referenced unit masonry standard.

B. Temporary Formwork: Construct formwork and shores to support reinforced masonry elements during construction.

C. Construct formwork to conform to shape, line, and dimensions shown. Make sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

D. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

E. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

1.38 FIELD QUALITY CONTROL

A. Brick Tests: For each type and grade of brick indicated, units will be tested by qualified independent testing laboratory per ASTM C 67 except 5 bricks will be selected at random for each 100,000 units or fraction thereof installed.

B. Concrete Masonry Unit Tests: For each type, class, and grade of concrete masonry unit indicated, units will be tested by qualified independent testing laboratory for strength, absorption, and moisture content per ASTM C 140.

C. Testing Frequency: Tests and evaluations listed in this article will be performed during construction for each 5000 sq. ft. of wall area or portion thereof.

D. Mortar properties will be tested per property specification of ASTM C 270.

E. Mortar composition and properties will be evaluated per ASTM C 780.

F. Grout compressive strength will be sampled and tested per ASTM C 1019.

G. Prism Test Method: For each type of wall construction indicated, masonry prisms will be tested per ASTM E 447, Method B, and as follows:

H. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.

I. Evaluation of Quality Control Tests: In absence of other indications of noncompliance with requirements, masonry will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

1.39 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.

C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Clean brick by means of bucket and brush hand-cleaning method described in BIA "Technical Note No. 20 Revised" using the following masonry cleaner:

4. Job-mixed detergent solution.

5. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 45 applicable to type of stain present on exposed surfaces.

D. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05050

MISCELLANEOUS METAL

PART 1 GENERAL

1.01 SCOPE

A. Provide labor, materials, and equipment for the installation of miscellaneous steel, iron, aluminum, and other miscellaneous metal work indicated on the Drawings, specified, and reasonably implied for a complete Project.

B. Miscellaneous Metal Included in Structural Drawings: All steel and iron items in the structural drawings except steel joists, structural beams, columns, and plates and concrete reinforcement shall be provided under the Miscellaneous Metal of these specifications.

1.02 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. North Carolina State Building Code, Volume I - General Construction
   2. North Carolina Occupational Safety and Health Standards for General Industry
   3. Occupational Safety and Health Administration, Volume I - General Industry Standards and Interpretations (OSHA)

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
   2. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Pipe railings.
      b. Gratings.
      c. Ladders.
      d. Stairs.
      e. Miscellaneous metals.
   3. Shop drawings for rail system, stairs, ladders, gratings, and any other items shall be signed, and sealed by a Professional Engineer registered in the State of North Carolina who is regularly engaged in the design of miscellaneous metal systems. Shop drawings shall certify that the system was designed in accordance with the N.C. Building Code, these specifications and other applicable standards.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 01600.

1.05 ACCEPTABLE ITEMS

A. Materials, products, patterns, and fabrication methods meeting the requirements of this specification and conforming to details and design indicated in the Drawings will be accepted.

1.06 BUILT-IN ITEMS

A. Built-in items shall be installed in ample time for incorporation with the work. The Contractor shall coordinate with the other trades in furnishing and installing materials in such a manner as to expedite the progress of all work.

1.07 WORKMANSHIP

A. Workmanship shall be in accordance with the best practices. Work shall be performed in an approved, workmanlike manner by mechanics skilled in fabricating each of the metals being used.

1.08 SUPPLEMENTARY PARTS

A. Supplementary parts necessary to complete each item, though such items are not definitely indicated or specified, shall be included. Anchors, sockets, sleeves, or other fastenings required for securing metal work to other construction shall be provided.

PART 2 PRODUCTS

2.01 PIPE RAIL SYSTEM

A. Pipe railing shall be designed and installed in accordance with OSHA and the N. C. State Building Code, Factory - Industrial occupancy, Group F, and the following requirements.

B. Rail requirements:

1.	Height:	42-inches to centerline of top rail. Not more than 34-inches nor less than 30-inches from leading edge of tread for stairs.
2.	Number of rails:	Two (One top, one intermediate)
3.	Rail Spacing:	Maximum clear distance between rails shall be 21-inches.
4.	Pipe cross section:	1-1/2-inch minimum diameter.
5.	Pipe material:	Schedule 40 (min.) aluminum alloy 6063-T6 or 6105-T5, ASTM B-429 or ASTM B-221.
6.	Toe plate:	4-inch high, mounted 1/4-inch above walking surface.
7.	Max. post spacing:	6 feet center to center.
8.	Finish:	Anodized. Pipe shall be plastic wrapped and shall not be removed until after installation.
9.	The top surface of the rail shall be smooth and not be interrupted by projections.	
10.	Rail along curved structures shall be curved to match radius of structure.	

11. Provide self-closing gate at rail openings.
12. Manufacturer shall provide expansion joint for rail and toe plate as necessary.
13. Aluminum surfaces in contact with concrete or grout shall have a coating of bituminous paint. When in contact with dissimilar metals pipe shall be protected by a mylar isolator or other approved material.

C. Rail system shall be of welded construction. Railings shall be shop assembled in the largest practical sections for shipping and installing. Posts shall be set in galvanized steel pipe sleeves set in the concrete. Caulk posts into sleeves with lead or other setting material.

D. Welds shall be ground smooth.

E. Shop drawings for rail system shall be signed and sealed by a professional engineer registered in the State of North Carolina who is regularly engaged in the design of pipe rail system. Shop drawings shall include a note that the rail system was designed in accordance with the N. C. State Building Code.

F. Rail system shall be as manufactured by Alumaguard, Hollaender Manufacturer, Thompson Fabricating Co., or equal.

2.02 ACCESS HATCH

A. Provide access hatches in conformance with the following requirements:
1. Size as indicated on the Drawings. Size is for the required minimum clear opening.
2. Provide aluminum extrusion frame and aluminum checkered tread plate for the door with a mill finish. Provide stainless steel hinges, nuts, bolts, and washers. Unit shall be tamperproof from outside.
3. Design and construct hatches for a minimum 300 lb / sq ft live load unless an H20 load is indicated on the Drawings. Maximum deflection shall not exceed 1/150 th of the span at the design load.
4. Thermally broken cover and curb featuring R-20+ insulation
5. EPDM gasket to provide wind and weather resistance
6. Engineered compression spring operators provide smooth, easy, one-hand operation.
7. Automatic hold-open arm locks the cover in the open position to ensure safe egress
8. Slam latch with interior and exterior padlock hasps
9. Corrosion resistant aluminum construction (optional powder coat paint finish shown)
10. Door shall have the following:
    a. Auto-lock stainless steel hold open arm with aluminum release handle.
    b. Door shall open to a full 90 degree position.
    c. Door shall close flush with frame.
    d. Manufacturer shall be Bilco, Electric Specialty, Halliday Products, Thompson Fabricating Co., Washington Aluminum, or equal.

2.03 STEEL

A. Steel generally shall be mild steel. When structural members are required, they shall conform to the requirements given under specifications for structural steel.

2.04 CAST IRON

A. Cast iron shall be soft grey iron true to pattern, smooth and straight, with smooth even edges and corners of a uniform thickness of metal and shall be entirely free from defects impairing strength, durability or appearance. Casing shall be of thickness and strength sufficient to withstand all strains that may be brought to bear upon them. Cast iron shall be ASTM A 48.

2.05 WROUGHT IRON

A. Wrought iron shall be best quality ductile forge iron.

2.06 ANCHORS AND BOLTS

A. Anchors and bolts for use in the attachment of miscellaneous steel, iron, etc., shall be furnished and installed in accordance with the details shown in the drawings or as required. Inserts and hangers of an approved type shall be furnished and installed wherever necessary for the attachment or suspending of structural parts to or from masonry, concrete, etc. Bolts set in concrete, shelf angles, and weld plates for hanger attachment shall be galvanized.

2.07 ALUMINUM SHAPES

A. Aluminum shapes, unless otherwise specified, shall have a mill aluminum finish.

2.08 EXTRUDED ALUMINUM

A. Extruded aluminum shall be in accordance with ASTM Specification B-221, allow GA 10A, commercially known as 638. Aluminum in contact with concrete, masonry, plaster, or other metals shall be protected with a coat of alkali resistant bituminous paint as recommended by aluminum manufacturer or two layers of roofers felt between the item and the contact surface.

2.09 SHOP PAINT

A. Shop paint shall be a lead-free, priming, protective paint as standard with the manufacturer and consistent with Section 09900, Painting.

2.10 STAINLESS STEEL

A. Stainless steel shall be Type 304 with 2B polished finish, except as otherwise indicated on the drawings.

2.11 SLEEVES

A. Sleeves will be provided by the trade involved. This Contractor shall see that they are properly set and held in place.

2.12 STEEL LINTELS

A. Steel lintels over masonry openings, where detailed or required, shall have at least 8" bearing at each end. Provide greater bearing when called for on drawings.

2.13 DOWNSPOUT BOOTS

A. Furnish and install boots equal to Neenah No. R-4925-L at all downspouts connecting to storm drainage. For downspouts with splash blocks at finish grade, furnish and install boots equal to Neenah No. R-4928-B.

2.14 GRATINGS

A. Gratings shall be provided where indicated. Gratings shall be of a rolled structural shape of aluminum or extruded aluminum of punched rectangular pattern, or swaged locked cross bar type pattern unless otherwise noted. The surface shall be slip resistant. Units shall be banded on ends and where cut around pipes or other obstructions to provide a neat, well-shaped opening adequately supported. The floor formed by the grating shall be designed to support a uniform level load of not less than 100 pounds per square foot (unless otherwise noted on the drawings) with a maximum deflection of 1/4 inch or 1/360th of the span. Aluminum gratings shall have a mill finish. Frames to support gratings shall be of standard structural shapes of sizes indicated. All necessary fastenings, clips, and bolts shall be provided. Provided in section all widths so that one man can remove and replace the section.

2.15 SAFETY NOSINGS

A. Safety nosings shall be of cast aluminum with cross-hatched or abrasive- surfaced nosing 3 inches wide and terminating at not more than 6 inches from the ends of treads for stairs and as indicated for platforms and landings. Safety nosings shall be provided with integrally cast or bent anchors for embedding into concrete and shall be flush with the top of the traffic surface. Safety nosings shall be placed on all cast-in-place steps even though not specifically shown on the drawings.

2.16 STEEL STAIRS

A. Steel stairs complete with structural columns, handrails, and necessary bolts and other fastenings shall conform to the following requirements.

B. Materials:
   1. Structural steel shall conform to ASTM Specification A36.
   2. Stair stringers shall be hot-dipped galvanized after fabrication.
   3. Stair treads shall be of the same type and spacing as grating specified in Section 2.16 herein. Bearing bars shall be selected in accordance with the NAAMM Metal Bar Grating Manual. Each tread shall have a cast aluminum abrasive nose.

C. Installation: Anchor bolts, grating fasteners, washers, and all parts or devices necessary for proper installation shall be furnished and installed. Lock washers shall be used under nuts.

D. Provide complete shop drawings prior to fabrication.

2.17 MISCELLANEOUS PIPE SUPPORTS AND SADDLES

A. Miscellaneous pipe supports and saddles shall be provided as indicated and necessary to support piping and provide blockage of pipe subject to pressure thrust.

2.18 MISCELLANEOUS PLATES AND SHAPES

A. Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work. Miscellaneous plates and shapes shall conform to ASTM Specification A36.

2.19 ANCHOR BOLTS

A. Anchor bolts placed into existing concrete shall be type 303 or 304 stainless steel expansion bolts. Bolts shall be Phillips RED HEAD Wedge Anchors as manufactured by ITT - Phillips Drill Company; Hilti Kwik Bolts as manufactured by Hilti Fastening Systems; Rawl-Studs as manufactured by Rawlplug Company, or approved equal.

B. Anchor bolts placed into new concrete shall be threaded Type 303 or 304 stainless steel rod L shaped or as indicated.

PART 3 EXECUTION

3.01 FABRICATION

A. Steel, iron, and other materials furnished under this section shall be well formed to shape and size required by drawings with all angles sharp and true with surfaces well finished, smooth and with well defined lines and arises. Punching and shearing shall be properly and neatly done. Permanent connections shall be riveted, bolted, or welded as required. Curved work shall be evenly sprung in uniform curves. Joints shall be milled to produce a neat, close fit in all cases. Necessary rabbets, lugs, and brackets shall be provided so that work can be assembled in a neat and substantial manner.

B. Holes shall be drilled where possible, and fasteners shall be concealed where practicable. Where possible, bolt, screw and rivet heads shall be countersunk flush. The thickness of metal and details of connections and supports shall be such as to provide adequate strength and stiffness. Exposed joints shall be formed to exclude water and make watertight wherever possible.

C. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water. Provide holes and connections for the work of other trades.

D. Except where otherwise specified for a particular item of work or for built-in work, metal work shall be fastened to solid masonry with expansion bolts and to hollow block with toggle bolts. Fastening to wood plugs in masonry will not be permitted. Holes for plugs or bolts shall be drilled to the exact diameter of the plug or bolts

using a rotary drill for concrete or a percussion drill for other masonry. Screws shall be threaded full length to the head of the screw.

E. Expansion anchors shall be installed in conformity with the manufacturer's recommendations for maximum holding power, but in no case shall the depth of hole be less than six bolt diameters. Unless otherwise indicated on the drawings, the minimum distance between the center of any expansion anchor and an edge or exterior corner of concrete shall be at least six bolt diameters, and the minimum distance between centers of expansion anchors shall be at least eight bolt diameters.

F. Before final acceptance of the work, all miscellaneous metal items shall be thoroughly cleaned using only mild soap and water where possible. Caustic cleaners shall not be used, and solvents shall be used only with extreme care.

G. Welding shall be done under proper supervision and in accordance with the latest edition of "Code for Fusion Welding and Gas Cutting in Building Construction" of the American Welding Society. All exposed welds shall be ground smooth. Prime all welds.

H. Shop paint, except as specified otherwise or shown in the drawings, shall be applied to all miscellaneous steel and iron after being cleaned thoroughly of all dirt, grease, loose scale, rust, or other foreign material.

I. Anchorage or attachment of miscellaneous metal items shall be by thru-bolts, bolts engaging lead or metal expansion shields, self-drilling devices similar and equal to "Red Heads". Rawl plugs or wood blocks shall not be used.

J. Structural design of items covered in these specifications shall conform to the Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.

K. Aluminum surfaces in contact with concrete or grout shall have a coating of bituminous paint - when in contact with dissimilar metals, pipe shall be protected by a Mylar isolator or other approved material.

3.02 GALVANIZING STEEL

A. Unless otherwise noted, all galvanized steel shall be hot dipped galvanized. Galvanizing shall be in accordance with ASTM A384, A385, and A386 of latest revision.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Structural steel framing members.
   2. Grouting base plates.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. American Institute of Steel Construction (AISC) - Specifications for Structural Steel Buildings.

B. American Welding Society (AWS) D1.1 - Structural Welding Code - Steel.

C. ASTM International (ASTM):
   1. A36/A36M - Standard Specification for Carbon Structural Steel.
   2. A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A307 - Standard Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners.
   4. A325 - Standard Specification for High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
   5. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   6. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   7. A572/A572M - Standard Specification for High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality.
   8. A992/A992M - Standard Specification for Steel for Structural Shapes.
   9. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-In. or 50-mm Cube Specimens).
   10. E164 - Standard Practice for Ultrasonic Contact Examination of Weldments.

D. Society for Protective Coatings (SSPC) - Painting Manual.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Indicate profiles, sizes, spacing, and location of structural members, openings, attachments, and fasteners, and connections not detailed.

B. Quality Control Submittals:
   1. Welder Qualifications: As required by AWS D1.1.

1.4 QUALITY ASSURANCE

A. Fabricator and Erector Qualifications: Minimum 5 years documented experience in work of this Section.

B. Welder Qualifications: AWS D1.1.

C. Design Requirements: Design connections not detailed on Drawings under supervision of a Professional Structural Engineer experienced in this work and registered in the State in which the project is located.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store steel above ground on platforms, skids, or other supports; separate with wooden separators.

B. Protect steel from corrosion.

C. Prevent damage to prime coat; use wooden protectors to prevent damage from chain or cable cinches.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel:
   1. Shapes, bars, and plates: ASTM A36/A36M; ASTM A572/A572M, Grade 50; ASTM A992
   2. Hollow structural sections: ASTM A500, Grade B.
   3. Pipe: ASTM A53/A53M, Grade B; ASTM A501.

2.2 ACCESSORIES

A. Anchor Bolts: ASTM A307.

B. High Strength Bolts: ASTM A325, Type 1, uncoated.

C. Standard Bolts: ASTM A307, Grade A.

D. Primer Paint: SSPC Paint 15, Type 1, red oxide.

E. Non Shrink Grout: Premixed, consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; minimum 7,000 PSI compressive strength at 28 days.

F. Welding Materials: AWS D1.1, type required for materials being welded.

2.3 FABRICATION

A. Fabricate structural steel in accordance with AISC Manual.

B. Welding: AWS D1.1. Stress relieve welded assemblies by heat treatment.

C. Where collection of water inside structural tubing could occur, provide drain hole at lowest point.

D. Cap open ends of tubes and seal weld. Wherever practical, weld connections all around. Seal seams that cannot be practically welded with joint sealer.

E. Shop Painting:
   1. Shop prime steel surfaces except:
      a. Surfaces to be welded.
      b. Contact surfaces of high strength friction type bolted connections.
      c. Surfaces to receive direct-applied fireproofing.
   2. Surface preparation: SSPC Method SP2 - Hand Tool Cleaning or Method SP3 - Power Tool Cleaning.
   3. Application: One coat; follow coating manufacturer's instructions.
   4. Minimum dry film thickness: 2.0 mils.

PART 3 EXECUTION

3.1 ERECTION OF STEEL FRAMING

A. Erect structural steel in accordance with AISC Specifications.

B. Accurately assemble to lines and elevations indicated, within specified erection tolerances.

C. Align and adjust members forming parts of complete frame or structure after assembly but before fastening.

D. Provide temporary shoring and bracing members with connections of sufficient strength to resist imposed loads.

E. Align column bases with leveling nuts.

F. Align bearing plates with leveling nuts.

G. Fasten splices of compression members after abutting surfaces have been brought completely into contact.

H. Clean bearing surfaces and surfaces that will be in permanent contact before members are assembled.

I. Locate splices only where indicated.

J. Tighten erection bolts and leave in place.

K. Do not correct fabrication by gas cutting on major members.

L. Remove temporary shoring and bracing members after permanent members are in place and final connections have been made.

M. Installation Tolerances:
   1. Maximum variation from plumb: 1/4 inch per story, noncumulative.
   2. Maximum variation from level: 1/4 inch in 10 feet, noncumulative.
   3. Maximum offset from alignment of adjacent members: 1/4 inch.

3.2 PLACEMENT OF GROUT

A. Remove loose and foreign matter from concrete; lightly roughen bonding surface.

B. Remove foreign materials from steel surfaces; align and level members in final position.

C. Just prior to grouting, thoroughly wet concrete surfaces; remove excess water.

D. Mix grout in accordance with manufacturer's instructions. Do not retemper.

E. Place grout continuously, by most practical means; avoid entrapped air. Do not vibrate grout.

3.3 FIELD QUALITY CONTROL

A. Testing and Inspection Services:
   1. Inspect steel elements for conformance to specified requirements including:
      a. Location and adequacy of bracing.
      b. Location and set of anchor bolts and other inserts.
      c. Alignment, plumb, camber, and other required attributes.
   2. Inspect high strength bolted construction in accordance with AISC Specification and as follows:
      a. Visually inspect high strength bolted connections.
      b. Check at least two bolts of every third connection with calibrated torque wrench for proper torque.
   3. Inspect field welds in accordance with AWS D1.1 and as follows:
      a. Visually inspect welds.
      b. Test full penetration welds by ultrasonic method in accordance with ASTM E164.
   4. Make one set of six test cubes for each 1/3 cubic yard of grout placed or fraction thereof:
      a. Mold and test cubes in accordance with ASTM C109; three at 7 days and three at 28 days.
      b. Restrain grout from expansion by use of top plate.

3.4 ADJUSTING

A. Touch up bolt heads, nuts, field welds, and abrasions in shop coating with same primer used in shop.

END OF SECTION

SECTION 06100

ROUGH CARPENTRY

PART 1GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wood blocking and furring.
   2. Telephone and electrical panel backboards.
   3. Roof curbs.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. American Wood Protection Association (AWPA) U1 - Use Category System - User Specification for Treated Wood.

B. ASTM International (ASTM):
   1. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.

C. National Institute of Standards and Technology (NIST) - Product Standard PS 20 - American Softwood Lumber Standard.

D. Southern Pine Inspection Bureau (SPIB) - Standard Grading Rules for Southern Pine Lumber.

1.3 SUBMITTALS

1.4 QUALITY ASSURANCE

A. Lumber Grading Agency: Certified to NIST PS 20.

B. Identify lumber and panel products by official grade mark.

C. Fire Retardant Treated Products: Bear label of recognized independent testing laboratory indicating flame spread rating of 25 or less, tested to ASTM E84.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store materials minimum 6 inches above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation.

B. Do not store seasoned or treated materials in damp location.

C. Protect edges and corners of sheet materials from damage.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber:
   1. Grading rules: SPIB.
   2. Grade: No. 1 Construction
   3. Surfacing: Surfaced four sides (S4S).
   4. Maximum moisture content: 19 percent.

B. Panel Products:
   1. Type: APA Plywood.
   2. Panel grade: APA Rated Sheathing.
   3. Exposure:
      a. Exterior applications: Exterior.
      b. Interior applications: Interior.

2.2 ACCESSORIES

A. Fasteners:
   1. Type and size: As required by conditions of use.
   2. Exterior locations and treated products: Stainless steel, ASTM F593, Type 304 or 316.
   3. Other interior locations: Stainless steel, ASTM F593, Type 304 or 316.

2.3 FABRICATION

A. Preservative Treatment:
   1. Treat lumber and panel products in accordance with AWPA U1:
      a. Interior locations: Category UC2 - Interior/Damp.
      b. Exterior locations above ground: Category UC3B - Above Ground/Exposed.
      c. Exterior locations in contact with ground: Category UC4B - Ground Contact/Heavy Duty.
   2. Treatment process: Type CCA - Chromated Copper Arsenate.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide blocking, nailers, grounds, furring, and other similar items required to receive and support work.

B. Set members level, plumb, and rigid.

C. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.

D. Install telephone and electrical panel backboards where indicated. Oversize panel by 12 inches on all sides.

END OF SECTION

SECTION 07141

COLD FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Edit the following paragraphs to include only those items specified in this section.

B. Section Includes:
   1. Cold fluid-applied polyurethane membrane waterproofing.

1.02 REFERENCES

A. In the following paragraphs, retain only those reference standards that are used elsewhere in this section.

B. ASTM International (ASTM) (www.astm.org):
   1. C836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
   2. D412 - Standard Specification for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
   1. D4261 - Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
   3. E96/E96M - Standard Test Method for Water Vapor Transmission of Materials.

1.03 SUBMITTALS

A. Limiting submittals to only those actually required helps to minimize liability arising from the review of submittals. Minimize submittals on smaller, less complex projects.

B. Include the following for submission of shop drawings, product data, and samples for the Architect's review.

C. Submittals for Review:
   1. Product Data: Manufacturer's data for waterproofing including product description and performance characteristics.
   2. Warranty: Sample warranty form.

D. Quality Control Submittals:
   1. Applicator's license certificate issued by manufacturer of waterproofing material.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Minimum 3 years documented experience in work of this Section.
   2. Licensed or certified by waterproofing manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store materials at minimum 70 degrees F; prevent damage to containers. Do not store in direct sunlight.

1.06 PROJECT CONDITIONS

A. Environmental Conditions:
   1. Do not apply waterproofing when ambient or surface temperature is less than 40 degrees F or if precipitation is imminent.
   2. Do not apply material to wet surfaces.

B. Substrate: Cured minimum 28 days prior to applying waterproofing.

1.07 WARRANTIES

A. Furnish manufacturer's 10 year warranty providing coverage against water leakage through waterproofing system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Kemper System America, Inc. (www.kemper-system.com)
   2. Neogard Corporation. (www.neogard.com)
   3. Tremco, Inc. (www.tremcosealants.com)
   4. Henry. (http://us.henry.com)
   5. Grace. (https://grace.com/en-us)

B. Substitutions: Under provisions of Division 01.

2.02 MATERIALS

A. Fluid Applied Waterproofing:
   1. Type: Single-component, bitumen modified, cold liquid applied moisture curing urethane complying with ASTM C836.
   2. Physical properties:
      a. Elongation: Minimum 600 percent, tested to ASTM D412.
      b. Tensile strength: Minimum 150 psi, tested to ASTM D412.
      c. 100 percent modulus: Minimum 80 psi, tested to ASTM D412.
      d. Crack bridging: Pass 1/16 inch with no loss of bond or cracking exhibited, cycled 10 times per 24 hours at 15 degrees F, tested to ASTM C836.
      e. Moisture vapor permeability: Maximum 0.1 perm, tested to ASTM E96.

2.03 ACCESSORIES

A. Surface Conditioner, Joint Sealers, and Patching Compounds: Type recommended by waterproofing manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to ASTM D4261.

B. Clean exposed metals; apply surface conditioner and coat of waterproofing material to minimum 60 mils thickness. Extend preparatory coat minimum 3 inches onto adjacent surfaces and up vertical surfaces minimum 6 inches.

C. Clean cracks and joints in substrate less than 1/16 inch in width and apply preparatory coat of waterproofing material, minimum 60 mils wet film thickness; extend minimum 3 inches onto adjacent surfaces.

D. Rout out cracks and joints over 1/16 inch in width to minimum 1/4 inch depth, and fill with waterproofing. Apply preparatory coat of waterproofing material, minimum 60 mils wet film thickness; extend minimum 3 inches onto adjacent surfaces.

E. At changes in plane of substrate, form cant of waterproofing material, minimum 1 inch high.

F. Allow preparatory work to cure minimum 12 hours, then clean and apply surface conditioner.

3.02 APPLICATION OF WATERPROOFING

A. Apply waterproofing system in accordance with manufacturer's instructions.

B. Apply in as many coats as needed to achieve minimum 60 mils wet film thickness, excluding preparatory work.

C. Extend membrane up vertical surfaces minimum 6 inches.

D. Seal items projecting through membrane.

E. Apply waterproofing with reinforcing fabric at locations of potential high movement, including intersections not structurally connected.

3.03 FIELD QUALITY CONTROL

A. Vertical Surfaces:
   1. Repair damaged and defective areas.

END OF SECTION

SECTION 07190

WATER REPELLENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Clear water repellent coating applied to exterior concrete masonry surfaces. Do not use on ground face concrete masonry.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. D4261 - Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
   2. E96/E96M - Standard Test Method for Water Vapor Transmission of Materials.
   3. E514/E514M - Standard Test Method for Water Penetration and Leakage Through Masonry.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Include product description and performance characteristics.
   2. Warranty: Sample warranty form.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 3 years documented experience in work of this Section.

B. Mockup:
   1. Size: 10 x 10 feet.
   2. Determine coverage rate for application.
   3. After curing, water test to verify sufficient coverage to repel moisture from surface.
   4. Verify that application of coating to substrate will not produce surface stains or discoloration.
   5. Locate where directed.

1.5 PROJECT CONDITIONS

A. Do not apply coating if:
   1. Ambient or surface temperature is below freezing.
   2. Possibility of entrapped or frozen water exists.
   3. Rain is expected during next 72 hours.

B. Do not apply during high winds.

C. Prevent overspray onto adjacent materials.

1.6 SEQUENCING

A. Allow joint sealants to cure minimum 48 hours after their application before applying coating.

B. Allow water repellent to cure minimum 5 days after application before applying joint sealers to coated surfaces.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. BASF. (www.buildingsystems.basf.com)
2. L&M Construction Chemicals, Inc. (www.lmcc.com)
3. Pecora Corp. (www.pecora.com)
4. ProSoCo, Inc. (www.prosoco.com) (Basis of Design)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Water Repellent:
1. Solvent based.
2. Contain minimum 9 percent silicone by weight.
3. Produce water repellent effect without altering color or texture of substrate.
4. Water repellency: Minimum 80 percent reduction in water absorption from control sample, tested to ASTM E514/E514M.
5. Water vapor transmission: Maximum 10 percent reduction from control sample, tested to ASTM E96/E96M.
6. Source: Sure Klean Custom Masonry Sealer by ProSoCoor approved substitute.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to ASTM D4261.

B. Allow surfaces to dry completely before beginning application.

3.2 APPLICATION

A. Follow manufacturer's instructions.

B. Apply at rate recommended by manufacturer unless otherwise determined by testing of mockup.

C. Apply in two coats.

D. Apply to following surfaces: Architecturalconcrete unit masonry except ground face.

3.3 FIELD QUALITY CONTROL

A. After coating has dried, test surfaces with water spray; reapply to any areas showing water absorption.

END OF SECTION

SECTION 07213

PRE-ENGINEERED BUILDING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes
   1. Pre-Engineered Building Insulation for New Construction.

1.02 RELATED SECTIONS

A. Section 13121 - Pre-Engineered Metal Buildings.

B. Division 15 - Mechanical; Rough-in utilities.

C. Division 16 - Electrical; Rough-in utilities.

1.03 REFERENCES

A. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. ASTM E 96 - Standard Test Method for Water Vapor Transmission of Materials in Sheet Form (Procedure B).

C. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

D. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

E. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

F. ASTM C 1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

1.04 DESIGN REQUIREMENTS

A. Insulating system shall have a continuous vapor barrier inside of building purlins, girts, and insulation to provide complete isolation from inside conditioned air.

1.05 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing product systems specified in this section with minimum five years documented experience.

B. Installer Qualifications: Company specializing in performing work of this section.

C. Insulation system components to include a ten-year limited material warranty.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products indoors and protect from moisture, construction traffic, and damage.

1.08 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer: Thermal Design, Inc., Simple Saver System. P.O. Box 468, 601 N. Main Street, Madison, NE 68748. ASD. Tel: (800) 255-0776 or (402) 454-6591. Fax: (402) 454-2708. Email: sales@thermaldesign.com, www.thermaldesign.com.

B. Dow

C. Owens-Corning

D. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.02 MATERIALS

A. System consists of Batt Insulation, Roof Insulation, Wall Insulation, Vapor Barrier Liner Fabric, Thermal Breaks, Straps, and other devices and components in a proprietary insulation system as follows:
   1. Batt Insulation: ASTM C 991 Type 1; preformed formaldehyde-free glass fiber batt conforming to the following:
      a Batt Size: Equal to purlin/girt spacing by manufacturer's standard lengths.
      b. Unfaced.

   2. Roof Insulation: Formaldehyde-free fiberglass batt or fiberglass blanket complying with ASTM C 991 Type 1 and ASTM E 84 with a thermal resistance and thickness as follows:
      a. As scheduled in this section.

3. Vapor Barrier Liner Fabric: Syseal® type woven, reinforced, high-density polyethylene yarns coated on both sides with a continuous white or colored polyethylene coatings, as follows:
   a. Product complies with ASTM C 1136, Types I through Type VI.
   b. Perm rating: 0.02 for fabric and for seams in accordance with ASTM E 96.
   c. Flame/Smoke Properties:
      1) 25/50 in accordance with ASTM E 84.
      2) Self-extinguishes with field test using matches or butane lighter.
   d. Ultra violet radiation inhibitor to minimum UVMAX® rating of 8.
   e. Size and seaming: Manufactured in large custom pieces by extrusion welding from roll goods, and fabricated to substantially fit defined building area with minimum practicable job site sealing.
   f. Provide with factory double, extrusion welded seams. Stapled seams or heat-melted seams are not acceptable due to degradation of fabric.
   g. Factory-folded to allow for rapid installation.
   h. Color:
      1) White.

4. Vapor Barrier Lap Sealant: Solvent-based, Simple Saver polyethylene fabric adhesive.

5. Vapor Barrier Tape: Double-sided sealant tape 3/4 inch (19 mm) wide by 1/32 inch (.79 mm) thick.

6. Vapor Barrier Patch Tape: Single-sided, adhesive backed sealant tape 3 inches (76 mm) wide made from same material as Syseal® type liner fabric.

7. Thermal Breaks:
   a. 1/8 inch (3 mm) thick by 3 inch (76 mm) wide white, closed-cell polyethylene foam with pre-applied adhesive film and peel-off backing.
   b. Polystyrene Snap-R snap-on thermal blocks.

8. Straps:
   a. 100 KSI minimum yield tempered, high-tensile-strength steel.
   b. Size: Not less than 0.020 inch (0.50 mm) thick by 1 inch (25 mm) by continuous length.
   c. Galvanized, primed, and painted to match specified finish color on the exposed side.
   d. Color:
   1) White.
   e. High-tensile-strength stainless steel.
   f. Woven polyester plastic. Color as selected.

9. Fasteners:
   a. For light gage steel: #12 by 3/4 (19 mm) inch plated Tek 2 type screws with sealing washer, painted to match specified color.
   b. For heavy gage steel: #12 by 1-1/2 inch (38 mm) plated Tek 4 type screws with sealing washer, painted to match specified color.

c. For wood, concrete, other materials: As recommended by manufacturer.

10. Wall Insulation Hangers: Fast-R preformed rigid hangers, 32 inch (813 mm) long galvanized steel strips with barbed arrows every 8 inches (203 mm) along its length.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building structure including all bracing and any concealed building. systems are completed and approved prior to installing liner system and insulation in the structure.

B. Correct any unsatisfactory conditions before proceeding.

C. If conditions are the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION – GENERAL

A. Install pre-engineered building insulation system in accordance with manufacturer's installation instructions and the approved shop drawings.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Install in exterior spaces without gaps or voids. Do not compress insulation.

D. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

E. Fit insulation tight in spaces and tight to exterior side of the sealed liner fabric and around mechanical and electrical services within plane of insulation.

3.03 3.3 ROOF INSULATION INSTALLATION

A. Straps:
1. Cut straps to length and install in the pattern and spacing indicated on shop drawings.
2. Tension straps to required value.

B. Vapor Barrier Fabric:
1. Install vapor barrier fabric in large one-piece custom fabricated pieces to substantially fit defined building areas with minimum practicable job site sealing.
2. Position pre-folded fabric on the strap platform along one eave purlin.
3. Clamp the two bottom corners at the eave and also centered on the bay.
4. Pull the other end of the pleat-folded fabric across the building width on the strap platform, pausing only at the ridge to fasten the straps and fabric in position where plane of roof changes and to release temporary fasteners on the opposite ridge purlins.
5. Once positioned, install fasteners from the bottom side at each strap/purlins intersection.

6. Trim edges and seal along the rafters.
7. All seams must be completely sealed and stapled seams not acceptable.

C. Insulation:
1. Unpack, and shake to a thickness exceeding the specified thickness.
2. Ensure that cavities are filled completely with insulation.
3. Place on the vapor barrier liner fabric without voids or gaps.
4. Place top layer of insulation over and perpendicular to the purlins without voids or gaps, as roof sheathing is applied.
5. Place thermal block on top of purlins or bottom of purlins for retrofit work, if no other thermal break exists.
6. Place new insulation between purlins at the required thickness for the R-value specified.

D. Seal vapor barrier fabric to the wall fabric and elsewhere as required to provide a continuous vapor barrier.

3.04 CLEANING

A. Clean dirt or exposed sealant from the exposed vapor barrier fabric.

B. Remove scraps and debris from the site.

3.05 PROTECTION

A. Protect system products until completion of installation.

B. Repair or replace damaged products before completion of insulation system installation.

3.06 SCHEDULE

A. Ceiling Insulation general: R-30.

END OF SECTION

SECTION 07214

BOARD INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Board insulation at cavity walls, and [at perimeter of foundation walls.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. C578 - Standard Specification for Rigid Cellular Polystyrene Thermal Insulation.
   2. C1303 - Standard Test Method for Estimating the Long-Term Change in Thermal Resistance of Unfaced Rigid Closed Cell Plastic Foams by Slicing and Scaling Under Controlled Laboratory Conditions.
   3. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. E96/E96M - Standard Test Method for Water Vapor Transmission of Materials.
   5. E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

1.3 SUBMITTALS

A. Quality Control Submittals:
   1. Certificates of Compliance: Certification from an independent testing laboratory that insulation meets fire hazard classification requirements.

1.4 QUALITY ASSURANCE

A. Fire Hazard Classification:
   1. Noncombustible, tested to ASTM E136.
   2. Flame spread/smoke developed rating of 25/50 or less, tested to ASTM E84.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store insulation in clean, dry, sheltered area, off ground or floor, until used. Protect against wetting and moisture absorption.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Polystyrene Insulation:
   1. Dow Chemical Co. (www.dowbuildingmaterials.com)

2. Owens Corning. (www.owenscorning.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Board Insulation (Walls above finished floor):
   1. ASTM C578, closed cell extruded polystyrene foam.
   2. Minimum compressive strength: 25 PSI.
   3. Thermal resistance: Minimum LTTR value of 4.8/inch.
   4. Water vapor permeance: Maximum 1.0 perms, tested to ASTM E96/E96M.

B. Board Insulation (Walls below finished floor):
   1. ASTM C578, closed cell extruded polystyrene foam.
   2. Minimum compressive strength: 40 PSI.
   3. Thermal resistance: Minimum LTTR value of 4.8/inch.
   4. Water vapor permeance: Maximum 1.0 perms, tested to ASTM E96/E96M.

2.3 ACCESSORIES

A. Adhesive:
   1. Type recommended by insulation manufacturer.

B. Tape: Minimum 2 inches wide, pressure sensitive, waterproof.

C. Metal Clips: Galvanized steel, L-shaped, 2 inches long.

D. Fasteners: Type best suited to application, hot-dip galvanized or fluoropolymer coated steel.

PART 3 EXECUTION

3.1 PREPARATION

A. Substrate:
   1. Remove protrusions flush with adjacent surface.
   2. Remove dirt, dust, oil, grease, and other materials that could impair adhesion.

3.2 INSTALLATION

A. Apply adhesive in continuous beads.

B. Install boards on foundation wall perimeter, horizontally.

C. Place boards in a method to maximize contact bedding.

D. Stagger side joints.

E. Butt edges and ends to adjacent boards and at perimeter.

F. Extend boards over control joints, unbonded to foundation 2 inches on one side of joint.

G. Cut and fit insulation tight to protrusions or interruptions to the insulation plane.

3.3 INSTALLATION

A. Apply adhesive in continuous beads.

B. Install boards horizontally in a method to maximize contact bedding.

END OF SECTION

SECTION 07215

BATT INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Batt insulation in interior and exterior wall assemblies.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. C665 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Wood Frame and Light Construction Buildings.
   2. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   3. E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C.

1.3 SUBMITTALS

A. Quality Control Submittals:
   1. Certificates of Compliance: Certification from an independent testing laboratory that insulation meets fire hazard classification requirements.

1.4 QUALITY ASSURANCE

A. Fire Hazard Classification:
   1. Noncombustible, tested to ASTM E136.
   2. Flame spread/smoke developed rating of 25/50 or less, tested to ASTM E84.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store insulation in clean, dry, sheltered area, off ground or floor, until used. Protect against wetting and moisture absorption.

1.6 PROJECT CONDITIONS

A. Do not install until insulation until building is substantially water and weather tight.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Johns Manville. (www.jm.com)
   2. Knauf Insulation. (www.knaufusa.com)

3. Owens Corning. (www.owenscorning.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Thermal Batt Insulation:
   1. Type: ASTM C665, glass fiber composition.
   2. Facing: Unfaced.
   3. Thermal resistance:
      a. 3-5/8 inches thick: R-value of 13.00.
      b. 6-1/4 inches thick: R-value of 19.00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Friction fit between framing members.

B. Butt insulation to adjacent construction. Butt ends and edges.

C. Carry insulation around pipes, wiring, boxes, and other components.

D. Ensure complete enclosure of spaces without voids.

END OF SECTION

SECTION 07260

VAPOR RETARDERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sheet materials for controlling vapor diffusion at floors.

B. Related Sections:
1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
1. E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
2. E1745 - Standard Test Method for Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

1.3 SUBMITTALS

A. Submittals for Review:
1. Product Data: Include product description and performance characteristics.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. Griffolyn, Division of Reef Industries. (www.reefindustries.com)
2. Raven Industries. (www.rufco.com)
3. W.R. Meadows, Inc. (www.wrmeadows.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Vapor Retarder: ASTM E1745, Class A, minimum 10 mil thick clear polyethylene film.

2.3 ACCESSORIES

A. Adhesive:
1. Compatible with vapor retarder and substrate, permanently non hardening.

B. Joint Tape: Minimum 2 inches wide, pressure sensitive, waterproof, compatible with vapor retarder.

PART 3 EXECUTION

3.1 INSTALLATION - UNDER SLABS ON GRADE

A. Install in accordance with manufacturer's instructions and ASTM E1643.

B. Remove sharp rocks and objects that could puncture vapor retarder.

C. Install vapor retarder without tears, voids, and holes.

D. Lap ends and edges minimum 6 inches over adjacent sheets.

E. Tape seal lapped joints, tears, holes, perimeter, and penetrations through vapor retarder.

3.2 REPAIR

A. Inspect vapor retarder for damage just prior to covering.

B. Clean damaged areas and cover with additional vapor retarder material cut minimum 6 inches larger than damaged area on all sides. Seal to main vapor retarder with continuous tape.

END OF SECTION

SECTION 07412

STANDING SEAM METAL ROOFING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the Conditions of the Contract and Division 01 Specification Sections apply to this section.

1.2 SUMMARY

A. Work described in this section includes pre-formed metal roofing system complete with clips, perimeter and penetration flashing, and closures.

B. Related Work Specified Elsewhere:
   1. Division 06 Section - Rough Carpentry for wood substrate components
   2. Division 07 Section - Roof Insulation
   3. Division 07 Section - Above-Grade Vapor Barriers
   4. Division 07 Section - Sheet Metal Flashing and Trim

1.3 REFERENCES

A. American Architectural Manufacturer Association (AAMA):
   1. AAMA 501.1 Standard Test Method for Metal Curtain Walls for Water Penetration using Dynamic Pressure.

B. American Society of Civil Engineers (ASCE):
   1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.

C. American Society for Testing and Materials (ASTM):
   1. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. ASTM D1056 Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
   3. ASTM D3575 Standard Test Methods for Flexible Cellular Materials made from Olefin Polymers.
   4. ASTM E283 Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   5. ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
   6. ASTM E1592 Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
   7. ASTM E1646 Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
   8. ASTM E1680 Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.
   9. ASTM E2140 - Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head

D. Testing Application Standards TAS
   1. TAS 100 Test Procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roof Systems
   2. TAS 125 Standard Requirements for Metal Roofing Systems
   3. TAS 114 app. G Test Procedure for Susceptibility to Leakage of Discontinuous Roof Systems

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
   1. Architectural Sheet Metal Manual, 5th edition.

F. Underwriters' Laboratories (UL):
   1. UL 263 Fire Tests of Building Constructions and Materials.
   2. UL 790 Tests for Fire Resistance of Roof Covering Materials.

G. Factory Mutual Research (FM):
   1. FM 4470 Approval Standard for Class 1 Panel Roofs.

1.4 SUBMITTALS FOR REVIEW

A. Shop Drawings showing layout of every roof panel and structural supporting member required in the installation with side laps and end laps marked within 1% deviation of their actual location.
   1. Provide details for edge conditions, seams, joints, corners, panel profiles, assembly anchoring techniques, round and square flashings and counter flashings.

B. Samples illustrating thickness, finish, color and textures of materials.

C. Product Data: Include manufacturer's detailed material and system description, panel and field seam installation instructions, engineering performance and finish specifications. Indicate hat channel and fastener spacing.

D. Specimen Warranty: Provide an unexecuted copy of the warranty specified for this Project, identifying the terms and conditions required of the Manufacturer and the Owner.

E. If a professional engineer stamped specification is not required for this project, please delete the following paragraph.

F. Any material submitted as equal to the specified material must be accompanied by a report signed and sealed by a professional engineer licensed in the state in which the installation is to take place. This report shall show that the submitted equal meets the Design and Performance criteria in this specification. Substitution requests submitted without licensed engineer approval will be rejected for non-conformance.

1.5 SUBMITTALS FOR INFORMATION

A. Design and Test Reports: Provide the following certified test reports from an independent testing laboratory:
   1. Independent laboratory testing report for system design load and seam integrity.

2. Professional engineer's documentation that roofing system incorporates sufficient allowance for stress and movement.
3. A letter from an officer of the manufacturing company certifying that the materials furnished for this project are the same as represented in tests and supporting data.
4. Manufacturer's verifications that the panels are factory roll formed.
5. ASTM E1592: Test results must clearly demonstrate compliance with the following requirements:
    a. The ultimate test failure load shall be reduced by the safety factor specified in article 1.11 to determine the allowable working load for the panel system.
    b. The proposed system has been tested to insure that the allowable working load of the panel system meets or exceeds the specified negative wind uplift pressures listed in article 1.11 of this specification for all roof zones.
    c. The test results are applicable for the thickness, width, and profile specified. Results are not applicable for systems that are thicker or wider than the system which was tested. If the tested material was not the specialty material specified herein (for instance, the tested material was galvalume steel), then the test results shall be reduce by the ratio of the yield strength (Fy) of the specified material to the tested material.
    d. The results must clearly show that the allowable clip spacing meets or exceeds the requirements specified in section 3.0 for all roof areas. Clip spacing shall not be reduced for any roof zone from that which is specified.
6. ASTM E283 and E331: Test results must clearly demonstrate compliance with the performance requirements specified in article 1.11.
7. ASTM E1646 and E1680: Test results must clearly demonstrate compliance with the performance requirements specified in article 1.11. Results are not applicable for systems that are thinner, wider, lower grade, or different material/profile than the system which was tested. The differential test pressures must be identical to those specified in article 1.11.
8. UL 790: The proposed roof panel shall be listed as a non-combustible roof covering material and be approved for use in a UL classification assembly.
9. UL 263: The proposed roof panel shall be listed for use in a UL fire rated construction assembly.
10. AAMA 501.1: Test report shall show passed ratings for panel type as specified.
11. TAS 100: Test report shall show passed ratings for panel type as specified.
12. TAS 125: Test report shall show rating no less that that as specified in article 1.11.
13. TAS 114 appendix G: Test report shall show passed ratings for panel type as specified.
14. ASTM E2140: Test report shall show passed ratings for panel type as specified.

B. Mill production reports certifying that the steel thicknesses are within allowable tolerances of the nominal or minimum thickness or gauge specified.

C. Design Loads: Submit copy of manufacturer's minimum design load calculations according to ASCE 7-05, Method 2 for Components and Cladding, sealed by a

registered professional engineer. In no case shall the design loads be taken to be less than those detailed in Design and Performance Criteria article.

D. Qualification Data for Roofing Installer. Refer to Quality Assurance Article below.

E. Certification of work progress inspection frequency. Refer to Quality Assurance Article below.

F. Pre-installation Roofing Conference Proceedings. Refer to Quality Assurance Article below.

1.6 CONTRACT CLOSEOUT SUBMITTALS

A. Special Project Warranty: Provide specified warranty for the Project, executed by the authorized agent of the Manufacturer.

B. Roofing Maintenance Instructions. Provide a manual of manufacturer's recommendations for maintenance of installed roofing systems.

C. Insurance Certification: Assist Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance on roofing and associated work.

D. Demonstration and Training Schedule: Provide a schedule of proposed dates and times for instruction of Owner's personnel in the maintenance requirements for completed roofing work. Refer to Part 3 for additional requirements.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Engage an Installer who has completed the Manufacturer's Approved Roofing Contractor course and is currently certified for the installation of this roof system.

B. If required, fabricator/installer shall submit work experience and evidence of adequate financial Responsibility. The Owner's representative reserves the right to inspect fabrication facilities in determining qualifications.

C. Source Limitations: Obtain all components of roof system from a single manufacturer, including roll goods materials if required. Secondary products that are required shall be recommended and approved in writing by the roofing system Manufacturer.
   1. Upon request of the Architect or Owner, submit Manufacturer's written approval of secondary components in list form, signed by an authorized agent of the Manufacturer.
   2. Manufacturer shall have direct authority and control over all fabrication of steel components as well as the raw materials used in their fabrication.

D. Source Quality Control: Manufacturer shall have in place a documented, standardized quality control program such as ISO-9001 approval.

E. Engage the Manufacturer's Field Representative to conduct required periodic inspections of work in progress as described herein and shall furnish written documentation of all such inspections.

F. Manufacturer shall provide the Owner project with a written statement that they will provide a site inspection 3 days per week to confirm that the project is being constructed as specified, by an experienced, full time employee of the company.

G. Alternate Manufacturers: The following manufacturer criteria must be submitted. Alternate systems will not be considered for approval unless each of these items has been submitted for review at least 10 business days prior to bid opening:
   1. Submit each item listed in article 1.4 (A through E) for evaluation of the proposed system.
   2. Tests shall have been made for identical systems within the ranges of specified performance criteria.
   3. Empirical calculations for roof performance shall only be acceptable for positive loads.
   4. A list of a minimum of five (5) jobs where the proposed alternate material was used under similar conditions. The reference list shall include date of project, size of project, project address, and telephone number of architect/owner contact.
   5. A financial statement demonstrating a minimum of a 3:1 ratio of assets to liabilities.
   6. A written statement from the manufacturer stating that they will provide the building owner with site inspections 3 days per week for a minimum of one (1) hour per day by an experienced, full time employee of the company.
   7. A written statement from the manufacturer stating that they will provide the engineer of record with a daily site inspection by an experienced full time employee of the company.
   8. A written statement from a corporate officer of the manufacturing company stating that he or she has reviewed the specifications and confirms that the proposed system meets or exceeds all performance requirements listed as well as meets the panel size, gauge, weight, clip design, sealant design, uplift pressures and height of the vertical seam
   9. A copy of manufacturer's 30 year warranty. Warranty must include coverage for all trim, flashing, and penetrations associated with this roof.
   10. Proof that the manufacturer has been in business for a minimum number of years equal to the warranty period required for this project.

1.8 PRE-INSTALLATION CONFERENCE

A. Convene a pre-roofing conference approximately two (2) weeks before scheduled commencement of roofing system installation and associated work.

B. Require attendance of installer of each component of associated work, installers of deck or substrate construction to receive roofing work, installers of rooftop units and other work in and around roofing which must precede or follow roofing work (including mechanical work if any), Architect, Owner, roofing system manufacturer's representative, and other representatives directly concerned with performance of the Work, including (where applicable) Owner's insurers, testing agencies and governing authorities. Objectives of conference to include:

1. Review foreseeable methods and procedures related to roofing work, including set up and mobilization areas for stored material and work area.
2. Tour representative areas of roofing substrates (decks), inspect and discuss condition of substrate, roof drains, curbs, penetrations and other preparatory work performed by others.
3. Review structural loading limitations of deck and inspect deck for loss of flatness and for required attachment.
4. Review roofing system requirements (drawings, specifications and other contract documents).
5. Review required submittals both completed and yet to be completed.
6. Review and finalize construction schedule related to roofing work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
7. Review required inspection, testing, certifying and material usage accounting procedures.
8. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions, including possibility of temporary roofing (if not mandatory requirement).
9. Record discussion of conference including decisions and agreements (or disagreements) reached. Furnish a copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.

C. Review notification procedures for inclement weather or non-working days.

D. The Owner's Representative will designate one of the conference participants to record the proceedings and promptly distribute them to the participants for record.

E. The intent of the conference is to resolve issues affecting the installation and performance of roofing work. Do not proceed with roofing work until such issues are resolved the satisfaction of the Owner and Engineer of Record. This shall not be construed as interference with the progress of Work on the part of the Owner or Engineer of Record.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's responsibilities:
1. All roof panels shall be shipped from the manufacturer with strippable film or similar packaging material separating the individual panels to minimize flexing, stressing, scratching or otherwise damaging the material during transit to the job.
2. Fully cover steel with tarpaulins or similar protective cover during transit to prevent dirt and debris from coming in contact with the finished goods.

B. Installer's responsibilities:
1. Stack pre-finished materials to prevent twisting, bending, abrasion and denting and elevate one end to facilitate moisture run-off.
2. Unload roof panels using a boom or crane, supporting the panels in at least two locations during lifting, and never lift more than three panels at a time.
3. Protect moisture-sensitive materials and water-based from the weather.
4. Inspect materials upon delivery. Reject and remove physically damaged or marred material from project site.

1.10 PROJECT CONDITIONS

A. Determine that work of other trades will not hamper or conflict with necessary fabrication and storage and protection requirements for roofing system.
   1. Protection:
      a. Protect completed roofing from subsequent construction operations. Comply with Manufacturer's recommendations.
      b. Do not overload roof with stored materials.
      c. Support no roof-mounted equipment directly on the roofing system.

B. Ascertain that work of other trades which penetrates the roof or is to be made watertight by the roof is in place an approved prior to installation of roofing.

1.11 DESIGN AND PERFORMANCE CRITERIA

A. Thermal Expansion and Contraction:
   1. Completed metal roofing and flashing system shall be capable of withstanding expansion and contraction of components caused by changes in temperature without buckling, producing excess stress on structure, anchors or fasteners, or reducing performance ability.
   2. The design temperature differential shall be not less than 200° F.
   3. Interface between panel and clip shall provide for unlimited thermal movement in each direction along the longitudinal direction.
   4. Location of metal roofing rigid connector shall be at roof ridge unless otherwise approved by the Project Architect. Metal ridge connector may require design as per job conditions by specified manufacturer.

B. Uniform Wind Load Capacity:
   1. Installed roof system shall withstand negative (uplift) design wind loading pressures complying with the following criteria. Anchor clips shall be installed exactly as spacing given in article 3.0.
      a. Design Code: ASCE 7-05, Method 2 for Components and Cladding.
      b. Safety Factor: 1.670 after any load reduction or material stress increase.
      c. Category IV Building with an Importance Factor of 1.15.
      d. Wind Speed: 102 mph.
      e. Ultimate Pullout Value: 574 pounds per each of the two fasteners holding the panel anchor to the roof decking or framing system.
      f. Exposure Category: C
      g. Design Roof Height: 26 feet.
      h. Minimum Building Width: 82 feet.
      i. Roof Pitch: Minimum 2 inches per foot.
         Roof Area Design Uplift Pressure:
            Zone 1 - Field of roof 31.8 psf
            Zone 2 – 33.0 and rakes 36.7 psf
            Zone 3 - Corners 49.1 psf
   2. Capacity shall be determined using pleated airbag method in accordance with ASTM E1592, testing of sheet metal roof panels. Allowable safe working loads shall be determined by dividing the ultimate test load by the safety factor specified above.

C. Underwriters' Laboratories, Inc., (UL) fire resistance P ratings for roof assemblies: If applicable, panel system shall be approved for use in an appropriate Construction Assembly, as defined by UL 263.

D. Underwriters' Laboratories, Inc., (UL) Class A fire rating per UL 790.

E. ASTM E283: Static pressure air infiltration (doors, windows, curtain walls):
   1. Pressure Leakage Rate
      a. 1.57 PSF 0.0007 cfm/sq.ft.
      b. 6.24 PSF 0.0002 cfm/sq.ft.
      c. 20.0 PSF 0.0036 cfm/sq.ft.

F. ASTM E331: Static pressure water infiltration (doors, windows, curtain walls):
   1. Pressure Result:
      a. 5 Gal./Hr. per S.F. and Static No Leakage
      b. Pressure of 20.0 Psf for 15 minutes

G. ASTM E1680: Static pressure air infiltration (roof panels):
   1. Pressure Leakage Rate
      a. 1.57 PSF 0.0054 cfm/sq.ft.
      b. 6.24 PSF 0.0054 cfm/sq.ft.
      c. 20.0 PSF 0.0027 cfm/sq.ft.

H. ASTM E1646: Static pressure water infiltration (roof panels):
   1. Pressure Result
      a. 5 Gal./Hr. per S.F. and Static No Leakage
      b. Pressure of 20.0 Psf for 15 minutes

I. Capacities for gauge, span or loading other than those tested may be determined by interpolation of test results within the range of test data. Extrapolations for conditions outside test range are not acceptable.

J. Water penetration (dynamic pressure): No water penetration, other than condensation, when exposed to dynamic rain and 70 mph wind velocities for not less than five minutes duration, when tested in accord with principles of AAMA 501.1.

K. Wind and wind driven rain resistance: No water penetration or panel movement when exposed to 110 mph wind velocities when tested in accordance with TAS 100.

L. The installed roof system assembly shall show that it can resist the calculated roof pressure in section 1.11.B in accordance with the test results of TAS 125.

M. Water penetration in low slope applications: No water penetration or panel movement when subject to 6" head of water for 6 hrs when tested in accordance with the ASTM E2140 and when subject to 6" head of water for 7 days when tested in accordance with the TAS 114 appendix G.

1.12 WARRANTIES

A. Manufacturer shall execute a single warranty covering of the following criteria. Multiple-source warranties are not acceptable.

1. Manufacturer's 30 year watertight warranty, including coverage for all trim, flashings, and penetrations associated with the roof area.
2. 20 year coverage on finish including checking, crazing, peeling, chalking, fading and/or adhesion.
3. Warranty shall commence on date of substantial completion.
4. Identify the duration of the Installer's workmanship provision.
5. Installer shall provide manufacturer with 2 year warranty covering roofing system installation and water tightness.
6. Provide a single warranty by a single approved manufacturer for standing seam roof areas, membrane roof areas, and transitions between the two material types.

1.13 MANUFACTURER'S INSPECTIONS

A. When the project is in progress, the roofing system manufacturer will inspect the work not less than 3 days per week. In addition, the manufacturer will:
   1. Keep the Architect and Owner informed as to the progress and quality of the work as observed.
   2. Report to the Architect in writing any failure or refusal of the Contractor to correct unacceptable practices called to the Contractor's attention.
   3. Confirm after completion that manufacturer has observed no applications procedures in conflict with the specifications other than those that may have been previously reported and corrected.

PART 2 PRODUCTS

2.1 PRODUCTS, GENERAL

A. Refer to Division 01 Section "Common Product Requirements."

B. Basis of Design: The Garland Company. Cleveland OH

Materials, manufacturer's product designations, and/or manufacturer's names specified herein shall be regarded as the minimum standard of quality required for work of this Section. Comply with all manufacturer and contractor/fabricator quality and performance criteria specified in Part 1.

C. Substitutions: Products proposed as equal to the products specified in this Section shall be submitted in accordance with Bidding Requirements and Division 01 provisions.
   1. Proposals shall be accompanied by a copy of the manufacturer's standard specification section. That specification section shall be signed and sealed by a professional engineer licensed in the state in which the installation is to take place. Substitution requests containing specifications without licensed engineer certification shall be rejected for non-conformance.
   2. Include a list of three (3) projects of similar type and extent, located within a one hundred mile radius from the location of the project. In addition, the three projects must be at least five (5) years old and be available for inspection by the Architect, Owner or Owner's Representative.
   3. Equivalency of performance criteria, warranty terms, submittal procedures, and contractual terms will constitute the basis of acceptance.

4. The Owner's decision regarding substitutions will be considered final. Unauthorized substitutions will be rejected.

2.2 ACCEPTABLE MANUFACTURERS

A. The design is based upon R-MER Span roofing systems engineered and manufactured by

The Garland Company
Website: www.garlandco.com

This is the specified system or equivalent of equal performance and design by:
Centria
Overly
Metal Roofing Systems

2.3 METAL ROOFING SYSTEM

A. Materials.
1. Panel material: 0.040" thickness aluminum, 3105-H14 alloy, smooth as per ASTM B209-96.
2. Flashing and flat stock material: Fabricate in profiles indicated on drawings of same material, thickness, and finish as roof system, unless indicated otherwise.

B. Finishes:
1. Exposed surfaces for coated panels:
   a. Two coat coil applied, baked-on full-strength (70% resin) fluorocarbon coating system (polyvinylidene fluoride, PVF2), applied by manufacturer's approved applicator.
   b. Coating system shall provide nominal 1.0 mil dry film thickness, consisting of primer and color coat.
   c. Color shall be a standard manufacturer color.
2. Unexposed surfaces for coated panels shall be baked-on polyester coating with .20 - .30 dry film thickness (TDF).

C. Characteristics:
1. Provide the same panel profile from a single manufacturer for all standing seam roof areas.
2. Provide standing seam panels incorporating mechanically interlocked, concealed anchor clips allowing unlimited thermal movement, and of configuration which will prevent entrance or passage of water.
   a. Panel/Cap configuration must have a total of four (4) layers of steel surrounding anchor clip for prevention of water infiltration and increased system strength designed to limit potential for panel blow-off.
   b. Profile of panel shall have mesa's every two (2) inches on center continuous throughout panel which are a minimum of one and one-half (1-1/2) inches wide.
   c. Exposed fasteners, screws and/or roof mastic are unacceptable and will be rejected. System configuration only allows for exposed fasteners at

panel overlap (if required) and trim details (as per manufacturer's guidelines).

d. Provide panels in continuous lengths from ridge to eave with no overlaps unless approved by manufacturer, in writing.
e. Panels lengths which exceed maximum shipping lengths shall be field rolled on equipment owned by the panel manufacturer. Seam sealant must be factory applied.
f. Seam caps shall be manufactured in the factory and may be installed with end laps. Seam sealant must be factory applied.

3. Concealed Standard Anchor Clips: Clips must be sixteen (16) gauge stainless steel, alloy 316L, one (1) piece clip with projecting legs for additional panel alignment and provision for unlimited thermal movement in each direction along the longitudinal dimension.
   a. Two (2) piece clips are unacceptable.
   b. Sealant applied in panel cap must be isolated from clip to insure that no sealant damage occurs from the movement of the panel during expansion and contraction.
   c. Clip must maintain a clearance of a minimum of three-eighths (3/8) inches between panel and substrate for proper ventilation to help prevent condensation on underside of panel and eliminate the contact of panel fastener head to panel.

4. Seam cap: Snap-on cap shall be a minimum of 1"wide "T" shaped of continuous length up to forty-five (45) feet according to job conditions and field seamed by means of manufacturer's standard seaming machine.
   a. Cap shall be designed to receive two (2) beads of continuous hot applied gasketing sealant which will be applied independent of anchor clip to allow unlimited thermal movement of panel without damage to cap sealant.
   b. Sealant shall be a SIS (Styrene-Isoprene-Styrene) block copolymer type thermoplastic rubber adhesive, non-fatigue water barrier.

5. Standing Seam Panel Width: 16".

6. Stiffening ribs: Located in flat of panel to minimize oil canning and telegraphing of structural members.

7. Replace ability: Panels shall be of a symmetrical design with snap on, mechanically seamed cap configuration such that individual panels may be removable for replacement without removing adjacent panels.

8. Panel ends shall be panned at ridge, headwall, and hip conditions, or where applicable.

9. Panel length: Full length without joints, including bends.

D. Accessories.
   1. Gable anchor clips for:
      a. Standing Seam style.
      b. Stainless steel, alloy 316L, minimum thickness 16 gauge

2. Fasteners:
   a. Concealed fasteners: Corrosion resistant steel fasteners (stainless steel) designed to meet structural loading requirements. Provide #14 as the minimum fastener size.
   b. Exposed fasteners: Series 410 stainless steel fasteners or one-eighth (1/8) inch diameter stainless steel waterproof rivets. All exposed fasteners shall be factory painted to match the color of the standing seam panels.
3. Closures: Factory precut closed cell foam meeting ASTM D1056 or ASTM D3575, enclosed in metal channel matching panels when used at hip, ridge, rake, and jamb.
4. Provide all miscellaneous accessories for complete installation.
5. Panel joint (end lap) sealant: Non-curing modified isobutylene tri-polymer tape of thickness to fully adhere to both surfaces being joined with indicated service life of 20 years.

2.4 ACCESSORY PRODUCTS

A. Sealant:
   1. Acceptable product:
      a. Concealed Application: Non-curing butyl sealant or equal.
      b. Exposed Application: Garland SS sealant or equal.
   2. Colors: As selected by architect from sealant manufacturer's standard selection.
   3. Underlayment: Self adhering 60 mil FIRE RATED underlayment manufactured and approved by the panel manufacturer.

2.5 FABRICATION

A. Shop fabricate metal roofing and flashing components to the maximum extent possible, forming metal work with clear, sharp, straight, and uniform bends and rises. Hem exposed edges of flashings.

B. Form flashing components from full single width sheet in minimum ten (10) foot lengths. Provide shop fabricated, mitered corners, joined using closed end pop rivets and joint sealant.

C. Fabricate roofing and related sheet metal work in accordance with approved shop drawings and applicable standards.

PART 3 EXECUTION

3.1 EXECUTION, GENERAL

A. Comply with requirements of Division 01 Section "Common Execution Requirements."

3.2 PREPARATION

A. Design system so that the panel installation may be started and/or terminated at any given point in the area.
   1. It is understood that the ongoing operations of the Owner are of a critical nature as to leak sensitivity. Do not work on more roof area than can be restored completely watertight in one day.

B. Remove existing metal roof, dirt and debris from the roof area. All materials shall be removed to provide a smooth, flat substrate without imperfections that will be evident in the finished work.
   1. Existing metal details and other metal accessories specified for re-use that interfere with the installation of the new roof system shall be carefully removed and set aside for re-use.
   2. Any metal described above that will come in contact with the new roof shall be checked for type and replaced or protected if galvanic action may be a problem.

C. Strip existing contaminating material from all metal components that are indicated to be re-utilized. Protect these metal components. Replace damaged components with new of similar type and dimension.

D. Replace wood blocks and/or sleepers indicated to be replaced with new pressure-treated wood, redwood, or other form of blocking acceptable to the Manufacturer.
   1. Do not use pressure-treated wood containing salt-based preservatives or materials corrosive to steel. Provide Material Safety Data Sheets to the roofing manufacturer for verification prior to installation.

E. Remove pipes, conduits or equipment indicated to be abandoned and removed.
   1. All curbs, soil stacks, and other interior flashing surfaces shall be extended to a minimum of 8" above the new horizontal roof surface or shall be pressure sealed at the top edge.

3.3 INSTALLATION, GENERAL

A. Install roof system when the atmospheric dry bulb temperature is minimum 40 degrees Fahrenheit and rising.

B. Install all components of the roof system in exact accordance with the manufacturer's standard published procedures as applicable to these project conditions and substrates.

C. Install all required vapor retarder, air seals and preliminary tapered, insulating substrates required per enclosed specifications.

D. Lay out and anchor all roof framing sections or purlins according to the approved roof plan.

3.4 ROOFING AND FLASHING INSTALLATION

A. Comply with all details and install roofing materials and flashings in accordance with approved shop drawings and manufacturer's product data, within specified erection tolerances.

B. Prepare roof for the installation of standing seam panels, including:
   1. Replace any rotted decking to match the existing material and thickness.
   2. Install all underlayments and/or temporary water proofing materials as required in this specification and bid documents.

C. Directly over the completed roof substrate, install one (1) piece panel anchor clips. All anchor clips will be set on sixteen (16) gauge galvanized pre-punched bearing plates to distribute the loads on the board insulation or all anchor clips will be fastened into the structural roof substrate based on the following spacing pattern:
   1. Clip spacing must be 5'0" for Zone 1 (field)
   2. Clip spacing must be 4'8"for Zone 2 (eave, ridge, hip, and rake).
   3. Clip spacing must be 3'6" for Zone 3 (corners)
   4. Clip spacing for Zones 2 & 3 must extend 3'0" feet onto the roof area.

D. Installation of Roof Panels: Roof panels can be installed by starting from either end and working towards the opposite end. Due to the symmetrical design of the specified panels system, it is also acceptable to start from the middle of the roof and work toward each end.
   1. A stainless steel pop rivet shall be secured through the anchor reveal of the panel leg and extend into the arm of the panel clip located at the ridge of the system. Provide at each arm of the clip along the ridge. The panel is then anchored at both sides of the clip.
      a. Capture all drilling debris during this operation with a rag or cloth placed on the panels at the drilling operation.
      b. Panels are not securely attached to the roof until fixed to the anchor clip. To avoid damage and injury, all panels shall be fixed to the anchor clip immediately as they are installed.
   2. Un-installed panels which are temporarily stored on the ground or roof shall be secured in place at the end of each day's work to prevent possible damage or injury.

E. Isolate dissimilar metals and masonry or concrete from metals with bituminous coating. Use gasketed fasteners where required to prevent corrosive action between fastener, substrate, and panels.

F. Limit exposed fasteners to extent indicated on shop drawings.

G. Anchorage shall allow for temperature expansion/contraction movement without stress or elongation of panels, clips, or anchors. Attach clips to structural substrate using fasteners of size and spacing as determined by manufacturer's design analysis to resist specified uplift and thermal movement forces.

H. Seal laps and joints in accordance with roofing system manufacturer's product data.

I. Coordinate flashing and sheet metal work to provide weather tight conditions at roof terminations. Fabricate and install in accordance with standards of SMACNA Manual.

J. Provide for temperature expansion/contraction movement of panels at roof penetrations and roof mounted equipment in accordance with system manufacturer's product data and design calculations.

K. Installed system shall be true to line and plane and free of dents, and physical defects. In light gauge panels with wide flat surfaces, some oil canning may be present. Oil canning does not affect the finish or structural integrity of the panel and is therefore not cause for rejection.

L. Maximum variation from true planes or lines shall be one-fourth (1/4) inch in twenty (20) feet and three-eighths (3/8) inch in forty (40) feet of more.

M. Form joints in linear sheet metal to allow for one-fourth (1/4) inch minimum expansion at twenty (20) feet on center maximum and eight (8) feet from corners.

N. At joints in linear sheet metal items, set sheet metal items in two (2) one-fourth (1/4) inch beads of butyl sealant. Extend sealant over all metal surfaces. Mate components for positive seal. Allow no sealant to migrate onto exposed surfaces.

O. Remove damaged work and replace with new, undamaged components.

P. Touch up exposed fasteners using paint furnished by roofing panel manufacturer and matching exposed panel surface finish.

Q. Clean exposed surfaces of roofing and accessories after completion of installation. Leave in clean condition at date of substantial completion. Touch up minor abrasions and scratches in finish.

3.5 CLEANING

A. Clean installed work in accordance with the manufacturer's instructions.

B. Replace damaged work than cannot be restored by normal cleaning methods.

3.6 CONSTRUCTION WASTE MANAGEMENT

A. Remove and properly dispose of waste products generated during roofing procedures. Comply with requirements of authorities having jurisdiction

3.7 FINAL INSPECTION

A. At completion of roofing installation and associated work, meet with Contractor, Architect, installer, installer of associated work, Owner, roofing system manufacturer's representative, and other representatives directly concerned with performance of roofing system.

B. Inspect roofing work and flashing of roof penetrations, walls, curbs and other equipment. List all items requiring correction or completion and furnish copy of list to each party in attendance.

C. Repair or replace deteriorated or defective work found at time above inspection as required to a produce an installation which is free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

D. Notify the Architect and Owner upon completion of corrections.

E. Following the final inspection, provide written notice of acceptance of the installation from the roofing system manufacturer.

F. Immediately correct roof leakage during construction. If the Contractor does not respond within twenty four (24) hours, the Owner will exercise rights to correct the Work under the terms of the Conditions of the Contract.

3.8 DEMONSTRATION AND TRAINING

A. At a time and date agreed to by the Owner, instruct the Owner's facility manager, or other representative designated by the Owner, on the following procedures:
   1. Roof troubleshooting procedures.
   2. Notification procedures for reporting leaks or other apparent roofing problems.
   3. Roofing maintenance.
   4. The Owner's obligations for maintaining the roofing warranty in effect and force.
   5. The Manufacturer's obligations for maintaining the roofing warranty in effect and force.

END OF SECTION

SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the Conditions of the Contract and Division 01 Specification Sections apply to this section.

1.02 SUMMARY

A. Provide all labor, equipment, and materials to fabricate and install the following.
   1. Edge strip and flashing.
   2. Fascia, soffit, and trim.
   3. Gutters, scuppers and down spouts.

B. Related Sections:
   1. Division 07 Section Common Work Results for Thermal and Moisture Protection.

C. Related Work Specified Elsewhere:
   1. Division 06 Section Rough Carpentry
   2. Division 07 Section Joint Sealants
   3. Division 07 Section Manufactured Metal Roof Panels

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM A792 Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy Coated by the Hot-Dip Process.
   2. ASTM D523 Standard Test Method for Specular Gloss
   3. ASTM D692 Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
   4. ASTM D1005 Standard Test Method for Measurement of Dry Film Thickness of Organic Coatings Using Micrometers
   5. ASTM D2178 Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
   6. ASTM D2244 Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
   7. ASTM D2794 Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
   8. ASTM D3359 Standard Test Methods for Measuring Adhesion by Tape Test
   9. ASTM D3363 Standard Test Method for Film Hardness by Pencil Test

10. ASTM D4145 Standard Test Method for Coating Flexibility of Prepainted Sheet
11. ASTM D4586 Standard Specification for Asphalt Roof Cement, Asbestos Free
12. ASTM E108 Standard Test Methods for Fire Tests of Roof Coverings

B. Factory Mutual Research Corporation (FMRC)

C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
1. 1993 Edition Architectural Sheet Metal Manual

D. National Coil Coaters Association (NCCA)

E. National Roofing Contractors Association (NRCA)
1. Roofing and Waterproofing Manual

1.04 SUBMITTALS FOR REVIEW

A. Product Data:
1. Provide manufacturer's specification data sheets for each product.
2. Metal material characteristics and installation recommendations.
3. Submit color chart prior to material ordering and/or fabrication so that equivalent colors to those specified can be approved.

B. Samples: Submit two (2) samples, illustrating typical metal edge, coping, gutters, fascia extenders for material and finish.

C. Specimen Warranty: Provide an unexecuted copy of the warranty specified for this Project, identifying the terms and conditions required of the Manufacturer and the Owner.

1.05 SUBMITTALS FOR INFORMATION

A. ASTM E108 or similar evidence of Class A Fire Resistance

B. Mill production reports certifying that the steel thicknesses are within allowable tolerances of the nominal or minimum thickness or gauge specified.

C. Qualification Data for Installer. Refer to Quality Assurance Article below.

D. Certification of work progress inspection. Refer to Quality Assurance Article below.

E. Certifications:
1. Submit roof manufacturer's certification that metal fasteners furnished are acceptable to roof manufacturer.
2. Submit roof manufacturer's certification that metal furnished is acceptable to roofing manufacturer as a component of roofing system and is eligible for roof manufacturer's system warranty.

1.06 CONTRACT CLOSEOUT SUBMITTALS

A. General: Comply with Requirements of Section 01 78 00 - Closeout Submittals.

B. Insurance Certification: Assist Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance on roofing and associated work.

1.07 QUALITY ASSURANCE

A. Engage an experienced roofing contractor specializing in sheet metal flashing work with a minimum of five (5) years experience.

B. Maintain a full-time supervisor/foreman who is on the job-site at all times during installation. Foreman must have a minimum of five (5) years experience with the installation of similar system to that specified.

C. Source Limitation: Obtain components from a single manufacturer. Secondary products which cannot be supplied by the specified manufacturer shall be approved in writing by the primary manufacturer prior to bidding.

D. Upon request fabricator/installer shall submit work experience and evidence of financial responsibility. The Owner's representative reserves the right to inspect fabrication facilities in determining qualifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers or packages with labels intact and legible.

B. Stack pre-formed and pre-finished material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

C. Prevent contact with materials which may cause discoloration or staining.

1.09 PROJECT CONDITIONS

A. Determine that work of other trades will not hamper or conflict with necessary fabrication and storage requirements for pre-formed metal edge system.

1.10 DESIGN AND PERFORMANCE CRITERIA

A. Thermal expansion and contraction:
   1. Completed metal edge flashing system shall be capable of withstanding expansion and contraction of components caused by

changes in temperature without buckling, producing excess stress on structure, anchors or fasteners, or reducing performance ability.

B. Factory Mutual Approvals
   1. Factory Mutual Research Corporation's (FMRC) wind uplift resistance classification: The roof perimeter flashing as defined in the FMRC Loss Prevention Data Sheets 1-7 and 1-49 shall be classified under an FM rating. System shall be classified as FM 1-120.1.11 WARRANTIES

A. Owner shall receive one (1) warranty from manufacturer of roofing materials covering all of the following criteria. Multiple warranties are not acceptable.
   1. Pre-finished metal material shall require a written twenty (20)-year non-prorated warranty covering fade, chalking and film integrity. The material shall not show a color change greater than 5 NBS color units per ASTM D2244 or chalking excess of 8 units per ASTM D659. If either occurs material shall be replaced per warranty, at no cost to the Owner.
   2. Changes: Changes or alterations in the edge metal system without prior written consent from the manufacturer shall render the system unacceptable for a warranty.
   3. Warranty shall commence on date of substantial completion or final payment, whichever is agreed by contract.
   4. The Contractor shall provide the Owner with a notarized written warranty assuring that all sheet metal work including caulking and fasteners to be watertight and secure for a period of two years from the date of final acceptance of the building. Warranty shall include all materials and workmanship required to repair any leaks that develop, and make good any damage to other work or equipment caused by such leaks or the repairs thereof.
   5. Installing roofing contractor shall be responsible for the installation of the edge metal system in general accordance with the membrane manufacturer's recommendations.
   6. One manufacturer shall provide a single warranty for all accessory metal for flashings, metal edges and copings, along with the warranty for metal roof areas, membrane roof areas, and any transitions between two different material types.

PART 2 — PRODUCTS

2.01 GENERAL

A. Refer to Division 01 Section "Common Product Requirements."

B. Basis of Design: Materials, manufacturer's product designations, and/or manufacturer's names specified herein shall be regarded as the minimum standard of quality required for work of this Section. Comply with all manufacturer and contractor/fabricator quality and performance criteria specified in Part 1.

C. Substitutions: Products proposed as equal to the products specified in this Section shall be submitted in accordance with Bidding Requirements and Division 01 provisions.
   1. Equivalency of performance criteria, warranty terms, submittal procedures, and contractual terms will constitute the basis of acceptance.
   2. The Owner's decision regarding substitutions will be considered final. Unauthorized substitutions will be rejected.

2.02 MATERIALS

A. General: Product designations for the materials used in this section shall be based on performance characteristics of the R-MER Wall-Pan System with v-grooves manufactured by the Garland Company, Cleveland, OH, and shall form the basis of the contract documents. This is the specified system or equivalent of equal performance and design by:

   Centria

B. Overly Materials:
   1. Exposed base metal material:
      a. Aluminum-zinc alloy (galvalume) coated steel, ASTM A792, coating designation AZ-50, in thickness of .032 nom. 36" to 48" by coil length, chemically treated, commercial or lock-forming quality.

C. Finishes:
   1. Exposed surfaces for coated panels:
      a. Steel Finishes: fluorocarbon finish. Epoxy primer baked both sides, .2-.25 mils thickness as approved by finish coat manufacturer.

Weathering finish as referred by National Coil Coaters Association (NCCA).

PROPERTY	TEST METHOD	FLUOROCARBON*
Pencil Hardness	ASTM D3363 NCCA II-2	HB-H
Bend	ASTM D-4145 NCCA II-19	O-T
Cross-Hatch Adhesion	ASTM D3359	no loss of adhesion
Gloss (60° angle)	ASTM D523	25+/-5%
Reverse or Impact	ASTM D2794	no cracking loss of adhesion
Nominal Thickness	ASTM D1005	
Primer		0.2 mils
Topcoat		0.8 mils

TOTAL 1.0 mils

* Subject to minimum quantity requirements

b. Color shall be as specified

2. Exposed and unexposed surfaces for mill finish flashing, fascia, and coping cap, shall be as shipped from the mill.

2.03 RELATED MATERIALS AND ACCESSORIES

A. Metal Primer: Zinc chromate type.

B. Plastic Cement: ASTM D 4586

C. Sealant: Specified in Section 07900 or on drawings.

D. Underlayment: ASTM D2178, No15 asphalt saturated roofing felt.

E. Slip Sheet: Rosin sized building paper.

F. Fasteners:
1. Corrosion resistant screw fastener as recommended by metal manufacturer. Finish exposed fasteners same as flashing metal.
2. Fastening shall conform to Factory Mutual requirements or as stated on section details, whichever is more stringent.

G. Gutter and Downspout Anchorage Devices: Material as specified for system.

PART 3 — EXECUTION

3.01 EXECUTION, GENERAL

A. Refer to Division 07 Section Common Work Results for Thermal and Moisture Protection.

3.02 PROTECTION

A. Isolate metal products from dissimilar metals, masonry or concrete with bituminous paint, tape, or slip sheet. Use gasketed fasteners where required to prevent corrosive reactions.

3.03 GENERAL

A. Secure fascia to wood nailers at the bottom edge with a continuous cleat.

B. Fastening of metal to walls and wood blocking shall comply with building code standards.

C. All accessories or other items essential to the completeness of sheet metal installation, whether specifically indicated or not, shall be provided and of the same material as item to which applied.

D. Allow sufficient clearances for expansion and contraction of linear metal components. Secure metal using fasteners as required by the system. Exposed face fastening will be rejected.

3.04 INSPECTION

A. Verify that curbs are solidly set and nailing strips located.

B. Perform field measurements prior to fabrication.

C. Coordinate work with work of other trades.

D. Verify that substrate is dry, clean and free of foreign matter.

E. Commencement of installation shall be considered acceptance of existing conditions.

3.05 SHOP-FABRICATED SHEET METAL

A. Metal work shall be shop fabricated to configurations and forms in accordance with recognized sheet metal practices.

B. Hem exposed edges.

C. Angle bottom edges of exposed vertical surfaces to form drip.

D. Lap corners with adjoining pieces fastened and set in sealant.

E. Form joints for gravel stop fascia system, coping cap with a 3/8" opening between sections. Back the opening with an internal drainage plate formed to the profile of fascia piece.

F. Install sheet metal to comply with referenced SMACNA and NRCA standards.

3.06 FLASHING MEMBRANE INSTALLATION

A. Edge Metal With Gutter
   1. Position base plies of the Built-Up and/or Modified Roofing membrane over the roof edge covering nailers completely, fastening eight (8) inches on center. Install membrane and cap sheet with proper material and procedure according to manufacturer's recommendations.
   2. Install gutter and strapping fastening six (6) inches on center.
   3. Install continuous cleat on face of nailer and fasten six (6) inches on center.

4. Install new edge metal hooked to continuous cleat. Set metal flange into roofing cement, nail every three (3) inches on center, and prime at a rate of one hundred (100) square feet per gallon.
5. Strip in edge metal with base flashing membrane extending six (6) inches into roof field, followed with a cap sheet extending nine (9) inches into the roof field. Install membrane and cap sheet with proper material and procedure according to manufacturer's recommendations.

3.07 CLEANING

A. Clean installed work in accordance with the manufacturer's instructions.

B. Replace damaged work than cannot be restored by normal cleaning methods.

3.08 CONSTRUCTION WASTE MANAGEMENT

A. Remove and properly dispose of waste products generated. Comply with requirements of authorities having jurisdiction

3.09 FINAL INSPECTION

A. At completion of installation and associated work, meet with Contractor, Architect, installer, installer of associated work, Owner, roofing system manufacturer's representative and other representatives directly concerned with performance of roofing system.

B. Inspect work and flashing of roof penetrations, walls, curbs and other equipment. List all items requiring correction or completion and furnish copy of list to each party in attendance.

C. Repair or replace deteriorated or defective work found at time above inspection as required to a produce an installation which is free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

D. Notify the Architect upon completion of corrections.

E. Following the final inspection, provide written notice of acceptance of the installation from the roofing system manufacturer.

F. Immediately correct roof leakage during construction. If the Contractor does not respond within twenty-four (24) hours, the Owner will exercise rights to correct the Work under the terms of the Conditions of the Contract.

3.10 DEMONSTRATION AND TRAINING

A. At a time and date agreed to by the Owner, instruct the Owner's facility manager, or other representative designated by the Owner, on the following procedures:

1. Troubleshooting procedures.
2. Notification procedures for reporting leaks or other apparent roofing problems.
3. Maintenance.
4. The Owner's obligations for maintaining the warranty in effect and force

END OF SECTION

SECTION 07640

MINERAL-FIBER CEMENT SIDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mineral-fiber cement siding, trim and soffits.
   2. Trim, anchorage, and accessories.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 07600 - Sheet Metal Flashing and Trim.
   3. Section 07920 - Joint Sealers.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. C1186 - Standard Specification for Flat, Non-Asbestos, Fiber-Cement Sheets.
   2. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Provide manufacturer's descriptive data, indicating profiles, sizes, fastening methods, surface texture, and finish.
   2. Samples: Submit 12 inch long siding samples.
   3. Warranty: Provide sample warranty form.

B. Quality Control Submittals:
   1. Certificates of Compliance: Certification from an independent testing laboratory that siding meets fire hazard classification requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years documented experience in work of this Section.

1.5 WARRANTIES

A. Furnish manufacturer's 30 year warranty providing coverage against cracking, rotting, or delamination of siding.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Design Basis: Contract Documents are based on products by James Hardie Building Products. (www.jameshardie.com)

B. Equivalent products by following manufacturers are acceptable:
   1. CertainTeed Corp. (www.certainteed.com)
   2. Maxitile. (www.maxitile.com)

C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Mineral-Fiber Cement Siding:
   1. ASTM C1186, Grade II, Type A; formulated from portland cement, ground sand, cellulose fibers, additives, and water; formed under pressure to required profile.
   2. Finish: Factory prime painted.
   3. Fire hazard classification: Class A, tested to ASTM E84.
   4. Board siding:
      a. Profile: Square HardiPanel.
      b. Size: 48 inches wide x maximum practical length.
      c. Thickness: 5/16 inch.
      d. Surface texture: Smooth.
   5. Soffits:
      a. Profile: Square HardiSoffit.
      b. Size: Soffit width x maximum practical length.
      c. Thickness: 1/4 inch.
      d. Surface texture: Smooth.
      e. Venting: Vented.
   6. Trim:
      a. Profile: Square HardiTrim.
      b. Size: 3.50, 7.25, and 11.25 inches wide x maximum practical length.
      c. Thickness: 3/4 inch.
      d. Surface texture: Wood grain.

2.3 ACCESSORIES

A. Fasteners: Type recommended by siding manufacturer; stainless steel.

B. Sheet Metal Flashings and Trim: Specified in Section 07600.

C. Joint Sealers: Specified in Section 07920.

PART 3 EXECUTION

3.1 INSTALLATION - BOARD SIDING AND SOFFITS

A. Install in accordance with manufacturer's instructions.

B. Install sheets vertically with edges and ends over firm bearing.

C. Butt joints tight.

D. Set plumb and level.

E. Cut siding to fit at perimeter and around penetrations with maximum 1/4 inch gaps. Smooth cut edges.

F. Install corner strips, closures, battens, and trim.

G. Fasten at maximum 12 inches on center in orderly fastening pattern.

H. Install metal flashings at internal and external corners, sills, and heads of wall openings. Fasten at 12 inches on center maximum.

I. Apply joint sealer between siding and trim and adjacent surfaces as specified in Section 07920.

3.2 INSTALLATION - TRIM

A. Install in accordance with manufacturer's instructions.

B. Butt joints tight.

C. Set plumb and level.

D. Cut to fit at perimeter and around penetrations with maximum 1/4 inch gaps. Smooth cut edges.

E. Fasten at maximum 12 inches on center.

END OF SECTION

SECTION 07840

FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Firestopping perimeter of and penetrations through fire rated assemblies.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops.
   2. E1966 - Standard Test Method for Fire-Resistive Joint Systems.
   3. E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Test Apparatus.

B. Underwriters Laboratories, Inc. (UL):
   1. 1479 - Fire Tests of Through-Penetration Firestops.
   2. 2079 - Fire Resistance of Building Joint Systems.

1.3 SYSTEM DESCRIPTION

A. Provide continuous protection against passage of heat, fire, smoke, and gases at perimeter of and penetrations through rated assemblies.

1.4 SUBMITTALS

A. Submittals for Review:
   1. Product Data:
      a. Firestopping schedule; prepare in tabular format and identify:
         1) Type of assembly receiving firestop and required fire rating.
         2) Type of penetrating item.
         3) Proposed firestop system.
      b. Include UL or equivalent details for each firestop system.
   2. Test Reports: Indicate conformance with ASTM E814, ASTM E1966, ASTM E2307, UL 1479, or UL 2079.

B. Quality Control Submittals:
   1. Certificates of Compliance: Indicate conformance of installed systems with specified requirements.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 3 years documented experience in work of this Section.

B. Firestopping: Fire resistance rating equivalent to adjacent construction; tested to ASTM E814, ASTM E1966, ASTM E2307, UL 1479, or UL 2079.

C. Mockups:
   1. Provide mockup of each firestopping system.
   2. Locate where directed.
   3. Approved mockups may not remain as part of the Work.

D. Pre-Installation Conference:
   1. Convene at site 2 weeks prior to beginning work of this Section.
   2. Attendance: Architect, Contractor, firestopping applicator, firestopping manufacturer's representative, and related trades.
   3. Review and discuss: Contract Documents, fire rating requirements, manufacturer's literature, job conditions, scheduling, and other matters affecting application.
   4. Tour representative areas of firestopping substrates; discuss substrate construction, related work, work conditions, materials compatibility, and protection after application.

1.6 PROJECT CONDITIONS

A. Do not apply sealants, mortars, or putties when temperature of substrate material and surrounding air is below 40 degrees F or is anticipated to drop below that temperature within 24 hours after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Hilti, Inc. (www.us.hilti.com)
   2. 3M Fire Protective Products. (www.3m.com)
   3. Nelson Firestop Products. (www.nelsonfirestop.com)
   4. Rectorseal. (www.rectorseal.com)
   5. Specified Technologies, Inc. (www.stifirestop.com)
   6. Tremco, Inc. (www.tremcosealants.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Firestopping: One or more of the following:
   1. Silicone elastomer compound: Single or multiple component, low modulus, moisture curing silicone sealant.
   2. Ceramic sealant: Single component, moisture curing ceramic sealant.
   3. Intumescent sealant: Single component, water based intumescent sealant.
   4. Acrylic sealant: Single component acrylic sealant, suitable for painting.
   5. Putty: Single component ceramic fiber base putty or intumescent elastomer putty that expands on exposure to surface heat gain.
   6. Mortar: Hydraulic cementitious mortar.

7. Pillows or blocks: Formed intumescent or mineral fiber pillows or blocks.
8. Intumescent strips: Solvent free intumescent wrap strips.
9. Mechanical devices: Incombustible fillers or silicone elastomer covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
10. Cast-in-place devices: Containing intumescent material and smoke/water seals.

2.3 ACCESSORIES

A. Forming and Damming Materials: As recommended by firestopping manufacturer for intended use.
   1. Permanent: Mineral fiber board, mineral fiber matting, or mineral fiber putty.
   2. Temporary: Plywood, particle board, or other.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare openings to receive firestopping as directed by manufacturer:
   1. Remove incidental and loose materials from penetration opening.
   2. Remove free liquids and oil from involved surfaces and penetration components.
   3. Install damming materials to accommodate and ensure proper thickness and fire rating requirements and provide containment during installation.
   4. Remove combustible materials and materials not intended for final penetration seal system.

3.2 INSTALLATION

A. Install firestopping at perimeter of and penetrations through fire rated assemblies.

B. Apply materials in accordance with manufacturer's instructions.

C. Apply firestopping material in sufficient thickness to achieve required ratings.

D. Compress fibered material to achieve a density of 40 percent of its uncompressed density.

E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

F. Place intumescent coating in sufficient coats to achieve rating required.

G. Remove dam material after firestopping material has cured.

H. Finish exposed surfaces to smooth, flush appearance.

END OF SECTION

SECTION 07920

JOINT SEALERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Joint backup materials.
   2. Joint sealers.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. C510 - Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
   2. C719 - Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).
   3. C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.
   4. C834 - Standard Specification for Latex Sealing Compounds.
   5. C919 - Standard Practice for Use of Sealants in Acoustical Applications.
   6. C920 - Standard Specification for Elastomeric Joint Sealants.
   7. C1193 - Standard Guide for Use of Joint Sealants.
   8. C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants.
   9. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
   10. D2203 - Standard Test Method for Staining from Sealants.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Indicate sealers, primers, backup materials, bond breakers, and accessories proposed for use.
   2. Samples:
      a. 1/2 x 1/2 x 3 inch long joint sealer samples showing available colors.
      b. 6 inch long joint backup material samples.
   3. Warranty: Sample warranty form.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 3 years documented experience in work of this Section.

B. Laboratory Pre-Construction Testing:
   1. Obtain representative samples of actual substrate materials.

2. Test sealers and accessories for following:
   a. Adhesion: Test to ASTM C794 and ASTM C719; determine surface preparation and required primer.
   b. Compatibility: Test to ASTM C1087; determine that materials in contact with sealers do not adversely affect sealant materials or sealant color.
   c. Staining: Test to ASTM D2203, ASTM C510, or ASTM C1248; determine that sealants will not stain joint substrates.
   d. Pre-construction testing is not required when sealant manufacturer furnishes data acceptable to Architect based on previous testing for materials matching those of this Project.

C. Field Pre-Construction Testing: Test each joint sealer and joint substrate before beginning work of this Section:
   1. Install sealers in mockups using joint preparation methods and materials recommended by sealer manufacturer.
   2. Install field-test joints in [inconspicuous location.] [location directed by Architect.] [_____.]
   3. Test sealers using manufacturer's standard field adhesion test; verify joint preparation and primer required to obtain optimum adhesion of sealants to joint substrate.
   4. When test indicates sealant adhesion failure, modify joint preparation, primer, or both and retest until joint passes sealant adhesion test.

1.5 PROJECT CONDITIONS

A. Do not apply sealers at temperatures below 40 degrees F unless approved by sealer manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. OSI (www.positough.com)
   2. BASF Building Systems. (www.buildingsystems.basf.com)
   3. Dow Corning Corp. (www.dowcorning.com)
   4. GE Silicones. (www.siliconeforbuilding.com)
   5. Pecora Corp. (www.pecora.com)
   6. Sika Corp. (www.sikausa.com)
   7. Tremco, Inc. (www.tremcosealants.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Joint Sealer Type 1:
   1. ASTM C920, Grade P, multiple component polyurethane type, self-leveling and slope grades, recommended by manufacturer for traffic bearing applications.
   2. Movement capability: Plus or minus 50 percent.
   3. Color: To be selected from manufacturer's full color range.

B. Joint Sealer Type 2:
   1. ASTM C920, Grade NS, multiple component polyurethane type, non sag.
   2. Movement capability: Plus or minus 50 percent.
   3. Color: To be selected from manufacturer's full color range.

C. Joint Sealer Type 4:
   1. ASTM C834, single component acrylic latex, non sag.
   2. Movement capability: Plus or minus 7-1/2 percent.
   3. Color: Clear.

D. Joint Sealer Type 5:
   1. ASTM C920, Grade NS, single component silicone, non sag, mildew resistant.
   2. Movement capability: Plus or minus 50 percent.
   3. Color: To be selected from manufacturer's full color range.

E. Joint Sealer Type 6:
   1. ASTM C920, Grade NS, single componentpolysulfide type, non sag, recommended by manufacturer for continuous water immersion.
   2. Movement capability: Plus or minus 25 percent.
   3. Color: To be selected from manufacturer's full color range.

2.3 ACCESSORIES

A. Primers, Bondbreakers, and Solvents: As recommended by sealer manufacturer.

B. Joint Backing:
   1. ASTM C1330, closed cell polyethylene foam, preformed round joint filler, non absorbing, non staining, resilient, compatible with sealer and primer, recommended by sealer manufacturer for each sealer type.
   2. Size: Minimum 1.25 times joint width.

2.4 MIXES

A. Mix multiple component sealers in accordance with manufacturer's instructions.
   1. Mix with mechanical mixer; prevent air entrainment and overheating.
   2. Continue mixing until color is uniform.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove loose and foreign matter that could impair adhesion. If surface has been subject to chemical contamination, contact sealer manufacturer for recommendation.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Protect adjacent surfaces with masking tape or protective coverings.

D. Sealer Dimensions:
   1. Minimum joint size: 1/4 x 1/4 inch.
   2. Joints 1/4 to 1/2 inch wide: Depth equal to width.

3. Joints over 1/2 inch wide: Depth equal to one half of width.

3.2 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Install sealers and accessories in accordance with ASTM C1193.

C. Install acoustical sealers and accessories in accordance with ASTM C919.

D. Install joint backing to maintain required sealer dimensions. Compress backing approximately 25 percent without puncturing skin. Do not twist or stretch.

E. Use bondbreaker tape where joint backing is not installed.

F. Fill joints full without air pockets, embedded materials, ridges, and sags.

G. Tool sealer to smooth profile.

H. Apply sealer within manufacturer's recommended temperature range.

3.3 CLEANING

A. Remove masking tape and protective coverings after sealer has cured.

B. Clean adjacent surfaces.

3.4 SCHEDULE

JOINT LOCATION OR TYPE	SEALER TYPE
Exterior Joints:	
Joints in horizontal surfaces subject to pedestrian or vehicular traffic	1
Joints in continuously immersed features	6
Joints in above-grade surfaces	2
Interior Joints:	
Joints in horizontal surfaces subject to pedestrian or vehicular traffic	1
Joints in toilet rooms, countertops, and kitchens	5
Other joints	4

END OF SECTION

SECTION 08113

STAINLESS STEEL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Description: This section includes interior and exterior stainless steel doors, frames and related sidelites, transoms, and windows where applicable.

B. Related Work:
   1. Finish hardware, including lock cylinders and thresholds.
   2. Glass and glazing.
   3. Caulking between frames and masonry.
   4. Structural members.

1.2 QUALITY ASSURANCE

A. Applicable standards of the following as referenced herein:
   1. AAMA, American Architectural Manufacturers Association
   2. ASTM, American Society for Testing and Materials
   3. ADA, American Disabilities Act
   4. NAAMM / HMMA, National Association of Architectural Metals Manufacturers

B. Manufacturer shall have been regularly engaged in manufacturing stainless steel doors and frames for a period of ten years. Doors and frames shall be fabricated by a single manufacturer. The manufacturer must have an effective quality control system in place.

C. Allowable Tolerances as stated in NAAMM / HMMA Technical Manual.

1.3 SUBMITTALS

A. Shop drawings: Indicate in elevation with sections and details to scale. Included glass and metal thicknesses, jointing details, field connections, anchorage, concealed and exposed fastening methods, door and framing reinforcement, and metal finishes. Indicate compliance with specified design criteria.

B. Finish Samples: Submit two (minimum 5" x 7") samples indicating texture to be expected of finished work.

C. Maintenance Data: Give instructions for general maintenance and repair of surfaces and finishes.

1.4 WARRANTY

A. Warrant stainless steel doors, frames, and window assemblies against defects in materials and workmanship for three (3) years from the date of installation in accordance with the manufacturer's instructions and NAAMM / HMMA Technical Manual.

PART 2 PRODUCTS

2.1 DOORS

A. Stainless Steel Materials: AISI Type 316
   1. Frames: 16 gauge
   2. Doors: 16 gauge

B. Abraded Finish: Random Swirl

C. Design: Flush

D. Door Thickness: 1 3/4"

E. Fire Rating: 180 minutes

F. Door Construction: Doors shall be unitized construction with continuous forms reinforcement stiffening channels welded into door body. Hardware Reinforcement: Seven gauge at hinges, eleven gauge at lock/latch preparations welded into door body.
   1. Door edge construction: Continuous Welded Seamless. Adhesive or screw applied weather strip shall not be accepted.
   2. Stainless steel cladding over aluminum, steel or wood constructed shall not be acceptable.

2.2 FRAMES

A. Construction:
   1. Stainless steel materials: 316
   2. Stainless steel thickness: 16 gauge
   3. Frames shall be welded units of the sizes and types shown on approved shop drawings. Knocked down frames shall not be accepted. Jamb, header, mullion, and sill profiles shall be in accordance with the frame schedule and as shown on the approved submittal drawings. All welds shall be finished smooth and regained to match.

B. Fasteners shall be stainless steel. Expose fasteners shall be countersunk and shall match framing.

2.3 FINISH HARDWARE

A. Doors and frames shall be mortised, reinforced, drilled, and tapped at the factory for completely templated mortise hardware only, in accordance with the final approved hardware schedule and templates provided by the hardware supplier. Where surface mounted, anchor hinges, or non-templated mortised hardware is to be applied, doors shall be reinforced, with all drilling and tapping done by others in the field. Reinforcement shall comply with NAAMM / HMMA 830 and 861.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install door assembly in accordance with manufacturer's instructions.

B. Anchor to adjacent construction without distortion or stress.

C. Fit and align door assembly including hardware, level and plumb, to provide smooth operation.

D. Position head and jamb weatherstripping to contact door sections when closed; secure in position.

3.2 CLEANING

A. Clean doors and frames in accordance with manufacturer's special instructions.

END OF SECTION

SECTION 08220

FIBERGLASS REINFORCED PLASTIC (FRP) DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiberglass Reinforced Plastic (FRP) Doors

B. Fiberglass Reinforced Plastic (FRP) Frames

1.02 RELATED SECTIONS

A. Division 1 - General Conditions, Supplementary Conditions

B. Division 4 - Unit Masonry

C. Division 8 - Finish Hardware

D. Division 8 - Glass and Glazing

1.03 QUALITY ASSURANCE

A. General Qualifications:
1. Manufacturer Qualifications: A company that specializes in manufacturing FRP doors and frames with a minimum of 15 years experience.
2. Quality Assurance: Obtain all FRP doors and FRP frames from a single manufacturer to ensure consistent quality.
3. Quality Assurance: Hardware and accessories for all FRP doors and FRP frames shall exactly adhere to the Architect's specification.
4. Quality Assurance: Glass for windows in doors shall be furnished per the Architect's instructions and specifications.

B. Regulatory Requirements:
1. Fire-rated door, panel and frame construction conforms to products tested under ASTM E152, UL10C & NFPA 252.
2. Install doors, panels and frames conforming to NFPA 80 for fire-rated class, ANSI A117.1 specifications for handicap accessibility, ADA requirements, ANSI A250.4-2011 cycle swing in excess of 1,000,000 cycles with no failure of any design features of the door.
3. Flame Spread: All rated FRP component parts, including the finish, shall have a flame spread classification of 25 or ess per ASTM E84 and shall be self extinguishing per ASTM D635, unless operating conditions dictate otherwise.
4. Resins and coatings to meet with USDA standards for incidental food contact, if applicable to this project.
5. Products manufactured--if so specified--that have passed the Florida Building Code (FBC), including Miami-Dade High Velocity Hurricane Zone (HVHZ).

C. Warranty:
To include ten (10) years free from defects in material and workmanship from date of shipment, and lifetime from **corrosion** from date of shipment, provided that the structural integrity of the doors and frames have not been violated or compromised.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01300.

B. Shop Drawings – Include the following:
1. Elevation of each door type including door size, handing and finish
2. Cutout locations for lites and hardware
3. Internal reinforcement
4. Frame configuration, anchor types and spacing

C. Product data including manufacturer's literature, fabrication descriptions and installation instructions.

D. Construction and/or color samples as requested.

1.05 DELIVERY, STORAGE AND PROTECTION

A. Doors and frames will be individually packaged in cardboard cartons. Cartons will be clearly labeled with project information and will include fasteners and installation instructions, if required. Only remove cartons upon arrival if cartons are wet or damaged.

B. Deliver and store doors and frames at the job site in such a manner as to prevent damage; out of weather and/or extreme temperatures. The doors shall be stored in a vertical position on blocking, clear of the floor and with blocking between the doors to permit air circulation between the doors.

C. All damaged or otherwise unsuitable doors and frames, when so ascertained, shall be immediately removed from job site.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Products manufactured by the following companies complying with these specifications will be acceptable:
1. CORRIM Company, Oshkosh, Wisconsin 54901. Phone: 920-231-2000 Fax: 920-231-2238 www.corrim.com
2. Fib-R-Door
3. Chem-Pruf
4. Substitutions may be considered under the provisions of Division 01 and the products are manufactured in the United States of America.

2.02 FRP DOORS

A. Door Fabrication:

1. Total door thickness to be a nominal 1-3/4 inches thick.
2. Lock stiles on non-rated and rated active leaves shall be factory beveled 1/8" in 2".
3. Provide doors with completely seamless construction on all six (6) surfaces.

B. Face Sheets: FRP face sheets shall be manufactured using a corrosion resistant resin system with light stabilizing additives. The resin shall be reinforced with fiberglass, 50% average by weight for enhanced strength. Face sheets shall be a minimum of 0.125 inch thick fiberglass. Face sheets will be Architect's choice of smooth, pebble or woodgrain seamless finish.

C. Stiles and Rails: Stiles and rails shall be 1-1/2 inch square pultruded fiberglass tubes. Non-rated and 20 minute doors will have a full width horizontal 1-1/2 inch square pultruded fiberglass tube every 24 inches in height for internal reinforcement. A 1-1/2 inch square solid fiberglass block shall be used at all hardware reinforcements and corner intersections. A minimum of 1,150 pounds screw withdrawal force shall be required per screw. The bottom rail shall allow for 1-1/4 inches of height alterability without loss of the panel's integrity. No metal or wood reinforcements, including #2 SPF (Spruce Pine Fir), will be allowed in any part of the stile and rail configuration.

D. Core:
1. Polyurethane Foam Core: A 1-1/2 inch thick rigid block of polyurethane shall be laminated to the interior of the panels. The "R" factor shall be 12. The polyurethane insulation shall be Class A and CFC free. Foam properties comply with ASTM E-84 and The North Carolina State Building Code.
2. Mineral Core: for 30 minute to 90 minute fire rated FRP doors.

E. Hardware Preparations: Doors shall be reinforced and mortised for hardware with 1-1/2 inches x 1-1/2 inches of solid fiberglass to allow application of hinges and locks, in accordance with the hardware schedule, hardware manufacturer's instructions and templates.
1. Reinforcement Blocking: Non-swelling polymer or firestop blocking will be used for all lockset, surface mounted hardware and thru-bolted hardware blocking.
2. Pilot holes for full mortise butt hinges will be pre-drilled by factory.
3. All hardware shall be attached / installed by using pilot hole and stainless steel wood screws.

F. Door Accessories
1. Glazing: Glazing support structures shall ensure that the glass area is weather sealed as not to permit moisture from entering the core of the door. This is to be accomplished by utilizing pultruded 1-1/2 inch square FRP tubes to fabricate the window opening. Glazing must allow for ready access for repair in the event of damage or replacement, without affecting the sealed integrity of the cutout in the door panel itself. Openings cut directly into the core material will not be allowed.
2. Louvers: Specified in Division 8. The louver opening will be fabricated in the same method as for glazing above.
3. Fasteners: Provide countersunk stainless steel fasteners as required for glazing openings and louvers.

4. Transoms: All transom panels will be identical to the doors in construction, materials, thickness, color and reinforcement.
5. Astragals: Astragals for pairs of doors to be fabricated with FRP material of manufacturer's standard flat design.

2.03 FRP FRAMES

A. Fabrication: FRP frames shall be rigid, free from defects and blemishes, and the finish shall match the doors. Fabricate FRP doors and frames as shown on the drawings. Field measurements shall be taken as required for coordinating with adjoining work.
1. Provide frames for doors, transoms, sidelites and borrowed lites, as required.
2. All frames shall be 100% pultruded fiberglass with an average 50% glass content by weight which results in an industrial fiberglass frame as strong as a 14 gauge hollow metal frame.
3. Non-rated and 20 minute UL labeled: Standard one piece FRP profile with integral stop: 6" x 2" equal rabbet.4 inch header.
4. 30 – 90 minute UL labeled FRP Frames: Standard one piece FRP profile with integral stop: 6" x 2" equal rabbet. Frames that must be grouted solid with mortar in the field to achieve label are not acceptable.
5. Head and jamb members of rated frames shall be standard 45 degree miter, providing a mitered corner connection, fabricated for Knocked Down (KD) field assembly.
6. Head and jamb members shall be one piece, resin bonded and assembled at factory on non-rated frames.

B. Reinforcements and Braces / Supports
1. Frames shall be reinforced and mortised for hardware in accordance with the hardware schedule, manufacturer's instructions and templates. No metal reinforcements will be allowed in any part of the FRP frame configuration.
2. Corner Reinforcement: 4 inches x 4 inches x 5-3/8 inches x 1/4 inch thick pultruded fiberglass angle. Attached to head bar at factory using stainless steel screws.
3. Mortise Hinge Reinforcement: 3 inches x 7 inches x 9/16 inch (or 3/8 inch) thick FRP material attached to frame by means of bonding and stainless steel countersunk screws.
4. Closer Reinforcement: 1-1/2 inches x 19 inches x 3/16 inch thick FRP material attached to frame by means of bonding.
5. Strike Reinforcement: 1-1/2 inches x 9 inches x 3/4 inch thick FRP material attached to frame by means of bonding and stainless steel countersunk screws.
6. Anchoring Systems - Furnish at least three (3) anchors in each jamb of frames up to 90 inches high and one (1) additional anchor for each 30 inches in height above 90 inches, in shapes, sizes and spacing shown or required for anchorage into adjoining wall construction.
   a. New Masonry: T-Strap or Wire Anchor (*optional:* stainless steel T-Strap)
   b. New Stud (before sheathing): New Stud Anchor
   c. Butt Existing Wall: Existing Opening Anchor; Masonry, Steel or Wood (optional: concealed)

d. Wrap Existing Wall: Compression Anchor
e. Consult factory for additional anchoring options.

2.04 FINISH

A. Seamless 25 mil matte gelcoat (smooth faces only), selected by Architect, from manufacturer's full range of colors
(*optional*: gloss polyurethane; all face options)
(*optional*: matte polyurethane; all face options)
(*optional*: Prime finish for field painting; all face options)
B. Finish on door and frame units will match

PART 3 EXECUTION

3.01 INSPECTION

Installer shall examine the substrate and conditions under which fiberglass reinforced plastic work is to be installed and notify the General Contractor in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 INSTALLATION

A. Doors and frames will be delivered in individual cartons with the identifying mark number listed on each carton.
B. Install FRP doors, frames and accessories in accordance with manufacturers printed instructions, final shop drawings, NFPA 80 standards at fire rated openings and / or HVHZ standards for FBC labeled openings.
C. Provide clearance for doors of 1/8 inch at jambs and heads; 1/4 inch clearance above threshold.
D. Fire labeled doors, frames and accessories must be installed by qualified, licensed installers adhering to the latest version of NFPA 80.

3.03 ADJUSTING

At substantial completion, adjust all operable components to ensure proper installation. Doors shall function smoothly and swing freely without binding. Doors shall remain open at any angle without being affected by gravitational influence.

3.04 CLEANING

Remove dirt and excess sealant from exposed surfaces. Follow the manufacturer's recommended cleaning techniques and procedures for cleaning all surfaces. Only use cleaning products that will not scratch or damage the surfaces and are recommended by the manufacturer.

END OF SECTION

SECTION 08330

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Steel overhead coiling doors.
   2. Operating hardware, controls, and supports.

B. Related Sections:
   1. Division 1: Administrative, procedural, and temporary work requirements.
   2. Division 8: Door Hardware
   3. Division 16:
      a. Connection to power supply and control devices.
      b. Connection to fire alarm and detection system.

1.02 REFERENCES

A. American National Standards Institute/Door and Access Systems Manufacturers Association International (ANSI/DASMA) 105 - Test Method for Thermal Transmittance and Air Infiltration of Garage Doors.

B. ASTM International (ASTM):
   1. A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   3. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

C. National Fenestration Rating Council (NFRC) 400 - Procedure for Determining Fenestration Product Air Leakage.

D. National Fire Protection Association (NFPA) 80 - Standard for Fire Doors and Fire Windows.

E. Underwriters Laboratories (UL) 10B - Standard for Fire Tests of Door Assemblies.

1.03 SYSTEM DESCRIPTION

A. Design Requirements: Design doors to withstand:
   1. Positive and negative design wind loads in accordance with North Carolina State Building Code without permanent deformation or damage.
   2. Movement caused by an ambient temperature range of 120degrees F and a surface temperature range of 160 degrees F.

B. Design Cycle Life: 50,000 cycles.

C. Operation:
   1. Motoroperated, with speed governor.
   2. Emergency closure achieved by means of fail safe, time delay release with battery backup to prevent nuisance drops.
   3. Drop testing performed from floor level without ladders or tools.

D. Air Infiltration: Maximum 1.0 cubic feet per square foot, tested to NFRC 400 or ANSI/DASMA 105.

1.04 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Indicate opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.
   2. Product Data: Provide information on component construction, anchorage method, and hardware.
   3. Samples: 3 x 3 inch coating samples showing available colors.

B. Closeout Submittals:
   1. Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. CHI Overhead Doors. (www.chiohd.com)
      a. Model 627 insulated exterior basis of design.
      b. Model 635 insulated, rated, interior basis of design.
   2. Janus International Corporation. (www.janusintl.com)
   3. Overhead Door Corporation. (www.overheaddoor.com)
   4. Raynor. (www.raynor.com)

B. Substitutions: Under provisions of Division 1.

2.02 INSULATED OVERHEAD COILING SERVICE DOORS

A. Overhead Coiling Stormtite Advanced Performance Insulated Service Doors: Overhead Door Corporation Stormtite AP Model 627.
   1. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.
      a. Flat profile type FIT-265 for doors up to 40 feet (12.19 m) wide.
      b. Front slat fabricated of:
         1) 22 gauge galvanized steel.
      c. Back slat fabricated of:
         1) 24 gauge galvanized steel.
      d. Slat cavity filled with CFC-free foamed-in-place, polyurethane insulation
         1) R-Value: 10.9, U-Value: 0.09.
   2. Performance:
      a. Through Curtain Sound Rating: Sound Rating: STC-28 (STC-30+ with HZ noise generator) as per ASTM E 90.
      b. Installed System Sound Rating: STC-21 as per ASTM E 90.
      c. U-factor: 0.84 NFRC test report, maximum U-factor of no higher than 1.00.
      d. Air Infiltration: Meets ASHRAE 90.1 and IECC 2012/2015 C402.4.3 Air leakage <1.00 cfm/ft2.
   3. Finish:
      a. Galvanized Steel: Slats and hood galvanized in accordance with ASTM A 653 and receive rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester top coat.
         1) Polyester Top Coat – Tan polyester.

2) Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.

4. Weatherseals:
   a. Vinyl bottom seal and internal hood seals.
   b. Interior and exterior EPDM triple-seal finned guide weatherseal.
   c. Lintel weatherseal.
   d. Air Infiltration Package: IECC 2012/2015 listed; product to meet C402.4.3 2012 Air leakage <1.00 cfm/ft2.
      1) Air infiltration perimeter seal package includes: guide cover, guide cap, PVC weatherseal on exterior of guide, EPDM triple finned weatherseal on interior of guide, lintel weatherseal and vinyl bottom seal.
5. Bottom bar:
   a. Two galvanized steel angles minimum thickness 1/8 inch (3 mm) bolted back to back to reinforce curtain in the guides.
6. Guides: Three structural steel angles.
   a. Finish: PowderGuard Weathered finish with iron/black powder.
7. Brackets:
   a. Galvanized steel to support counterbalance, curtain and hood.
8. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.
9. Hood: Provide with internal hood baffle weatherseal.
   a. 24 gauge galvanized steel with intermediate supports as required.
10. Electric Motor Operation: Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second.
    a. Sensing Edge Protection:
       1) Electric sensing edge.
    b. Operator Controls:
       1) Push-button operated control stations with open, close, and stop buttons.
       2) Controls for interior location.
       3) Controls surface mounted.
    c. Motor Voltage: 115/230 single phase, 60 Hz.
11. Windload Design:
    a. As required by North Carolina State Building Code
12. Locking:
    a. Chain keeper locks for chain hoist operation.
13. Wall Mounting Condition:
    a. Face-of-wall mounting

PART 3 EXECUTION

3.01 INSTALLATION

A. Install door assembly in accordance with manufacturer's instructions.

B. Anchor to adjacent construction without distortion or stress.

C. Fit and align door assembly including hardware, level and plumb, to provide smooth operation.

D. Make connections between power supply, operator, and controls as specified in Division 16.

E. Make connections between door release mechanism and fire alarm and detection system as specified in Division 16.

3.02 ADJUSTING

A. Adjust doors for smooth operation throughout full operating range.

B. Touch up minor scratches and abrasions in finish coat to match factory finish.

END OF SECTION

SECTION 08360

SECTION OVERHEAD DOORS

GENERAL

1.01 SUMMARY

A. Section Includes: Electrically operated sectional doors, operators, controls and accessories.

B. Related Sections:

1. Division 5 Sections: Miscellaneous Metals for steel supports.

2. Division 8 Sections: Hardware, Locks, Access Panels.

3. Division 9 Sections: Finish Painting, Field Painting.

4. Division 16 Sections: Electrical connections and service for powered door operators.

1.02 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

B. American Society for Testing and Materials (ASTM):

1. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance:

1. Wind Loads: Uniform design pressure of 30 psf.

B. Spring Cycle Requirements: 50,000 cycles.

1.04 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Product Data: Submit manufacturer's product data and installation instructions.

C. Shop Drawings: Provide drawings indicating track details, head and jamb conditions, spring shafts, anchorage, accessories, finish colors, patterns and textures, operator mounts and other related information.

D. Samples: Submit selection and verification samples of metal finishes.

E. Quality Assurance Submittals: Submit the following:

1. Certificates: Submit manufacturer's certificate that products meet or exceed specified requirements.

2. Certificates: Submit installer qualifications.

F. Closeout Submittals: Submit the following:

1. Warranty documents specified herein.

G. Material content documentation required as per Section 01331.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity, and trained and authorized by the door dealer to perform the work of this section.

B. Preinstallation Meetings: <Insert requirements for meeting>. Verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Division 1 Project Management and Coordination (Project Meetings) Section.

1.06 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 1 Product Requirements Section.

B. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1.07 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.

1.08 MAINTENANCE

A. Maintenance Service: Submit for Owner's consideration and acceptance maintenance service agreement for products installed.

PRODUCTS

1.09 MANUFACTURER

A. Manufacturer: Raynor Door. Product: Alumaview Standard.

B. Manufacturer: Amarr.

C. Wayne – Dalton.

D. Substitutions: Under provisions of Section 01631.

1.10 DOOR OPERATORS

A. Provide doors designed for electric motor operation.

B. Manufacturer Product Designation: Raynor PowerHoist Basic (Model Series PHB):

1. Type: Jackshaft.

2. Motor Horsepower Rating: Intermittent 1/2 HP.

3. Electrical Requirements: 480 volt three phase.
   a. Sufficient power to operate door at average speed of 12 inches per second.
   b. Manually operable in case of power failure.

4. Duty Cycle: 10 cycles/hour.

5. Control Wiring: Solid state circuitry with provisions for connection of safety edge to reverse, external radio control hook-up, maximum run timer shut-off, timer to close. Three button momentary contact "open-close-stop".

1.11 DOOR SECTIONS

A. Material: 1-3/4 inches thick, 6036-T6 aluminum alloy stiles and rails joined together with 1/4 inch diameter screws. Aluminum panels 0.050 inch thick fill spaces between stiles and rails, sealed with polyethylene foam and held in place with gray snap-in extruded PVC retainer. Combined dimension of two adjoining intermediate meeting rails 1-1/2 inches. End stiles hollow enclosed type 2-5/8 inches wide as determined by overall door width. Center stiles 7/16 inch wide. Bottom rail height 4-5/8 inches.

B. Mounting: Sections mounted in door opening using Lap Jamb Angle Mounting: section overlap door jambs by 1 inch on each side of door opening.

C. Seals: Flexible U-shaped vinyl seal retained in bottom aluminum rail of door.

D. Trussing: Doors designed to withstand specified windload. Deflection of door in horizontal position to be maximum of 1/120th of door width.

E. Finish: Powdercoat: as selected from manufacturer's selection of a minimum of 150 colors.

F. Windows: Provide door sections with windows in lieu of 0.050 inch (1.3mm) aluminum filler panels. Windows shall be placed in one panel of each overhead door. That panel shall be the one with a bottom edge closest to, but not less than, 5'-0" above finished floor.

G. Glass Glazing: Furnished windows 1/4 inch Tinted Tempered Glass consisting of one pane of 1/4 inch non-insulated glass.

1.12 TRACK

A. Material: Hot-dipped galvanized steel (ASTM A-653), fully adjustable for adequate sealing of door to jamb or weatherseal.

B. Configuration Type: Standard Lift.

C. Size: 2 inches.

D. Mounting: Floor-to-Shaft Angle-Mount consisting of continuous angle extending from the floor, past header, completely up to door shaft for use with steel, wood, or masonry jambs. Continuous angle size not less than 2-5/16 inches by 4 inches x 3/32 inch on 2-inch track.

E. Finish: Galvanized

1.13 COUNTERBALANCE SYSTEM

A. Type: Provided with aircraft-type, galvanized steel lifting cables with minimum safety factor of 5 to 1. Weight Counterbalance for lift clearance and vertical lift type configurations.

1.14 HARDWARE

A. Hinges and Brackets: Fabricated from galvanized steel.

B. Track Rollers: 2 inches diameter consistent with track size, with hardened steel ball bearings.

C. Perimeter Seal: Furnish doors with perimeter seal.

D. Locks: Furnish door system with exterior lock with five-pin tumbler cylinder, night latch and steel bar engaging track.

EXECUTION

1.15 MANUFACTURER'S INSTRUCTIONS

A. Comply with instructions and recommendations of door manufacturer.

1.16 EXAMINATION

A. Site Verification of Conditions: Verify through direct observation and field measurement that site conditions are acceptable for installation of doors, operators, controls and accessories. Ensure that openings square, flush and plumb.

B. Do not proceed with installation of doors, operators, controls and accessories until unacceptable conditions are corrected.

1.17 INSTALLATION

A. General: Install door, track and operating equipment complete with all necessary accessories and hardware according to shop drawings, manufacturer's instructions.

1.18 ADJUSTING

A. General: Lubricate bearings and sliding parts, assure weathertight fit around door perimeter and adjust doors for proper operation, balance, clearance and similar requirements.

1.19 CLEANING

A. Remove temporary coverings and protection of adjacent work areas. Repair or replace installed products damaged prior to or during installation.

B. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Remove and legally dispose of construction debris from project site.

END OF SECTION

SECTION 08410

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aluminum entrance doors and frames.
   2. Aluminum framed glazed storefronts.
   3. Glass infill panels.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 07 9200 - Joint Sealers.
   3. Section 08 7100 - Door Hardware.
   4. Section 08 8000 - Glazing.

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
   1. 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
   2. 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Architectural Extrusions and Panels.

B. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. E283 - Standard Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors.
   4. E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors under the Influence of Wind Loads.
   5. E547 - Standard Test Method for Water Penetration of Exterior Windows, Doors, and Curtain Walls by Cyclical Static Air Pressure Differential.
   6. E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
   7. E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Design [exterior] systems to withstand:
   1. Design wind pressure in accordance with North Carolina Stata Building Code, with maximum allowable deflection of L/175, tested in accordance with ASTM E330.

2. Movement caused by an ambient temperature range of 120 degrees F and a surface temperature range of 160 degrees F.

B. Performance Requirements:
1. Air infiltration, tested to ASTM E283.
a. Entrances:
1) Single door: Maximum 0.5 CFM per minute per linear foot of perimeter crack, at static pressure differential of 6.24 PSF.
2) Pairs of doors: Maximum 1.0 CFM per minute per linear foot of perimeter crack, at static pressure differential of1.567 PSF.
b. Storefront: 0.06 CFM per square foot of fixed area at static pressure differential of 6.24 PSF.
2. Water infiltration: No uncontrolled water leakage, tested to ASTM E547 at minimum test pressure of 6.24 PSF for inswing doors and 15.0 PSF for outswing doors and storefront .
3. Uniform structural loading: No glass breakage or permanent damage to fasteners or system components, tested to ASTM E330 at 1.5 times design pressure.
4. Thermal transmittance due to conduction (Uc): Maximum 0.60, tested to AAMA 1503 on two 6'-0" x 6'-0" units with 1 inch clear insulating glass.
5. Condensation resistance factor (CRF): Minimum 50, tested to AAMA 1503.

1.4 SUBMITTALS

A. Submittals for Review:
1. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, trim, sealers, hardware, and accessories.
2. Samples:
a. 3 x 3 inch coating samples showing available colors.

B. Quality Control Submittals:
1. Test Reports: Certified results of previous tests by a recognized independent laboratory substantiating compliance with specified design and performance criteria, current within past 5 years.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years documented experience in work of this Section.

B. Conform to applicable accessibility code for locating hardware and for door opening force requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. EFCO Corporation. (www.efcocorp.com)
2. Kawneer Co., Inc. (www.kawneer.com)
3. Oldcastle BuildingEnvelope. (www.oldcastlebe.com)
4. Tubelite, Inc. (www.tubeliteinc.com)
5. YKK AP America, Inc. (www.ykkap.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Aluminum:
   1. Extrusions: ASTM B221, 6063-T5 alloy and temper.
   2. Sheet: ASTM B209, alloy and temper best suited to application.

2.3 COMPONENTS

A. Entrances Doors: Wide stile configuration with nominal 5 inch vertical stiles and top rail and 6 inch bottom rail, thermally broken.

B. Storefront: Flush glazing system designed to receive 1 inch glass by means of elastomeric gaskets; 2 inch face width x 4-1/2 inch depth, center glass application , thermally broken .

C. Door Hardware: Specified in Section 08 7100.

2.4 ACCESSORIES

A. Fasteners:
   1. Series 300 stainless steel for wet locations and exposed fasteners.
   2. Stainless or fluoropolymer coated steel for other locations.

B. Joint Sealers: Specified in Section 07 9200.

C. Glass and Glazing Accessories: Specified in Section 08 8000.

D. Weatherstripping: Replaceable, resilient bulb type.

2.5 FABRICATION

A. Fabricate with minimal clearances and shim spaces around perimeter.

B. Accurately fit and secure joints and intersections. Make joints flush, hairline, and weathertight.

C. Fabricate in largest practical units.

D. Conceal fasteners and attachments from view.

E. Fabricate aluminum components with integral low conductance thermal barrier located between exterior and interior exposed components that eliminates metal-to-metal contact.

F. Doors:
   1. Mechanically fastened and welded corner construction.

2. Fabricate stiles and rails of minimum 0.188 inch thick extrusions and glass stops from minimum 0.050 inch thick extrusions.
3. Provide weatherstripping at door head, jambs, meeting stiles, and sills.
4. Prepare with internal reinforcements for door hardware.

2.6 FINISHES

A. Aluminum: AAMA 2605, fluoropolymer coating containing minimum 70 percent PVDF resins, three coat system, color to be selected from manufacturer's full color range.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

B. Install components plumb and level, in proper plane, free from warp and twist.

C. Anchor to supporting construction.

D. Set thresholds and sill members exposed to weather in mastic and secure.

E. Install hardware using templates provided by manufacturer.

F. Install glass and accessories in accordance with Section 08 8000.

G. Installation Tolerances:
1. Maximum variation from plumb or level: 1/8 inch in 3 feet or 1/4 inch in any 10 feet, whichever is less.
2. Maximum misalignment of members abutting end to end: 1/32 inch.
3. Sealant space between framing members and adjacent construction: 1/2 inch plus or minus 1/8 inch.

3.2 ADJUSTING

A. Adjust hardware for smooth operation.

Adjust doors to operate with maximum opening forces in accordance with applicable accessibility code.

B. Touch up minor scratches and abrasions to match original finish.

C. Adjust weatherstripping to contact appropriate surfaces and form weather seal.

END OF SECTION

SECTION 08451

FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aluminum framed vertical glazing system.
   2. Sandwich panels of translucent fiberglass skins separated with aluminum grid.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 07 9200 - Joint Sealers.

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
   1. 611 - Voluntary Specification for Anodized Architectural Aluminum.
   2. 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

B. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.2 - Structural Welding Code - Aluminum.

C. ASTM International (ASTM):
   1. A36/A36M - Standard Specification for Carbon Structural Steel.
   2. B85 - Standard Specification for Aluminum-Alloy Die Casting.
   3. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   4. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   5. C920 - Standard Specification for Elastomeric Joint Sealants.
   6. E283 - Standard Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors.
   7. E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

1.3 SYSTEM DESCRIPTION

A. Translucent Panel System: Reinforced, thermally broken, translucent panel system, with support framing, battens, cap strips, related flashings, anchorage and attachment devices.

B. Design Requirements:
   1. Design translucent system to withstand:
      a. Live and dead loads in accordance with Building Code.

b. Design wind pressure in accordance with North Carolina Building Code, tested in accordance with ASTM E330.
c. Concentrated 250 pound live load applied at any point on aluminum framing members.
d. Movement caused by an ambient temperature range of 120 degrees F and a surface temperature range of 160 degrees F.
e. Movement between translucent panel system and adjacent construction.
f. Dynamic loading and release of loads.
g. Deflection of supports.

2. Not permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, and damage, loosening, weakening, or opening of components of system.
3. Design system under direction of Professional Structural Engineer licensed in State in which Project is located, with minimum 2 years experience in work of this Section.

C. Deflection and Stress Limits:
1. Normal to plane of panels, deflection of framing members shall not exceed L/360 or 3/4 inch, whichever is less. Where joint sealer joint occurs between framing members and building elements, deflection of framing members shall not exceed one half of joint width, or less if required by joint sealer manufacturer.
2. At connection points of framing members to anchors, anchor deflection in any direction shall not exceed 1/16 inch.

D. Performance Requirements:
1. Air infiltration: Maximum 0.06 CFM per square foot, tested to ASTM E283 at pressure differential across assembly of 6.24 PSF.
2. Water penetration: No water penetration as defined in AAMA 501, tested to ASTM E331 at minimum 12.0 PSF.
3. Uniform structural loading: No panel breakage or permanent damage to fasteners or system components, tested to ASTM E330 at 1.5 times the design pressure.
4. Thermal transmittance due to conduction (Uc): Maximum 0.60, tested to AAMA 1503.
5. Condensation resistance factor (CRF): Minimum 50, tested to AAMA 1503.

1.4 SUBMITTALS

A. Submittals for Review:
1. Shop Drawings - Show:
a. Joining techniques, provision for expansion and contraction, anchorage details, and framing member profiles, elevations, and details.
b. Materials and finishes.
c. Relative layout of adjacent and supporting construction.
d. Translucent panels, setting blocks, jamb blocking, and glazing seals.
e. Weep drainage network.
f. Joint sealants, backer rods, bond breakers, and primers.
g. Loads applied to structure: Location, direction, and magnitude.
2. Samples: System samples, 12 x 24 inches, illustrating aluminum framing system, panels, and accessories.

3. Warranty: Sample warranty form.

B. Quality Control Submittals:
1. Test Reports: Certified results of previous tests by a recognized independent laboratory substantiating compliance with specified design and performance criteria, current within past 5 years.
2. Welder Qualifications: As required by AWS D1.1.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years documented experience in work of this Section.

B. Welder Qualifications: AWS D1.1 and D1.2.

1.6 WARRANTIES

A. Furnish manufacturer's year warranty providing coverage against water leakage through translucent panel system and reduction of performance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. Kalwall Corporation. (www.kalwall.com)
2. Major Industries, Inc. (www.majorskylights.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Aluminum Components: Alloy and temper best suited to application.
1. Extrusions: ASTM B221.
2. Sheet: ASTM B209.
3. Castings: ASTM B85.

B. Steel Shapes: ASTM A36/A36M.

2.3 ACCESSORIES

A. Fasteners:
1. Series 300 stainless steel for wet locations and exposed fasteners.
2. Stainless or corrosion resistant coated steel for other locations.

B. Joint Sealers:
1. Perimeter: Specified in Section 07 9200.
2. Internal: ASTM C920, Type S, Grade NS, Class 25, Uses NT, M, A, and O; single component silicone, non sag, plus or minus 25 percent movement capability.

C. Anchors: Cast iron, malleable iron, or steel.

D. Primer Paint: Zinc rich type.

2.4 COMPONENTS

A. Panels:
   1. Type: Translucent glass fiber sheet bonded to both sides of structural extruded aluminum grid; exposed surfaces of exterior sheet chemically and permanently treated to protect against surface erosion and extreme weather conditions.
   2. Size: 2-3/4 inches deep x maximum panel size; 12 x 24 inch grid design.
   3. Colors:
      a. Exterior sheet: White.
      b. Interior sheet: White.
   4. Thermal resistance: U-value of 0.24 BTU/square foot/hour/degree F.
   5. Visible light transmittance: 35 percent.

2.5 FABRICATION

A. Fabricate with minimum clearances and shim spaces around perimeter, yet enabling installation and dynamic movement.

B. Accurately fit and secure joints and intersections. Make joints flush, hairline, and weathertight.

C. Fabricate in largest practical units.

D. Conceal fasteners and attachments from view.

E. Reinforce framing members with internal steel when required to support imposed loads.

F. Fabricate so that components will not be excessively strained under normal conditions of use.

G. Provide slotted holes for erection adjustment.

H. Furnish fascias, covers, closures, and trim members that are attached to translucent panel system.

I. Make provision in design to drain to exterior leakage of water occurring at joints and condensation taking place within construction. Provide gutters at horizontals at bottom of panels; weep to exterior through baffled weep holes.

J. Fabricate aluminum components with integral low conductance thermal barrier located between exterior and interior exposed components that eliminates metal-to-metal contact.

2.6 FINISHES

A. Aluminum: AAMA 611, Architectural Class I anodized to 0.0007 inch minimum thickness, clear.

B. Ferrous Metals: Hot dip galvanized.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

B. Install components plumb and level, in proper plane, free from warp and twist.

C. Anchor to supporting construction.

D. Weld adjustable anchorage connections after translucent panel system is properly positioned. Perform welding in accordance with AWS D1.1 and D1.2.

E. Compensate for predictable conditions that could cause system to exceed allowable tolerances.

F. Employ reinforcing members if required. If temporary braces or erection clips are used, prevent damage to exposed surfaces.

G. Installation Tolerances:
   1. Variation from plane or locations shown on Shop Drawings: Maximum 1/8 inch in 10 feet of length or 1/2 inch in any total length.
   2. Offset from true alignment between two identical members abutting end to end in line: Maximum 1/32 inch.
   3. Joint sealer space between translucent panel system and adjacent construction: 1/4 inch plus or minus 1/8 inch.

3.2 ADJUSTING

A. Touch up minor scratches and abrasions on finished surfaces to match original finish.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hardware for fiberglass and stainless steel doors.
   2. Weatherstripping and thresholds.
   3. Seals.
   4. Hardware for other sections referencing this section.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
   1. A156.1 - Butts and Hinges.
   2. A156.2 - Bored and Preassembled Locks and Latches.
   3. A156.3 - Exit Devices.
   4. A156.4 - Door Controls - Closers.
   5. A156.5 - Auxiliary Locks and Associated Products.
   6. A156.13 - Mortise Locks and Latches.
   7. A156.18 - Materials and Finishes.
   8. A156.26 - Continuous Hinges.

B. National Fire Protection Association (NFPA)
   1. 80 - Standard for Fire Doors and Windows.
   2. 105 - Installation of Smoke Control Door Assemblies.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Schedule hardware by door type and location; show door size, hand, thickness, edge bevel, hardware components and quantities, keying, and finishes.
   2. Product Data: Manufacturer's descriptive data for each component.
   3. Samples: One sample of each hardware item, if requested. Samples will be returned for installation on Project.
   4. Warranty: Sample warranty form.

B. Closeout Submittals:
   1. Copy of approved hardware schedule.
   2. Keying list.
   3. Keys; tag with mark corresponding to keying schedule.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years documented experience in work of this Section.

B. Provide hardware labeled by recognized independent testing laboratory and meeting requirements of NFPA 80 for fire rated doors.

C. Provide smoke gasketing at fire rated doors in accordance with NFPA 105.

D. Conform to applicable accessibility code for locating hardware and for door opening force requirements.

E. Pre-Installation Conference:
   1. Convene at site prior to ordering permanent cylinders for Project.
   2. Attendance: Architect, Owner, Contractor, Construction Observer, and hardware supplier.
   3. Review, discuss, and finalize Owner's keying requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Pack hardware items separately, with fasteners, installation instructions, and templates.

B. Mark containers with item number corresponding to hardware schedule.

1.6 WARRANTIES

A. Furnish manufacturer's 3 year warranty for locksets, latchsets and door closers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Hinges:

1.	Hager	BB1199	BB1279	BB1168	BB1193
2.	McKinney	T4A3386	TA2714	T4A3786	TA2314
3.	Stanley	FBB199	FBB168	FBB179	FBB191
4.	HB Ives	5BB1HW	5BB1		

B. Acceptable Manufacturers - Exit Devices:

1.	Von Duprin	99 Series	US26D
2.	Sargent	88 Series	US32D
3.	Precision	2000 Series	US32D

C. Acceptable Manufacturers - Locks:

1.	Sargent	8200 LNJ	SERIES US26D
2.	Schlage-	9300 03A	SERIES US26D
3.	Best	45H 3H	SERIES US26D

D. Acceptable Manufacturers - Closers:

1.	Sargent	281 Series
2.	LCN	4040XP Series
3.	Ryobi	4551 Series

E. Acceptable Manufacturers – Overhead Stops:
   1. Glynn Johnson
      a. 900 Series US32D
      b. 454 Series US32D
   2. ABH
      a. 9020 Series US32D
      b. 4400 Series US32D
   3. Sargent
      a. 590 Series US32D
      b. 1540 Series US32D

F. Substitutions: Under provisions of Division 01.

2.2 MANUFACTURED UNITS

A. Butt Hinges:
   1. Description: ANSI/BHMA A156.1, full mortise type, five knuckle, non rising pin, hole in bottom tip for pin removal.
   2. Exterior outswinging doors: Provide set screw in barrel making hinge non-removable when door is closed.
   3. Weight: Heavy weight.
   4. Bearing type: Ball bearing.
   5. Size: 4-1/2 x 4-1/2.

B. Locksets, Latchsets, Deadbolts, and Cylinders:
   1. Locksets and latchsets:
      a. Type: ANSI/BHMA A156.13, Grade 1, mortise, lever handles.
      b. Lever design: To be selected from manufacturer's full range of selections. Provide tactile contact surfaces on doors into hazardous areas.
   2. Deadbolts:
      a. Type: ANSI/BHMA A156.5, cylindrical type with 1 inch bolt throw.
      b. Functions: As scheduled.
   3. Strike plates: Curved lip, minimum lip projection necessary to protect door frame and trim and to conceal edges of strike cutout.
   4. Strike boxes: Plastic.
   5. Cylinders: Seven pin, solid brass , removable core type.
   6. Keys: Solid brass or nickel silver.
   7. Keying:
      a. Construction key locks.
      b. Grand Master key locks in one set..
      c. Key alike, cross key, or otherwise key as directed by Owner.
      d. Provide four keys for each lock and 6 master keys.
      e. Inscribe keys with lock manufacturer and notation DO NOT DUPLICATE.

C. Closers:
   1. Description: ANSI/BHMA A156.4, overhead exposed, plastic cover, adjustable for door sizes 1 through 6.
   2. Construction: Cast iron body, rack and pinion operation with compression spring, fully hydraulic.
   3. Closing and latching speeds and backcheck: Controlled by independently adjustable concealed valves.

4. Mounting: Surface mounted, non handed with universal regular or parallel arm. Suitable for mounting on 1-3/4 inch minimum door top rail or transom bar without drop plate.
5. Adjustable opening force in accordance with applicable accessibility code.]

D. Exit Devices:
1. Description: ANSI/BHMA A156.3, Grade 1, push pad type.
2. Type: Rim.
3. Outside trim: To be selected from manufacturer's full range of selections.
4. Cylinders: Same as specified above for locksets.

2.3 FINISHES

A. Finishes: To ANSI/BHMA A156.18.

B. Door Closers: Finish No. 689, silver enamel.

C. Hinges at Fire-Rated Doors: Finish No. 652, satin chrome plated.

D. Thresholds and Door Seal Housings: Clear anodized.

E. Other: Finish No. 630, satin stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install hardware in accordance with approved hardware schedule and manufacturer's instructions.

B. Install mortise items flush with adjacent surfaces.

C. Install locksets, closers, and trim after finish painting.

D. Set thresholds in mastic and secure.

E. Mount closers so that closers and closer arms are not visible on corridor or public side of doors or on exterior of building.

F. Mounting Heights - Finished Floor to Center Line of:
1. Locksets: 38 inches.
2. Push and pull plates: 42 inches.
3. Dead locks: 48 inches.
4. Push pad exit devices: 42 inches.
5. Top hinge: Maximum 10 inches from frame head.
6. Bottom hinge: Maximum 12-1/2 inches from floor.
7. Intermediate hinges: Equally spaced.

3.2 PROTECTION

A. Remove or protect hardware until painting is completed.

3.3 ADJUSTING

A. Test and adjust hardware for quiet, smooth operation, free from binding and rattling.

B. Adjust doors to operate with maximum opening forces in accordance with applicable accessibility code.

3.4 MANUFACTURER LIST

Code	Name
AD	Adams Rite
CR	Corbin Russwin
FL	Falcon Lock
IV	Ives
LO	Schlage Electronics
MC	McKinney
NA	National Guard
PE	Pemko
RO	Rockwood
RX	Rixson
SA	Sargent
SD	Security Door Controls
VO	Von Duprin

3.5 SCHEDULE

SET #01 - AL DR X AL FR				
1	Continuous Hinge	MCK-12HD 83 EPT	CLEAR	MC
1	Deadlock	2490A	628	SD
1	Mortise Cylinder	1020-114-A01 KY3 MK	630	CR
1	Push/Pull Set	RM251 33" TYPE 12XHD FASTENING	US32D	RO
1	Closer	351 PS	EN	SA
1	Spacer Kit	581-2	EN	SA
1	Switch	679-05HM		LO
1	Power Transfer	EPT 10	SP28	FL
1	Drip Cap	16 A 40"		NA
1	Saddle Threshold	425 HD 36" 10-24 MS/LA	AL	NA
	NOTE: DOOR SWITCH.			
SET #02				
3	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
1	Lockset	ML2051 LSA	630	CR
1	Closer	351 PS	EN	SA
1	Protection Plate	K1050 10" x 34"	US32D	RO
1	Smoke Seal	S88 BL 17'		PE
SET #03				
3	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
1	Lockset	ML2051 LSA	630	CR
1	Closer	351 UO	EN	SA
1	Protection Plate	K1050 10" x 34"	US32D	RO
1	Wall Bumper	409	US32D	RO
1	Smoke Seal	S88 BL 17'		PE
SET #04				
6	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
2	Flush Bolts	555	US26D	RO

	1	Lockset	ML2055 LSA	630	CR
	2	Overhead Holder	9-326	630	RX
	1	Dust Proof Strike	570	US26D	RO
	1	Smoke Seal	S88 BL 25'		PE
SET #05					
	3	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
	1	Passage Set	ML2010 LSA	630	CR
	1	Wall Bumper	409	US32D	RO
	1	Smoke Seal	S88 BL 17'		PE
SET #06					
	3	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
	1	Privacy Set	ML2030 LSA M19V	630	CR
	1	Closer	351 UO	EN	SA
	1	Protection Plate	K1050 10" x 34"	US32D	RO
	1	Wall Bumper	409	US32D	RO
	1	Smoke Seal	S88 BL 17'		PE
SET #07					
	3	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
	1	Privacy Set	ML2030 LSA M19V	630	CR
	1	Closer	351 UO	EN	SA
	1	Overhead Stop	9-336	630	RX
	1	Protection Plate	K1050 10" x 34"	US32D	RO
	1	Smoke Seal	S88 BL 17'		PE
SET #08					
	3	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
	1	Lockset	ML2057 LSA	630	CR
	1	Overhead Holder	9-326	630	RX
	1	Smoke Seal	S88 BL 17'		PE
SET #09					
	1	Continuous Hinge	112HD 83" EPT	US28	IV
	1	Electrified Lockset	ML20906 LSA M92	626	CR
	1	Closer	351 PS	EN	SA
	1	Protection Plate	K1050 10" x 34"	US32D	RO
	1	Switch	679-05HM		LO
	1	Power Transfer	EPT 10	SP28	FL
	1	Drip Cap	16 A 40"		NA
	1	Weatherstrip	290 APK 1 x 36" 2 x 84"		PE
	1	Door Bottom	345 A 36"		PE
	1	Saddle Threshold	425 HD 36" 10-24 MS/LA	AL	NA
		NOTE: CARD READER X RX X DC.			
SET #10					
	1	Continuous Hinge	112HD 83" EPT	US28	IV
	1	Exit Device	RX 99L x E996L-R&V 07	US26D	VO
	1	Rim Cylinder	3020-138 KY3 MK	630	CR
	1	Closer	351 CPSH	EN	SA
	1	Protection Plate	K1050 10" x 34"	US32D	RO
	1	Switch	679-05HM		LO
	1	Power Transfer	EPT 10	SP28	FL
	1	Drip Cap	16 A 40"		NA
	1	Weatherstrip	290 APK 1 x 36" 2 x 84"		PE
	1	Door Bottom	345 A 36"		PE
	1	Saddle Threshold	425 HD 36" 10-24 MS/LA	AL	NA
		NOTE: CARD READER X RX X DC.			
SET #11					
	1	Continuous Hinge	112HD 83" EPT	US28	IV
	1	Exit Device	RX 99NL x 990NL-R&V	US26D	VO
	1	Rim Cylinder	3020-138 KY3 MK	630	CR

	1	Closer	351 CPSH	EN	SA
	1	Protection Plate	K1050 10" x 34"	US32D	RO
	1	Switch	679-05HM		LO
	1	Power Transfer	EPT 10	SP28	FL
	1	Drip Cap	16 A 40"		NA
	1	Weatherstrip	290 APK 1 x 36" 2 x 84"		PE
	1	Door Bottom	345 A 36"		PE
	1	Saddle Threshold	425 HD 36" 10-24 MS/LA	AL	NA
		NOTE: DOOR CONTACT.			
SET #12					
	1	Continuous Hinge	MCK-12HD 83	CLEAR	MC
	1	Exit Device	99L x 996L-R&V 07	US26D	VO
	1	Rim Cylinder	3020-138 KY3 MK	630	CR
	1	Closer	351 PS	EN	SA
	1	Protection Plate	K1050 10" x 34"	US32D	RO
	1	Smoke Seal	S88 BL 17'		PE
SET #13					
	2	Continuous Hinge	MCK-12HD 83	CLEAR	MC
	2	Fire Exit Device	9927L-F x 996L-R&V 07 LBRAFL	US26D	VO
	2	Rim Cylinder	3020-138 KY3 MK	630	CR
	2	Closer	351 PS	EN	SA
	2	Protection Plate	K1050 10" x 34"	US32D	RO
	1	Smoke Seal	S88 BL 25'		PE
	2	Length Adhesive Seal	S772 BL 7'		PE
SET #14					
	2	Continuous Hinge	112HD 83" EPT	US28	IV
	1	Key Removable Mullion	KR4954 7'6"	SP28	VO
	1	Exit Device	RX 99L x E996L-R&V 07	US26D	VO
	1	Exit Device	RX 99EO	US26D	VO
	1	Rim Cylinder	3020-138 KY3 MK	630	CR
	1	Mortise Cylinder	1020-114-A01 KY3 MK	630	CR
	2	Closer	351 CPSH	EN	SA
	2	Protection Plate	K1050 10" x 34"	US32D	RO
	2	Switch	679-05HM		LO
	2	Power Transfer	EPT 10	SP28	FL
	1	Weatherstrip	290 APK 1 x 72" 2 x 84"		PE
	1	Mullion Gasket	5110 BL 120"		PE
	1	Raindrip	346 A 76"		PE
	2	Door Bottom	345 A 36"		PE
	1	Saddle Threshold	425 HD 72" 10-24 MS/LA	AL	NA
		NOTE: CARD READER X RX X DC.			
SET #15					
	5	Hinges	TA2314 4 1/2 X 4 1/2	32D	MC
	1	Hinges	TA2314-QC 4 1/2 X 4 1/2	32D	MC
	2	Flush Bolts	555	US26D	RO
	1	Electrified Lockset	ML20906 LSA M92	626	CR
	2	Overhead Holder	9-326	630	RX
	1	Switch	679-05HM	LO	
	1	Power Transfer	EPT 10	SP28	FL
	1	Dust Proof Strike	570	US26D	RO
	1	Smoke Seal	S88 BL 25'		PE
	1	Saddle Threshold	425 HD 72" 10-24 MS/LA	AL	NA

END OF SECTION

SECTION 08800

GLAZING

PART 1GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Glass for other sections referencing this Section.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA) 800 - Voluntary Specifications and Test Methods for Sealants.

B. ASTM International (ASTM):
   1. C509 - Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
   2. C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.
   3. C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
   4. C920 - Standard Specification for Elastomeric Joint Sealants.
   5. C1036 - Standard Specification for Flat Glass.
   6. C1048 - Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT, Coated and Uncoated Glass.
   7. C1115 - Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
   8. C1184 - Standard Specification for Structural Silicone Sealants.
   9. C1294 - Standard Test Method for Compatibility of Insulating Glass Edge Sealants with Liquid-Applied Glazing Materials.
   10. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
   11. E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.
   12. E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.
   13. E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.

C. Consumer Product Safety Commission (CPSC) 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

D. Glass Association of North America (GANA):
   1. Engineering Standards Manual.
   2. Glazing Manual.

E. Insulating Glass Manufacturers Alliance (IGMA):
   1. IGMA TB-3001 - Sloped Glazing Guidelines.
   2. SIGMA TM-3000 - Glazing Guidelines for Sealed Insulating Glass Units.

F. National Fenestration Rating Council (NFRC):
   1. 100 - Procedure for Determining Fenestration Product Thermal Properties.
   2. 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficients at Normal Incidence.
   3. 300 - Procedures for Determining Solar Optical Properties of Simple Fenestration Products.

1.3 SYSTEM DESCRIPTION

A. Glass Thicknesses:
   1. Indicated thicknesses are minimums; select actual glass thicknesses by analyzing loads and conditions.
   2. Size glass to withstand positive and negative wind pressure acting normal to plane in accordance with North Carolina State Building Code as measured in accordance with ASTM E330.
   3. Provide glass in thicknesses and strengths to meet or exceed following criteria:
      a. Comply with ASTM E1300.
      b. Probability of breakage for vertical glazing: 8 lites per 1000 for lites set within 15 degrees of vertical and under wind load for load duration of 3 seconds.
      c. Thickness of tinted glass: Provide same thickness for each tint color for all applications.

B. Thermal and Optical Performance Properties: Provide glass meeting specified performance properties, based on manufacturer's published test data for units of thickness indicated:
   1. U-factor: Per NFRC 100 expressed as Btu/square foot x hour x degree F.
   2. Solar heat gain coefficient: Per NFRC 200.
   3. Solar optical properties: Per NFRC 300.

1.4 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Descriptive data and performance attributes for insulated glass.
   2. Warranty: Sample warranty form.

B. Quality Control Submittals:
   1. Test Report: Preconstruction adhesion and compatibility test report from glazing sealant manufacturer, based on submitted samples or acceptable data from previous testing of current formulations with similar products.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years documented experience in work of this Section.

B. Regulatory Requirements:

1. Provide safety glass for locations subject to human impact as required by North Carolina State Building Code.
2. Safety glass: Tested and labeled to CPSC 16 CFR 1201.

C. Perform Work in accordance with GANA Glazing Manual and SIGMA TM-3000.

1.6 PROJECT CONDITIONS

A. Perform glazing when ambient temperature is above 40 degrees F.

B. Perform glazing on dry surfaces.

1.7 WARRANTIES

A. Insulating Glass Units: Provide manufacturer's 10 year warranty against material obstruction of vision through unit due to:
1. Intrusion of dust or moisture.
2. Internal condensation.
3. Film formation on internal glass surfaces caused by failure of hermetic seal except failure caused in whole or in part by breakage or fracturing of any portion of glass surface.

B. Glass Coatings: Provide manufacturer's 10 year warranty against peeling, cracking, or deterioration of coating under normal conditions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Glass:
1. Guardian Industries Corp. (www.guardian.com)
2. Oldcastle BuildingEnvelope. (www.oldcastlebe.com)
3. Pilkington Architectural. (www.pilkington.com)
4. PPG Industries, Inc. (www.ppgglazing.com) (Basis of Design)
5. Viracon, Inc. (www.viracon.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS - GLASS

A. Clear Glass: ASTM C1036, Type 1 transparent flat, Class 1 clear, Quality q3 glazing select.

B. Clear Tempered Glass: ASTM C1048, Type 1 transparent flat, Class 1 clear, Quality q3 glazing select,. Kind FT fully tempered.

2.3 ACCESSORIES

A. Setting Blocks: ASTM C864, neoprene or EPDM, or ASTM C1115, silicone; 80 to 90 Shore A durometer hardness.

B. Spacers: ASTM C864, neoprene or EPDM, or ASTM C1115, silicone; 50 to 60 Shore A durometer hardness.

C. Glazing Gaskets:
   1. Dense compression gaskets: ASTM C864, neoprene or EPDM, or ASTM C1115, silicone or thermoplastic polyolefin rubber, molded or extruded shape to fit glazing channel retaining slot; black color.
   2. Soft compression gaskets: ASTM C509, Type II, black, molded or extruded, neoprene, EPDM, silicone or thermoplastic polyolefin rubber, of profile and hardness required to maintain watertight seal; black color.

D. Glazing Sealant: ASTM C920, Type S, Grade NS, Class 25; single component silicone, low modulus, non sag, color to be selected from manufacturer's full color range.

E. Sealant Backing: ASTM C1330, Type O, size and density to control glazing sealant depth and produce optimum glazing sealant performance.

F. Primer: As recommended by glazing sealant manufacturer.

G. Glazing Tape: AAMA 800; closed cell polyvinyl chloride foam, maximum 2 percent water absorption by volume, designed for 25 percent compression percent for air barrier and vapor retarder seal, black color, coiled on release paper over adhesive on two sides; widths required for installation.

2.4 FABRICATION

A. Annealed Glass: Comply with ASTM C1036.

B. Tempered Glass:
   1. Comply with ASTM C1048.
   2. Process in horizontal position so that inherent roller distortion will run parallel to building floor lines after installation.

C. Sealed Insulating Glass:
   1. Comply with ASTM E2190.
   2. Fabricate spacer bar frame of tubular aluminum filled with desiccant.
   3. Bond spacer bar frame to glass panes with twin primary seals.
   4. Fill space outside frame to glass edge with elastomeric sealant.

D. Low-E Coated Glass: Apply low-emissivity coating to scheduled glass surface.

E. Source Quality Control:
   1. Preconstruction adhesion and compatibility testing:
      a. Perform adhesion test including ultraviolet exposure through glass on production samples of metals and glass in accordance with ASTM C794.
      b. Test glass units, glazing materials, and glass framing members with specified finish for sealant compatibility, priming, and preparation requirements for optimum adhesion and performance.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean glazing rabbets; remove loose and foreign matter.

B. Remove protective coatings on metal surfaces.

C. Clean glass just prior to installation.

3.2 INSTALLATION - GENERAL

A. Install glass in accordance with glass manufacturer's instructions.

B. Maintain manufacturer's recommended edge and face clearances between glass and frame members.

3.3 INSTALLATION - SEALANT AND TAPE GLAZING METHOD

A. Apply tape to permanent stops, projecting slightly above sight line.

B. Press glass into contact with tape.

C. Install removable stops with spacer shims between stop and glass.

D. Fill gap between removable stop and glass with glazing sealant.

E. Trim protruding tape edges.

3.4 PROTECTION

A. After installation, mark glass with an 'X' using removable plastic tape.

3.5 SCHEDULE

A. Type SG-A:
   1. Description:
      a. Outboard lite: 1/4 inch thick ultra-clear glass, tempered where required, with low-e coating on No. 2 surface].
      b. Inboard lite: 1/4 inch thick ultra-clear glass, tempered where required.
   2. Total unit thickness: 1 inch.
   3. Performance characteristics:
      a. Visible transmittance: 74 percent.
      b. Solar heat gain coefficient: 0.4.
      c. Light to solar gain ratio: 1.85
   4. Source: Solarban 60.
   5. Locations: Aluminum-framed entrances and storefront.

B. Type FG-A:
   1. Description: 1/4 inch thick clear tempered glass.

2. Locations: Interior doors and glazed openings at locations subject to human impact

END OF SECTION

SECTION 09220

METAL SUPPORT ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Metal stud interior partition framing.
   2. Suspended metal channel interior ceiling framing.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A641 - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   2. A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
   3. C645 - Standard Specification for Non-Load (Axial) Bearing Steel Studs, Runners (Track), and Rigid Furring Channels for Screw Application of Gypsum Board.
   4. C754 - Standard Practice for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Wall board, Backing Board, or Water-Resistant Backing Board.

B. Gypsum Association (GA) GA-600 - Fire Resistance Design Manual.

C. Underwriters Laboratories, Inc. (UL) - Fire Resistance Directory.

1.03 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Illustrate framing types, gages, and locations.

1.04 QUALITY ASSURANCE

A. Fire Resistance Ratings:
   1. Construct assemblies to achieve fire resistance ratings indicated on Drawings, in accordance with applicable North Carolina State Building Code, GA or UL design number.
   2. If requirements of assembly numbers referenced conflict with Contract Document requirements, conform to assembly requirements.

B. Deflection Limits:
   1. Limit deflection of partitions to following limits, based on 5 PSF uniform design load.
      a. Partitions: L/120.

b. If partition height exceeds stud manufacturer's limiting height for applicable loading and deflection, install bracing above ceiling, decrease stud spacing, or increase stud gage.

2. Limit deflection of ceilings to L/360.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
1. California Expanded Metal Company. (www.cemcosteel.com)
2. ClarkDietrich Building Systems. (www.clarkdietrich.com)
3. Craco Mfg., Inc. (www.cracometals.com)
4. Marino Ware Industries. (www.marinoware.com)
5. USG. (www.usg.com)
6. Armstrong World Industries, Inc.

B. Substitutions: Under provisions of Division 01.

2.02 MATERIALS

A. Steel: ASTM A1003/1003M, Class G40 hot dip galvanized.

2.03 COMPONENTS

A. Provide components in accordance with ASTM C645. Referenced ASTM C645 includes metal thickness.

B. Studs: Non-load bearing rolled steel, channel shaped, punched for utility access.

C. Top and Bottom Runners:
1. Same material and finish as studs channel shaped.
2. Deflection compensating top runners: Deep leg runners with slotted screw holes; permit plus or minus 1/2 inch movement of overhead structure without damage to partition.

D. Suspended Ceiling Framing:
1. Main bean: HD8906 12 ft. HD Drywall Man Beam by Armstrong World Industries, Inc., or approved substitute.
2. Cross Tee: LX945P 4ft Cross Tee by Armstrong World Industries, Inc. or approved substitute.
3. Molding: KAM1512 12ft Knurled angle Molding 1-1/2" Face by Armstrong World Industries, Inc. or approved substitute.

2.04 ACCESSORIES

A. Fasteners: 3/8 inch long pan head screws.

B. Wire: ASTM A 641, galvanized steel.
1. Hanger wire: 8 gage.

2. Tie wire: 18 gage, soft annealed.

C. Wall Furring Brackets: Galvanized steel, two piece adjustable type.

D. Furring Channel Clips: Galvanized steel.

PART 3 EXECUTION

3.01 INSTALLATION OF PARTITION FRAMING

A. Install in accordance with ASTM C754 and manufacturer's instructions.

B. Attach top and bottom runner channels at ends and 24 inches on center maximum.

C. Position studs vertically in runners, spaced maximum 16 inches on center unless indicated otherwise.

D. Install deflection compensating top runner at partitions extending to structure. Cut studs 1/2 inch shorter than required length and fit into top runner. Fasten studs to top runner in manner permitting runner movement.

E. Locate studs maximum 2 inches from door frames and abutting construction.

F. Use double studs on both sides of openings in partitions.

G. Install horizontal runner as header above openings in partitions. Install studs from header to top runner.

H. Brace furred partitions with adjustable bracket located at mid height.

I. Provide wood or metal bracing in partitions to receive and support fixtures, trim, accessories and other applied items.

J. Brace ceiling height partitions to structure at 48 inches on center maximum.

3.02 INSTALLATION OF CEILING FRAMING

A. Install in accordance with ASTM C754 and manufacturer's instructions.

B. Space hanger wires 36 inches on center maximum along runner channels and within 6 inches of ends of channels; secure to structure above.

C. Space runner channels 48 inches on center maximum and within 6 inches of abutting construction.
1. Position channels for ceiling height; level and saddle tie along channels.
2. Provide 1 inch clearance between channels and abutting construction.
3. Overlap channel ends 12 inches at splices; secure each end with double loop tie wire.

D. Space furring channels 16 inches on center maximum, perpendicular to runners and within 6 inches of abutting construction.
   1. Provide 1 inch clearance between channels and abutting construction.
   2. Secure to runners with clips on alternate sides of runners; saddle tie if clips cannot be alternated.
   3. Overlap channel ends 8 inches at splices; secure each end with double loop tie wire.

E. Where openings interrupt furring or runner channels, install reinforcing to restore stability.

F. Provide double runner or furring channels side by side where [expansion and] control joints occur; do not continue channels over joints.

END OF SECTION

SECTION 09250

GYPSUM BOARD

PART 1GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Acoustical insulation.
   2. Gypsum board.
   3. Taping and bedding of gypsum board.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 07920 - Joint Sealers.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A108.11 - Interior Installation of Cementitious Backer Units.
   2. A118.9 - Test Methods and Specifications for Cementitious Backer Units.

B. ASTM International (ASTM):
   1. C475 - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
   2. C1002 - Standard Specification for Steel Drill Screws for the Application of Gypsum Board.
   3. C1047 - Standard Specifications for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
   4. C1396 - Standard Specification for Gypsum Board.
   5. E413 - Standard Test Method for Classification for Rating Sound Insulation.

C. Gypsum Association (GA):
   1. GA-214 - Levels of Gypsum Board Finish.
   2. GA-216 - Recommended Specifications for the Application and Finishing of Gypsum Board.

D. Underwriters Laboratories, Inc. (UL) - Fire Resistance Directory.

1.03 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Illustrate panel product types, thicknesses, and locations; acoustical insulation; and accessories.

1.04 QUALITY ASSURANCE

A. Fire Resistance Ratings:
   1. Construct assemblies to achieve fire resistance ratings indicated on Drawings, in accordance with applicable UL design number.

2. If requirements of assembly numbers referenced conflict with Contract Document requirements, conform to assembly requirements.

B. Acoustic Ratings: Construct assemblies to achieve acoustic ratings indicated on Drawings, tested to ASTM E90 and classified in accordance with ASTM E413.

1.05 PROJECT CONDITIONS

A. Do not install gypsum board until building is substantially weathertight.

B. Maintain temperature in spaces in which work is being performed above 50 degrees F during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers - Gypsum Panels:
1. CertainTeed Gypsum, Inc. (www.certainteed.com)
2. GP Gypsum Corporation. (www.gp.com)
3. National Gypsum Co. (www.nationalgypsum.com)
4. Temple-Inland. (www.templeinland.com)
5. USG Corporation. (www.usg.com)

B. Acceptable Manufacturers - Cementitious Panels:
1. James Hardie Building Products, Inc. (www.jameshardie.com)
2. CertainTeed Gypsum, Inc. (www.certainteed.com)
3. USG Corporation. (www.usg.com)

C. Substitutions: Under provisions of Division 01.

2.02 MATERIALS - GYPSUM PANELS

A. Regular Gypsum Board: ASTM C1396; 48 inches wide x 5/8 inch thick, maximum practical length, tapered edge.

B. Fire Resistant Gypsum Board: ASTM C1396, Type X; 48 inches wide x 5/8 inch thick, maximum practical length, tapered edge; apply to fire rated assemblies.

2.03 ACCESSORIES

A. Fasteners: ASTM C1002, Type W screws, minimum 5/8 inch penetration into framing.

B. Adhesive:
1. Type recommended by gypsum panel manufacturer.

C. Trim Accessories: ASTM C1047.
1. Material: Formed steel, minimum 26 gage core steel, hot dip galvanized finish, expanded flanges.
2. Corner reinforcement: GA-216, Type CB-100 x 100.

3. Casing: GA-216, Type LC.
4. Control joint. GA-216, 4.7.3 Control joints in the gypsum panel products shall be placed where any of the conditions described in Sections 4.7.3.1 through 4.7.3.7 exist.

D. Acoustical Sealer: Specified in Section 07900.

E. Joint Treatment Materials:
1. Reinforcing tape and joint compound; ASTM C475.

PART 3 EXECUTION

3.01 INSTALLATION OF GYPSUM PANELS

A. Install panels and accessories in accordance with ASTM C754, GA-216, and manufacturer's instructions.

B. Accurately cut panels to fit around openings and projections. Do not tear face paper or break gypsum core.

C. Apply panels at non fire-rated assemblies in most economical manner, with ends and edges occurring over supports.

D. Apply panels at fire-rated assemblies as required by design assembly.

E. Stagger joints on opposite sides of partitions.

F. Do not locate joints to align with edges of openings unless a control joint is installed.

G. Mechanically fasten panels to framing. Place fasteners minimum 3/8 inch from edges of panels; drive heads slightly below surface. Stagger fasteners at abutting edges.

H. Apply face layer of double layer applications with joints offset from those in base layer; secure with mechanical fasteners to framing or with adhesive to base layer.

I. At deflection compensating head tracks, cut panels 1/2 inch short of structure at head; do not secure panels to top runner channel.

J. Treat cut edges and holes in moisture resistant gypsum board with joint sealer.

K. Where recessed items occur in fire rated partitions, box item on all sides with gypsum board as required to maintain continuity of fire rating.

3.02 INSTALLATION OF ACCESSORIES

A. Install in accordance with manufacturer's instructions.

B. Install corner reinforcement at outside corners. Use single lengths where length of corner does not exceed standard length.

C. Install casings where indicated and where gypsum board abuts dissimilar materials or stops with edge exposed.

D. Install control joints at ceilings:
   1. At maximum 50 feet on center.
   2. Where ceiling framing changes direction.

E. Install control joints at walls and partitions:
   1. At changes in backup material.
   2. At maximum 30 feet on center.
   3. Above both jambs of openings in partitions.

3.03 JOINT TREATMENT

A. Treat joints and fasteners in gypsum board in accordance with GA-214.

B. Levels of Finish:
   1. Surfaces in plenums janitor closets: Level 1 finish.
   2. Surfaces to receive paints wall coverings: Level 4 finish.

END OF SECTION

SECTION 09510

ACOUSTICAL CEILINGS

PART 1GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Suspended metal ceiling grid system.
   2. Acoustical panels.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. A641 - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   2. C635 - Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
   3. C636 - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
   4. E1264 - Standard Classification of Acoustical Ceiling Products.

B. Ceiling and Interior Systems Construction Association (CISCA) - Ceiling Systems Handbook.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Samples:
      a. 12 x 12 inch acoustical panel samples.
      b. 6 inch long suspension system samples showing each profile.

B. Quality Control Submittals:
   1. Certificates of Compliance: Certification from an independent testing laboratory that acoustical panels meet fire hazard classification requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years documented experience in work of this Section.

1.5 PROJECT CONDITIONS

A. Environmental Requirements: Install in approximately same conditions of temperature and humidity as will prevail after installation.

1.6 MAINTENANCE

A. Extra Materials: 2 percent of acoustical panels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Suspension System:
   1. Armstrong World Industries, Inc. (www.armstrong.com/ceilings)
   2. Chicago Metallic Corporation. (www.chicago-metallic.com)
   3. USG Corporation. (www.usg.com)

B. Acceptable Manufacturers - Acoustical Units:
   1. Armstrong World Industries, Inc. (www.armstrong.com/ceilings)
   2. Certainteed Corporation (www.certainteed.com)
   3. USG Corporation. (www.usg.com)

C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Suspension Grid System:
   1. ASTM C635, heavy duty, die cut, interlocking ends.
   2. Grid type: Exposed T.
   3. Material: [Galvanized steel. Aluminum cap.
   4. Runners: 1-1/2 inches high, 15/16 inch exposed width, flush profile.
   5. Perimeter molding: Angle shape.
   6. Finish: Factory applied enamel paint, sprayed and baked, white color.
   7. Accessories: Stabilizer bars, clips, and splices.

B. Acoustical Panels:
   1. Source: Fine Fissured by Armstrong World Industries, Inc or approved substitute.
   2. Size: 24 x 24 inches x 3/4 inch thick.
   3. Edge configuration: Beveled Tegular.
   4. Performance requirements: Tested in accordance with ASTM E1264.
      a. NRC: 0.70.
      b. CAC: 0.40.
      c. Light reflectance: LR-0.85.

C. Acoustical Panels:
   1. Source: Ceramaguard Fine Fissured by Armstrong or approved substitute.
   2. Size: 24 x 24 inches x 5/8 inch thick.
   3. Edge configuration: Square.
   4. Performance requirements: Tested in accordance with ASTM E1264.
      a. NRC: 55.
      b. CAC: 38.
      c. Light reflectance: LR-82.

2.3 ACCESSORIES

A. Support Channels: Galvanized steel; size and type to suit application.

B. Hanger Wire:
   1. ASTM A641, minimum 12 gage galvanized steel.

C. Touch-Up Paint: Color to match acoustical panels and suspension grid.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install ceilings in accordance with ASTM C636 and CISCA Handbook.

B. Minimize panels less than one half size.

C. Install molding around perimeters and abutting surfaces. Miter molding at exterior corners; cut flanges and bend web to form interior corners.

D. Space hanger wires maximum 48 inches on center. Install additional hangers where required to support light fixtures and ceiling supported equipment.

E. Do not suspend hangers directly from metal deck. Attach steel channel horizontally to adjacent framing members; place hanger at regular spacing.

F. Hang suspension system independent of walls, columns, ducts, pipes, and conduit.

G. Where ducts or other equipment prevent regular spacing of hangers:
   1. Reinforce nearest related hangers to span extra distance, or:
   2. Suspend steel channel horizontally beneath duct or equipment; place hanger at regular spacing.

H. Install main tees at maximum 48 inches on center.

I. Install cross tees to form 24 x 24 inch modules. Lock cross tees to main tees.

J. Support ends of tees on flange of perimeter molding.

K. Place acoustical panels with edges resting flat on suspension grid.

L. Cutting Acoustic Units:
   1. Cut to fit irregular grid and perimeter edge trim and around penetrations.
   2. Locate cuts to be concealed.
   3. Cut and field paint exposed edges of reveal edge units to match factory edge.

M. Installation Tolerances: Ceilings level to 1/8 inch in 12 feet measured in any direction.

3.2 ADJUSTING

A. Touch up minor scratches and abrasions to match factory finish.

END OF SECTION

SECTION 09651

RESILIENT BASE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resilient wall base.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM) F1861 - Standard Specification for Resilient Wall Base.

B. Resilient Floor Covering Institute (RFCI) - FloorScore Certification Program.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Samples: 4 inch long samples showing available colors.

1.4 MAINTENANCE

A. Extra Materials: 2 percent of each profile and color.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers - Base:
   1. Allstate Rubber Corp. (www.allstaterubber.com)
   2. Armstrong World Industries. (www.armstrong.com)
   3. Burke Flooring. (www.burkeflooring.com)
   4. Johnsonite, Inc. (www.johnsonite.com)
   5. Roppe Corp. (www.roppe.com)

B. Acceptable Manufacturers – Installation Materials:
   1. BASF Corporation. (www.buildingsystems.basf.com)

C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Resilient Base:
   1. Type: ASTM F1861, thermoset vulcanized rubber.
   2. Thickness: 0.125 inch.
   3. Profile: Coved.
   4. Height: 4 inches.
   5. Length: Continuous rolls.
   6. Color: To be selected from manufacturer's full color range.

7. Finish: Satin.
8. outside corners: Preformed; profile, size, and color to match base.

2.3 ACCESSORIES

A. Adhesive:
1. Water based, waterproof, recommended by base manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare surfaces to receive base:
1. Remove materials that could interfere with adhesion.
2. Fill low spots with patching compound; finish flush with adjacent surface.
3. Remove high spots, ridges and nibs.

3.2 INSTALLATION

A. Apply adhesive continuously to back of base.

B. Maintain top edge true to line and bottom edge in continuous contact with floor. Butt joints tight; butt base tight to adjacent construction.

C. Do not install pieces less than 12 inches long.

D. Miter and butt inside corners.

E. At outside corners install preformed corner pieces.

F. At exposed ends, install premolded units.

G. Scribe to door frames and other interruptions.

END OF SECTION

SECTION 09900

PAINTING

PART 1 GENERAL

1.01 SCOPE

A. Work under this section shall include the painting of all surfaces specified herein and indicated on the Drawings.

1.02 DESCRIPTION

A. Provide the painting required to paint the newly constructed areas under this contract.

B. Where new pumps are to be installed, paint the entire piping and pumping system at continuous connection. Where new work is installed within existing, paintings should continue as follows:
   1. Continuous Surface: To the nearest intersection.
   2. Assembly: Entire Assembly

1.03 REFERENCE STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. National Sanitation Foundation (NSF)
      a. Std. 61 Drinking Water System Components - Health Effects.

1.04 QUALITY ASSURANCE

A. Paint supplier shall verify the compatibility of the specified paint systems to the surface to be painted both new and existing. Submit certification that the paint systems to be used are suitable for the surface to be painted. Notify Engineer of suggested changes in the paint system with the paint submittal.

B. Ensure compatibility of shop applied primers with the paints specified herein. If shop applied primers are incompatible contractor shall remove incompatible primer with SSPC SP-6 commercial blast.

C. Painting of surface indicates acceptance of surface for paint system being used.

D. Paints and varnishes shall be the standard products of the Valspar Corporation, Tnemec Company, Sherwin Williams Company, Glidden, PPG Company, Carboline or equal.

1.05 SUBMITTALS

A. Submit the following in accordance with Section, Submittals:
   1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met. Submit for each of the following materials:
      a. Each type of paint.
   2. Certification: Provide a letter at the end of the Project certifying the following actual work dates, that the cure time for each coat complied with the

manufacturer's requirements, and the manner of application pertaining to the surface preparation, number and type of coats and mil thickness is as specified.

a. Start and completion dates for each paint coat for each major work area.

3. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
   a. Paint Schedule: Submit five (5) copies of the manufacturer's data sheet for each type of paint proposed to be used on the Project. Use paint schedule as indicated in these specifications as a format guide. The data sheet shall include, but not be limited to, the following:
      1) Paint system.
      2) Requirements for the following:
         i) Handling and storage.
         ii) Health and safety.
         iii) Surface preparation.
         iv) Application.
         v) Curing time between coats and for immersion as appropriate.
      3) Certification by NSF, International in accordance with NSF Std. 61 for interior paint systems.
      4) Recommended Dry Film Thickness (DFT).
4. Samples: Submit five (5) color cards with paint schedule submittal.

1.06 DELIVERY, STORAGE, AND HANDLING

A. The Product shall be handled in accordance with Section, Material and Equipment.

B. Mixing of paints shall be restricted to locations directed.

C. Take necessary precautions to prevent fire.

PART 2 PRODUCTS

2.01 PAINTING MATERIALS

A. Cleaners, thinners, driers, and other additives and surface treatment materials shall be those approved for use by the manufacturer of the paints.

B. Products used in areas to be in contact with potable water shall be certified in accordance with NSF Std. 61.

2.02 PAINTING SCHEDULE

A. For convenience only, the paints specified herein, unless listed otherwise, are as manufactured by Tnemec, Carboline, Sherwin-Williams or equal. Similar paints as manufactured by other manufacturers will be acceptable.

B. Paint on this project shall be of one manufacturer.

C. Exterior Metal Doors and Frames, except aluminum:
   1. 1 coat Tnemec Chem-Prime 37-77, Valspar V13-R-28 Chromax Primer, Carboline Carbocoat 150, Sherwin-Williams Kem Kromik Universal Primer or equal (2 mils dry).
   2. 2 coats Tnemec Tneme-Gloss, Valspar 20 series M&F Enamel, Carboline Carbocoat 139, Sherwin-Williams Industrial Enamel VOC Complying or equal (2 mils dry per coat).

D. Interior Ceilings including Steel Beams and Galvanized Steel Deck (acoustical type ceilings will not be painted):
   1. 1 coat Tnemec 66-1211 Prime, Valspar 13-R-62 Epoxy Primer, Carboline 893SG, Sherwin-Williams Tile Clad HS or equal (3 mils dry).
   2. 2 coats Tnemec 66 Hi-Build Epoxoline, Valspar 89 series H.B. Epoxy, Carboline Carboguard 893SG, Sherwin-Williams Tile Clad HS or equal (2 mils dry per coat).

E. Interior above Grade Masonry and Concrete Walls, except glazed tile:
   1. 1 coat Tnemec 54-562 masonry surfaces, Valspar 79-W-8 latex Block Filler, Carboline Sanitile 100, Sherwin-Williams Heavy Duty Block Filler or equal (CMU surfaces 80 sq ft/gal, CIP or precast surfaces (100 sq ft/gal) or as necessary to achieve 10 pinholes or less per sq. ft.) Note for chemically corrosive environments Tnemec 54-660, Carboline Sanitile 600, Sherwin-Williams Kem Cati-Coat HS or equal will be required in lieu of Tnemec 54-562, Caroline Sanitile 100, Sherwin-Williams Heavy Duty Block Filler or equal.
   2. 2 coats Tnemec 66 Series Hi-Build Epoxoline, Valspar 89 Series H.B. Epoxy, Sherwin-Williams Water Based Tile Clad Epoxy or equal (2 mils dry per coat) or Carboline Sanitile 655 (1 coat @ 4.0-6.0 mils DFT). Note for chemically corrosive environments Sherwin-Williams Sher-Tile HS (1 coat @ 4.0-6.0 mils DFT)
   3. 1 coat Tnemec Tneme-Gloss, Valspar 84 Series Epoxy Enamel or equal (2 mils dry). Note that Carboline and Sherwin-Williams systems do not require a "Step 3" coating.

F. Exterior above Grade Masonry and Concrete Walls: **(OMITTED)**

G. Interior Concrete Ceilings: **(OMITTED)**

H. Concrete Floors: **(OMITTED)**

I. Exterior Woodwork: Millwork and trim shall be back primed before erection.
   1. 1 coat Tnemec 36-603 undercoater, one coat Valspar 47-W-22 Damp Grip/undercoater, Carboline Carbocrylic 120, Sherwin-Williams PrepRite Wall & Wood Primer, or equal (2 mils dry).
   2. 1 coat Tnemec 6 - Tneme-cryl, Valspar 20 Series M&F Enamel, Carboline Carbocrylic 3359, Sherwin-Williams DTM Primer/Finish, or equal (2 mils).
   3. 1 coat Tnemec 6-Tneme-cryl, Valspar 20 Series M&F Enamel, Carboline Carbocrylic 3359, Sherwin-Williams DTM Primer/Finish, or equal (2 mils dry).

J. Exterior Metal Work not Specified Otherwise:
   1. Galvanized, zinc coated, aluminum and bronze surfaces shall not be painted. On surfaces which have been shop coated, the priming coat may be omitted. Surfaces upon which shop coat has been damaged shall have metal cleaned to satisfaction of the Engineer and the cleaned surfaces primed with the specified primer. Surfaces so primed shall then be painted as specified.
   2. Non-Submerged:
      a. Surface Preparation: SSPC SP-6 Commercial Blast.
      b. 1 coat Tnemec 66-1211 Epoxoline primer, Valspar 13-R-62 Epoxy Primer, or equal (3 mils dry) or Carboline Carboguard 893 SG, Sherwin-Williams Tile Clad HS (1 coat @ 3.0-5.0 mils DFT).
      c. 1 coat Tnemec 66 Series Hi-Build Epoxoline, Valspar 89 Series H.B. Epoxy, or equal (2 mils dry) or Carboline's Carboguard 893 SG, Sherwin-Williams Tile Clad HS (1 coat @ 3.0-5.0 mils DFT).

d. Provide 1 coat Tnemec urethane Series 73, or equal (2 mils dry), Carboline Carbothane 133HB, or Sherwin-Williams Acrolon 218 HS (1 coat @ 3.0-5.0 mils DFT).
e. For bituminous coated piping, apply 1 coat of Tnemec Series 66-1211 or Sherwin-Williams Macropoxy 646 Fast Cure Epoxy (2.5 mils dry) followed by 1 coat Tnemic 66 Series Hi-Build Epoxoline or Sherwin-Williams Macropoxy 646 Fast Cure Epoxy (same color as top coat) and 1 coat of Tnemec Series 73 Endura-Shield or Sherwin-Williams Acrolon 218 HS (urethane finish) (2 mils dry per coat) or equal paint system.

3. Submerged or Intermittently Submerged: (NOTE: Omit primer if field blasted.)
   a. Surface Preparation: SSPC SP-10 near white.
   b. 1 coat Tnemec 66-1211 Epoxoline primer, Valspar 78-W-3 H.B. Epoxy, Sherwin-Williams Macropoxy 646 Fast Cure Epoxy, or equal (2 mils dry) or Carboline Carboguard 691 (1 coat @ 5.0-6.0 mils DFT).
   c. 2 coats Tnemec 66 Series Hi-Build Epoxoline, Valspar 78 Series H.B. Epoxy, Sherwin-Williams Macropoxy 646 Fast Cure Epoxy, or equal (3 mils dry per coat) or Carboline Carboguard 691 (1 coat @ 12.0-15.0 mils DFT).

K. Interior Metalwork:
   1. Surface Preparation: SSPC SP-6, commercial grade.
   2. 1 coat Tnemec 77 Chem-Prime, Valspar V13-R-28 Chromox Primer, Sherwin-Williams Kem Kromik Universal Primer, or equal (2 mils dry) or Carboline's Carboguard 893SG (1 coat @ 3.0-5.0 mils DFT).
   3. 2 coats Tnemec 66 Series Hi-Build Epoxoline, Valspar 89 Series H.B. Epoxy, Sherwin-Williams Tile Clad HS, or equal (2 mils dry per coat) or Carboline's Carboguard 893 SG (1 coat @ 3.0-5.0 mils DFT).
   4. For bituminous coated piping, apply 1 coat of Tnemec Series 66-1211, 2 coats Sherwin-Williams Macropoxy 646 Fast Cure Epoxy or equal (2.5 mils dry) followed by 2 coats Tnemic 66 Series Hi-Build Epoxoline or equal (2 mils dry per coat).

L. Submerged or Intermittently Submerged Concrete: **(OMITTED)**

M. Pipe Trenches (RO Treatment Area):
   1. The corrosion protection coating system shall be 100% Volume Solids, High Build, Amine Cured Epoxy designed for the protection of concrete and steel in highly corrosive hydrogen sulfide (microbial induced) environments associated with wastewater applications including lift stations, digesters, aeration basins, manholes and wet wells. The application thickness shall be 120 – 125 mils DFT, when applied to concrete lining surfaces. The specified film thickness shall be applied via spray application in a single coat with multiple passes.
   2. Physical Properties
      a. Adhesion – ASTM D4541: Concrete failure
      b. Abrasion Resistance – ASTM D4060, 1000 g load / 1000 cycles: CS17 wheel – 112 mg loss, max.
      c. Compressive Strength – ASTM D695: 8,800 psi min.
      d. Durometer Hardness – ASTM 2240: Shore D – 70, min.
      e. Flexural Strength – ASTM D790: 12,400 psi min.
      f. Tensile Elongation – ASTM D638: 4.6% max.
      g. Tensile Strength – ASTM D638: 7,600 psi min.
   3. Acceptable Manufacturers: Cor-Cote SC "Sewer-Coat" Epoxy by Sherwin Williams, Raven 405 by RLS Solutions, Inc., Tnemec Series 434 Perma-Shield H2S, or equal.

N. Exposed piping, ductwork, electrical conduits and other utility items shall be painted to match the adjacent surface colors. Each item shall be treated and primed in accordance with paint manufacturer's recommendations.

O. Finished copper work shall be cleaned immediately after erection and coated with one coal of boiled linseed oil meeting the requirements of ASTM 0260-61.

P. Plastic Pipes: (Legends on pipes)
   1. Solvent wipe area to be painted.
   2. Sand lightly with 120 grit aluminum oxide sand paper.
   3. Dust area.
   4. 1 coat of polyamide epoxy (3 mils dry), such as Carboline Carboguard 893SG, Sherwin-Williams Tile Clad HS, or equal.
   5. Color coding to be selected by the Engineer.

Q. Flouride Feed System Concrete Floor
   1. Surface Preparation: SSPC SP13/NACE 6; ICRI CSP 3.
   2. Primer: Tnemec Series 201 Epoxoprimer, or equal, applied at 4.0-6.0 dry mils.
   3. 1st Coat: Tnemec Series 282 Tneme-Glaze, or equal, applied at 8.0-10.0 dry mils.
   4. 2nd Coat: Tnemec Series 282 Tneme-Glaze, or equal, applied at 8.0-10.0 dry mils.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Surfaces to be painted shall be thoroughly clean and shall be dry when paint is applied. Painting materials shall be thoroughly worked into all joints, crevices, and open spaces.

B. Colors and shades of colors shall be as directed unless specified otherwise.

C. Finished surfaces shall be smooth, even and free of defects prior to painting.

D. Surfaces which are inaccessible for painting after erection shall be treated, primed and painted prior to erection.

E. Equipment nameplates, tags, signs, and equipment lubrication points shall be masked or otherwise protected from covering with paint.

F. Properly mask and protect portion of finished work not to be painted.

G. Damaged painting shall be retouched before applying the succeeding coat.

H. Existing bare surfaces and surfaces made bare by cleaning methods shall be primed prior to painting.

I. The number of paint coats specified shall be in addition to spot priming and shop prime coats except as indicated otherwise.

J. Copper and aluminum, except for pipe identification, shall not be painted.

K. Paints shall be applied strictly in accordance with the manufacturer's direction and thinners shall be of the type required by the individual paint specifications. No thinners will be stored on site or used unless specifically authorized by the Engineer.

3.02 SURFACE PREPARATION

A. General: Dirt, rust, loose scale and particles, disintegrated paint, grease, and foreign matter shall be removed by scraping, sand blasting, wire brushing, or other approved methods, from all surfaces which are to receive paint or other finish. Surfaces shall be free from dust and in proper condition to receive paint or other finish, Where necessary, putty shall be applied with a knife. Sand-papering, where necessary, shall be done after the undercoats are dry.

B. Concrete and Masonry: Dirt, fungus, grease, and oil shall be removed prior to application of paint by washing the surface with a solution composed of from 2 to 8 ounces of trisodium phosphate per gallon of hot water and then rinsing thoroughly with fresh water. Efflorescence shall be removed from concrete and masonry surfaces by scraping, wire brushing and washing with a 5 to 10 percent by weight, solution of muriatic acid and then washing thoroughly with fresh water, removing all traces of the acid. The trisodium phosphate and muriatic acid solutions shall be strengths to perform their functions properly. Glaze and all loose particles and scale shall be removed by wire brushing. All concrete and masonry surfaces to be painted shall be given a neutralizing treatment consisting of 2 pounds of sinz sulphate in one gallon of warm water. The neutralizer shall be applied liberally and allowed to dry, following which the surfaces shall be rinsed thoroughly with clean water and allowed to dry for not less than 48 hours before paint is applied.

C. Wood: Wood shall be clean, smooth and free of oil, grease, dirt, mildew, loose paint or other contaminants. Defects such as knots in new wood shall be sealed with 4 lbs cut shellac reduced with an equal volume of shellac thinner. Nail holes, cracks and other structural defects shall be caulked or spackled smooth. Sand where required.

D. Ferrous Metal
   1. New Metal: New metal work shall be cleaned in accordance with the Steel Structure Painting Council Specifications indicated in the painting schedule for the respective service indicated.
   2. Existing Metal: Existing metal surfaces to be painted shall be closely examined to determine the exact condition of the existing paint coating. The existing surface shall then be prepared for painting as required by the Engineer and as recommended by the paint manufacturer. As a minimum loose, spoiled and brittle paint shall be removed. Exposed metal shall be hand cleaned. The following table shall be used as a guide for determining the degree of surface preparation.

Surface Condition	Degree of Preservation
75% intact	Hand clean and spot primer base areas
Less than 75% intact	Total sandblast
Brittle, corroded	Total sandblast

E. Piping, Fittings and Mechanical and Electrical Equipment:
   1. Piping to be insulated, except zinc-coated pipe, prior to the application of the insulation, shall be coated with one coat of approved pretreatment coating to a dry film thickness of 0.3 to 0.5 mil, and then given two coats of zinc-chromate primer, each coat applied to a minimum dry film thickness of one mil. Zinc-coated piping under insulation shall not be painted.
   2. Pipe hangers, structural supports, pipe and fittings, conduit and conduit fittings, pipe covering, insulation and miscellaneous steel and iron work shall be painted to match the adjacent interior surfaces and exterior work shall be as directed, utilizing the painting schedule as hereinbefore specified.

3. Factory finished surfaces shall be painted as indicated.

3.03 APPLICATION

A. Workmanship shall be first-class in every respect. Paint shall be applied to dry, except as otherwise specified, on thoroughly clean surfaces only and shall be worked into all joints, crevices, and open spaces thoroughly. Paint shall be applied carefully with good clean brushes. Sufficient time shall be allowed between coats to permit thorough drying, and each coat shall be in proper condition to receive the next coat before its application. Finish coats shall be smooth and free from runs, sags, blisters, or other defects. Each coat of paint shall be sufficiently heavy to cover completely the previous coat or surface. Exterior paint shall not be applied during foggy or inclement weather.

3.04 PIPE COLOR CODING AND LEGEND

A. Color Coding: Interior exposed piping shall be painted in their entirety in accordance with the color code approved by the Engineer. PVC piping to be painted with 15" long color bands at intervals less than 15' OC and at all junction points and valves.

B. Legend: Exposed pipes, both interior and exterior, shall be marked with the service of the pipe stenciled on the pipe at intervals not exceeding 15' on center spacing and at each valve, tie or other junction of two or more pipes. Indicate the direction of flow adjacent to the legend. The legend shall be stenciled with contrasting colors of either black or white. Use the following chart for determining the size of the lettering.

Outside Diameter of the Pipe (inches)	Size of Letters (inches)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
Over 10	3-1/2

3.05 COATING THICKNESS

A. General: Thickness of coatings shall be checked by a dry film thickness gauge of the magnetic type operated electrically or by permanent magnet. Gauges shall be calibrated with a standard which is approximately the same thickness as the coating to be measured and, if possible, on metal identical both in composition and surface texture to that underlying coating. The Contractor shall be responsible for providing a gauge for checking the film thickness.

B. The total dry mil thickness of the coating for masonry surfaces shall not be less than 6.0 mils.

C. The total dry mil thickness of the coating for exposed metal surfaces subject to submergence in wastewater shall be not less than 10 mils.

3.06 CLEAN-UP

A. On completion of the painting work, clean all paint spots and other paint material from surfaces not intended for painting. Clean all rubbish and accumulated material from the work site. Leave the work in a clean and orderly condition, acceptable to the Engineer. No payment for painting work will be approved until the contractor has requested anticipated and firm thickness has been verified.

END OF SECTION

SECTION 10110

VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Tack boards.

B. Related Sections:
1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. A135.4 - Basic Hardboard.

B. ASTM International (ASTM):
1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. E84 - Standard Test Method for Surface Burning Characteristics for Building Materials.

1.3 SUBMITTALS

A. Submittals for Review:
1. Product Data: Descriptive data on display boards, color chart, tack boards, frame, trim, and accessories.
2. Samples:
a. 3 x 3 inch fabric facing samplesin each color.

1.4 QUALITY ASSURANCE

A. Fabric: Fire hazard classification of 25 or less, tested to ASTM E84.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. Aywon, Inc. (www.aywon.com)
2. Best-Rite Mfg. (www.bestrite.com)
3. Claridge Products and Equipment, Inc. (www.claridgeproducts.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Aluminum:
   1. Sheet: ASTM B209, 6063-T52 alloy and temper.
   2. Extrusions: ASTM B221, 6061 or 6063 alloy, temper best suited to application.

B. Hardboard: ANSI A135.4, tempered.

C. Fabric: Manufacturer's standard fabric.

D. Cork: Natural cork.

2.3 ACCESSORIES

A. Fasteners: Type best suited to application.

B. Adhesive:
   1. Type recommended by marker board manufacturer; compatible with substrate materials.

2.4 FABRICATION

A. Tack Boards:
   1. Facing: Fabric.
   2. Cork:[1/4 inch thick.
   3. Backing: 1/4 inch thickhardboard.
   4. Size: 36 x 24 inches.

B. Frame and Trim:
   1. Frame: Extruded aluminum, manufacturer's standard profile, concealed fasteners.

2.5 FINISHES

A. Fabric: color to be selected from manufacturer's full color range.

B. Aluminum Frame and Trim: Anodized, clear color.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install visual display boards in accordance with manufacturer's instructions.

B. Set plumb and level.

C. Secure with concealed fasteners.

3.2 PROTECTION

A. Cover board surfaces with temporary protective cover taped to frame.

3.3 SCHEDULE

A. Lobby 101.

END OF SECTION

SECTION 10300

PLAQUES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cast bronze building dedication plaque.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM) E527 - Standard Practice for Numbering Metals and Alloys.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings:
      a. Cross section through plaque showing border, background, and attachment methods.
      b. Layout showing artwork, letters, background, and textures.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. A.R.K. Ramos Mfg. Co., Inc. (www.arkramos.com)
   2. Gemini, Inc. (www.signletters.com)
   3. Metallic Arts. (www.metallicarts.com)
   4. Or Equal.

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Bronze: Copper UNS Alloy No. C38500, architectural bronze.

2.3 ACCESSORIES

A. Fasteners: Concealed, same material as plaque, type best suited to application.

2.4 FABRICATION

A. Cast plaques free from pits, gas holes, and warped surfaces.

B. Hand tool letters and artwork to sharp, clean edges.

C. Chemically clean completed castings.

D. Border: Raised single line.

E. Edges: Beveled.

F. Letter Style: To be selected.

G. Copy: As defined on approved Shop Drawings.

H. Size: 18 x 24 inches.

2.5 FINISHES

A. Background: Leatherette. Painted, color to be selected.

B. Borders, Letters, and Raised Artwork: Satin.

C. Apply two coats clear acrylic lacquer to exposed surfaces.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount plaques using concealed fasteners.

B. Set plumb, level, and rigid.

C. Isolate dissimilar metals from contact by use of bituminous coating.

3.2 SCHEDULE

A. Lobby 100.

END OF SECTION

SECTION 10400

INTERIOR PANEL SIGNS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic interior panel signs.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Include sign locations, sizes, mounting heights, and content.
   2. Color Chart.
   3. Samples:
      a. 3 x 3 inch sign samples showing available colors. in selected color.
      b. [After color selection, submit] Typical sign illustrating pictograms, characters, and Braille indications.

1.3 QUALITY ASSURANCE

A. Conform to applicable accessibility code for sign design, construction, location, and mounting height.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. APCO Graphics, Inc. (www.apcosigns.com)
   2. Best Sign Systems, Inc. (www.bestsigns.com) (HC 300, Basis of Design)
   3. Seton Identification Products. (www.seton.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Signs:
   1. Type: Melamine plastic laminate with contrasting color core, non static, fire retardant, self extinguishing, matte finish.
   2. Thickness: 1/8 inch.
   3. Face and core colors: To be selected from manufacturer's full color range.

2.3 ACCESSORIES

A. Adhesive:
   1. Type recommended by sign manufacturer.

2.4 FABRICATION

A. Fabricate signs by reverse engraving process to produce characters and graphics in contrasting color, raised 1/32 inch.

B. Characters:
   1. Height: 5/8 inch.
   2. Style: Sans serif style to be selected, upper case.
   3. Width to height ratio: Between 3:5 and 1:1.
   4. Stroke width to height ratio: Between 1:5 and 1:10.

C. Pictograms: Universal accessibility symbols, 6 inches high.

D. Provide Braille indications for each character.

E. Corners: 1/2 inch radius.

F. Edges: Beveled.

G. Border: 3/8 inch wide.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces of loose and foreign matter.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

B. Locate signs on wall adjacent to scheduled doors and openings.

3.3 SCHEDULE

LOCATION	SIGN SIZE	CONTENT
Men's Toilets	6 x 8 inches	"MEN" and male pictogram
Women's Toilets	6 x 8 inches	"WOMEN" and female pictogram
Shower	6 x 8 inches	"WC/SHOWER" and male and female pictograms
Rooms	6 x 6 inches	Room name and number at each interior door and opening

END OF SECTION

SECTION 10430

DIMENSIONAL LETTER SIGNAGE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cast dimensional characters.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For Signs
   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period. Warranty period shall be five (5) years from the date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

2.2 DIMENSIONAL CHARACTERS

A. Cast characters as shown on Elevation 1/A120: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. A.R.K. Ramos
      b. ACE Sign Systems, Inc.

c. ASI Sign Systems, Inc.
d. Cosco
e. Gemini Incorporated
f. Matthews International Corporation: Bronze Division
g. Metal Arts
h. Metallic Arts
i. Southwell Company

2. Character Material: Cast Aluminum
3. Character Height: 12 inches
4. Finishes:
   a. Integral Aluminum Finish: Clear anodized.
   b. Overcoat: Manufacturer's standard baked-on clear coating.
5. Mounting: Concealed studs.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standars as required for secure anchorage of signs, non-corrosive and compatible with each material joined, and complying with the following:
   1. Use concealed fasteners and anchors unless indicated to be exposed.
   2. For exterior exposure, furnish nonferrous metal devices unless otherwise indicated.
   3. Exposed Metal Fastener Components, General:
      a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
   4. Sign Mounting Fasteners:
      a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.

2.4 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
   1. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scales, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
   1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:
   1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
      a. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION

SECTION 10508

METAL LOCKERS

PART 1GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal locker units with hinged doors.
2. Metal bases, tops, and filler panels.
3. Wood benches.

B. Related Sections:
1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
1. A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

1.3 SUBMITTALS

A. Submittals for Review:
1. Shop Drawings: Include dimensioned layout, elevations, trim, closures, and accessories.
2. Product Data: Manufacturer's descriptive data.
3. Samples: 3 x 3 inch paint samples showing available colors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. Interior Steel Products Co. (www.interior-steel.com)
2. List Industries Inc. (www.listindustries.com)
3. Lyon Workspace Products. (www.lyonworkspace.com)
4. Penco Products, Inc. (www.pencoproducts.com)
5. Republic Storage Systems Co., Inc. (www.republicstorage.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Galvanized Steel Sheet: ASTM A653/A653M, Structural Quality, G90 coating class.

2.3 COMPONENTS

A. Lockers:
1. Type: Standard louver.

2. Configuration: Single tier.
3. Size: 12 inches wide x 12 inches deep x 78 inches high.
4. Mounting: Surface mounted.
5. Class: Conventional.

6. Construction:
   a. Frame and door: Minimum 16 gage galvanized steel, welded joints.
   b. Sides, and back: Minimum 24 gage galvanized steel.
   c. Ends, sloped tops, and filler panels: Minimum 20 gage galvanized steel.
7. Latching device: Tamper proof automatic three point latch.
8. Locks: Padlock provisions.
9. Accessories:
   a. For each locker: Two double prong hooks, coat hanger bar, metal number plate, and rubber bumper.
   b. 4 inch high closed base.
   c. End and filler panels.
   d. Sloped metal top with end closures .

B. Locker Benches:
1. Type: Free standing.
2. Size: 9-1/2 inches wide x 17-1/2 inches high x 2 feet long.
3. Construction: Laminated Maple with 1/4" x 3" anodizes aluminum bar stock pedestals.

2.4 FINISHES

A. Steel: Baked enamel, color to be selected from manufacturer's full color range. Two-tone colors.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

B. Set plumb, level, and aligned.

C. Attach lockers to supporting construction with anchors best suited to substrate conditions.

D. Bolt adjacent locker units together to provide rigid installation.

E. Install end panels, filler panels, sloped tops, and bases.

3.2 ADJUSTING

A. Adjust doors and latches to operate correctly.

B. Touch up minor scratches and abrasions to match factory finish.

END OF SECTION

SECTION 10523

FIRE EXTINGUISHERS AND CABINETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Portable fire extinguishers.
   2. Cabinets.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM) E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops.

B. National Fire Protection Association (NFPA) 10 - Portable Fire Extinguishers.

C. Underwriters Laboratories (UL):
   1. 299 - Dry Chemical Fire Extinguishers.
   2. 711 - Rating and Fire Testing of Fire Extinguishers.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Indicate cabinet locations and mounting heights.
   2. Product Data: Include data on extinguishers and cabinets, cabinet dimensions, operational features, materials, finishes, and anchorage.

B. Closeout Submittals:
   1. Maintenance Data: Include test, refill, or recharge schedules and re-certification requirements.

1.4 QUALITY ASSURANCE

A. Provide fire extinguishers complying with UL 711 and NFPA 10.

B. Cabinets in Fire Rated Partitions: Tested in accordance with ASTM E814 with fire resistance rating equivalent to adjacent construction.

C. Conform to applicable accessibility code for locating extinguishers.

1.5 PROJECT CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Ansul Incorporated. (www.ansul.com)
   2. JL Industries. (www.jlindustries.com)
   3. Larsen's Mfg. Co. (www.larsensmfg.com)

B. Substitutions: Under provisions of Division 01.

2.2 COMPONENTS

A. Extinguishers:
   1. Multi-purpose dry chemical type, UL 299, stainless steel tank, Class 4A:60B:C, 10 pound nominal capacity.
   2. Free from CFCs, HCFCs, and Halons.

B. Cabinets:
   1. Formed stainless steel sheet, 18 gage minimum.
   2. Configuration: Surface mounted, sized to accommodate extinguishers.
   3. Trim: Flat trim.
   4. Door:
      a. Vertical glass style, equipped with pull handle and latch.
      b. Hinge doors for 180 degree opening with continuous piano hinge.
      c. Glazing: Clear tempered glass.
      d. Graphics: Letter FIRE EXTINGUISHER vertically on door in white die-cut vinyl pressure sensitive letters.

2.3 ACCESSORIES

A. Mounting Hardware: Type best suited to application.

2.4 FINISHES

A. Cabinet: No. 4 satin.

B. Extinguishers: No. 8 polished

PART 3 EXECUTION

3.1 INSTALLATION

A. Install cabinets per with manufacturer's instructions at locations designated "FE" on plan.

B. Set plumb, level, and rigid.

C. Place an extinguisher in each cabinet.

END OF SECTION

SECTION 10800

TOILET ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Toilet, and shower accessories.
   2. Framed mirrors.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Division 16: Connection to power supply.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. A123/A123M - Standard Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products.
   2. A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   3. A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   4. A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   5. B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
   6. C1036 - Standard Specification for Flat Glass.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Product Data:
      a. Schedule accessories by room; show plans and elevations, and identify room name and number, type and quantity of accessories, and mounting heights.
      b. Include manufacturer's brochures showing sizes, details of function, finishes, and attachment methods.
   2. Samples: One of each accessory [, if requested].
   3. Warranty: Sample warranty form.

1.4 QUALITY ASSURANCE

A. Conform to applicable accessibility code for locating accessories.

1.5 WARRANTIES

A. Furnish manufacturer's 10 year warranty providing coverage against mirror silver spoilage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. A and J Washroom Accessories. (www.ajwashroom.com)
   2. American Specialties, Inc. (www.americanspecialties.com)
   3. Bobrick Washroom Equipment, Inc. (www.bobrick.com)
   4. Bradley Corp. (www.bradleycorp.com)
   5. GAMCO. (www.gamcousa.com)
   6. Excel. (www.exceldryer.com)
   7. World Dryer. (www.worlddryer.com)
   8. American Dryer. (www.americandryer.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Stainless Steel:
   1. Sheet: ASTM A666, Type 304, rollable temper.
   2. Tubing: ASTM A269.

B. Galvanized Steel:
   1. ASTM A1008/A1008M.

C. Mirror Glass: ASTM C1036, Type I, Class 1, Quality q1, 3/16 inch thick.

2.3 ACCESSORIES

A. Fasteners: Stainless steel where exposed, hot dip galvanized where concealed; type best suited to substrate conditions.

2.4 FABRICATION

A. Use stainless steel for exposed surfaces; galvanized steel may be used in concealed locations.

B. Form exposed surfaces from single sheet of stock, free from joints, and flat, without distortion.

C. Weld joints of fabricated components and grind smooth.

D. Fabricate grab bars of tubing, free of visible joints, return to wall with end attachment flanges. Peen grip surfaces.

E. Fabricate soap dispensers to operate with less than 5 pound force.

F. Provide hangers, adapters, anchor plates, and accessories required for installation.

G. Key locks alike; furnish six keys.

H. Mirrors:
1. Frame: One piece, roll formed stainless steel channel, 1/2 x 1/2 inch, with corners mitered and welded.
2. Mirror: Apply one coat of silver, one coat of electroplated copper, and one coat of organic mirror backing compound to back surface of glass.
3. Backing: Galvanized steel sheet.
4. Isolate glass from frame and backing with resilient, waterproof padding.

I. Shop assemble units and package complete with anchors and fittings.

2.5 FINISHES

A. Stainless Steel: No. 4 satin.

B. Galvanizing: ASTM A123/A123M to 1.25 ounces per square foot.

C. Chrome Plating: ASTM B456, Type SC 2, polished.

D. Polyethylene: White.

E. Enamel: White.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set plumb, level, square, and rigid.

C. Install wiring between power supply and accessories.

3.2 SCHEDULE

NO.	DESCRIPTION	MANUFACTURER	MODEL NO.
B	Toilet Tissue Dispenser	Bobrick	B-264
C	Soap Dispenser	Bobrick	818615
E	Feminine Tampon/Napkin Disposal	Bobrick	B-270
F	Grab Bars	Bobrick	B-5806.99
G	Robe Hook	Bobrick	B-212
H	Mop Holder (in Janitor's Closet 121)	Bobrick	B-239x34
I	Paper Towel Dispenser	Bobrick	B-262
J	Shower Curtain Rod (in Locker 108)	Bobrick	B207

END OF SECTION

SECTION 10850

SOLID SURFACING SHOWER STALL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Solid surfacing shower stall.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   2. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association (NFPA) 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

1.03 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Include dimensioned layout, elevations, trim, closures, and accessories.
   2. Product Data: Manufacturer's descriptive data for panels, hardware, and accessories.
   3. Samples: [2 x 3] [__ x __] inch samples [showing available colors.] [in each color.]

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5 years experience in manufacture of solid plastic shower and dressing compartments with products in satisfactory use under similar service conditions.

B. Installer Qualifications: Minimum 3 years experience in work of this Section.

1.05 WARRANTIES

C. Provide manufacturer's 25 year warranty against breakage, corrosion, and delamination under normal conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Contract Documents are based on products by Swan. (www.swanstone.com)

B. Kohler

C. Inpro

D. Grifform

E. Substitutions: Under provisions of Division 01.

2.02 MATERIALS

A. Floor and wall kit:
   1. Material: Homogenous compression molded sheet material composed of polymer resins, aggregates, and coloring agents.
   2. Thickness: 1/4 inch minimum.
   3. Surface finish: Satin.
   4. Color: White

B. Aluminum Extrusions: ASTM B221, 6463-T5 alloy and temper.

2.03 COMPONENTS

A. Transfer shower floor 37" x 38" (STS-3738)

B. Compatible Swanstone Wall Kits 36" x 48" x 96" (SK-364896)

C. Folding Shower Seat 23-1/3" x 22-1/2" (BF-2300L)

D. (2) Stainless Steel Grab Bars 24" (BF-5024)

E. Collapsible Threshold (BF-CT)

PART 3 EXECUTION

3.01 INSTALLATION

A. Install compartments in accordance with manufacturer's instructions and approved Shop Drawings.

B. Install rigid, straight, plumb, and level.

C. Not Acceptable: Evidence of cutting, drilling, or patching.

END OF SECTION

SECTION 11064

VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational pump system:
   1. Vertical turbine pumps and motors with mounting plates.
   2. Suction cans.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Section 01210 Allowances
   2. Section 13445 Supervisory Control and Data Acquisition System
   3. Section 16420 Enclosed Motor Controllers

1.03 SYSTEM DESCRIPTION

A. High Service Pumps
   1. Function: Pump treated water from the ground storage tank to the distribution system
   2. Number of Pumps: Three (two duty, one standby)
   3. Performance Requirements
      a. Pump Speed: 1200 RPM
      b. Max Allowable NPSHR: 15 ft
      c. Capacity: 2,250 gpm
      d. Total Dynamic Head: 259 ft
      e. Min. Bowl Efficiency: 78%
      f. Max. Flow Ratio (rated / BEP): 85%
   4. Pump Characteristics
      a. Number of Stages: 5
      b. Impeller Type: Enclosed
      c. Impeller Material: Bronze
      d. Maximum sphere size: 1.00 inches
      e. Minimum pump column size: 14 inch
      f. Minimum Discharge Size: 14 inch, 125 lb flanges
      g. Minimum Lineshaft Size: 1 15/16 inches
      h. Lineshaft Material: 416 stainless steel
      i. Minimum Bowl Shaft Size: 2 3/16 inches
      j. Bowl Material: Epoxied Cast Iron
      k. Lineshaft Lubrication: Water
      l. Minimum Can Diameter: 30 inches
   5. Motor Characteristics
      a. Maximum Horsepower: 250 hp
      b. Maximum Speed: 1200 rpm
      c. Voltage: 460 V, 3 phase, 60 Hz
      d. Motor shall be non-overloading over the entire pump curve.
   6. Controls
      a. As specified in Section 16420

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
   1. Certification: A certified factory hydrostatic and performance test shall be performed on each bowl assembly in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition. Submit certified pump curves after approval of Manufacturer's Data and Shop Drawings and prior to purchase.
   2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Pumps.
      b. Float switch.
      c. Pressure Gauges.
   3. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Mounting details, including sub-base soleplate plate assembly.
      b. Electrical diagram(s) for complete operating system.
      c. Layout of control panel face.
   4. Manufacturer's Installation Procedures.
   5. Test Reports: Upon testing of the installed system, field test reports shall be submitted in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
   6. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the total system as indicated below.
   7. Parts: Provide a parts list for each piece of equipment.
   8. Equipment and Performance Data: Pump characteristic curves showing capacity in gpm, minimum submergence, head, efficiency, and pumping horsepower from 0 to 110 percent of design capacity.

B. Submit Operation and Maintenance Instructions in accordance with Section 01330, Submittals and the following:
   1. Pump station equipment shall be submitted in three ring binders as appropriate and shall include equipment in this section and the generator and associated electrical components.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service for each piece of equipment.
      b. Pump and motor plate data.
   3. After the front page provide the pump curve and field test report.

1.05 QUALITY ASSURANCE

A. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.
   1. Product manufacturer shall have a minimum of ten (10) years of experience. Pump bowl assembly shall be a standard product of the manufacturer for a minimum of ten (10) years.
   2. All major components of the pump including bowl assembly, column, shaft, discharge head, can, soleplate and motor shall be supplied by the pump

manufacturer. The manufacturer shall not under any circumstances re-brand the bowl assembly of one manufacturer to another.

3. Equipment shall be as manufactured by Fairbanks Nijhuis, Layne Verti-Line, Byron Jackson, Goulds, or Floway.
4. Pumps shall be manufactured at a facility that holds a certificate of registration for a Quality Management System with a ISO 9001:2008 rating.

B. Pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

C. Submit the name, address, and phone number of the firm that will provide required repair or replacement during the warranty period.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pumps and controls to the job site in as large of units as practical to require the minimum amount of field connection and assembly.

1.07 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of substantial completion of pump station.

PART 2 PRODUCTS

2.01 PUMP

A. Bowl Assembly

1. The bowls shall be made of close-grained cast iron conforming to ASTM A48 CL30. Castings shall be free from blowholes, sand holes and shall be accurately machined and fitted to close dimensions.
2. Bowls 8" and above shall be flange connected with 316 stainless steel bolts, nuts and washers.
3. Bowls shall be designed with smooth passages to ensure efficient operation and the exterior shall be coated with Tnemec N140 Pota-Pox Plus, or equal
4. The casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head whichever is greater.
5. Bowl wear ring shall be 416 stainless steel.
6. Provide a 316 stainless steel basket strainer on bowl assembly for each pump.

B. Impeller

1. The impeller shall be bronze construction. They shall be of one-piece construction, single suction, enclosed vane, and radial flow design. The waterways through the impeller shall have extremely smooth contours, devoid of sharp corners, so as to promote maximum efficiency.
2. The impeller is to be balanced and secured to the shaft by means of a stainless steel drive collet for bowl shafts 2-3/16" diameter and smaller. For bowl shafts larger than 2-3/16" impellers shall be secured to the shaft using a combination of a thrust washer, key and/or snap rings.
3. Impellers shall be adjustable by means of a top shaft-adjusting nut.

C. Impeller Shaft

1. Impeller shaft shall be of stainless steel construction conforming to ASTM A582 (416 stainless steel).

2. The shaft shall be supported by bronze or neoprene bearings located on both sides of each impeller.
3. Impeller shaft coupling shall be of stainless steel construction conforming to ASTM A582 (416 stainless steel).

D. Wearing Rings

1. Wear rings shall be provided on both the impellers and bowls on bowls of nominal diameter of 8" or larger so that clearances can be maintained throughout the life of the rings and minimize recirculation.
2. Impeller wear rings shall be of the radial-type.
3. Bowl wear rings shall be of the radial-type.
4. Wear rings shall be attached to the impellers and bowls using an interference fit and Loctite.
5. Wear rings shall be 316 stainless steel.

E. Column

1. Column pipe in sizes 4" through 14" diameter shall be furnished in interchangeable sections not over ten feet in length, and shall be flanged connected with 316 stainless steel bolts, washers and nuts.

F. Lineshaft

1. Lineshafting shall be of ample size to transmit the torque and operate the pump without distortion or vibration.
2. Lineshafting shall be made of 416 stainless steel furnished in interchangeable sections not over ten feet in length.
3. Lineshafting shall be coupled with extra-strong threaded 416 stainless steel couplings machined from solid bar stainless steel.
4. Lineshafting shall be fitted with stainless steel replaceable sleeves at each bearing and shall conform to AISI 304 material.
5. Lineshaft bearings shall be of neoprene material construction.
6. Lineshaft bearings shall be retained in bronze guides that are fitted into the column coupling and secured in place by the butted column pipe ends. (for column sizes larger than 16" retainers shall be steel and fabricated into the column assembly.

G. Discharge Head

1. The pump discharge head shall be of the above ground type of fabricated steel construction with an ANSI 125# discharge flange.
2. The discharge head shall be of sufficient design to support the entire weight of the pump and driver.
3. A drive shaft of the same material as the lineshaft shall extend through the sealing assembly of the discharge head and be coupled to a vertical hollow shaft driver.
4. The shaft sealing assembly shall consist of a cast iron packing box, bronze packing gland, bronze packing box bushing, stainless steel packing gland nuts and bolts, synthetic packing and a Teflon water seal ring.
5. Packing box shall be rated for 175 PSI.
6. Discharge head openings shall be fitted with guards to prevent access to the rotating shaft and/or coupling.
7. Provide connection for flush water lubrication.

H. Sole Plate

1. The pump shall be mounted and supported by a separate steel base plate (soleplate). The soleplate shall be drilled to match the base flange drilling of the discharge head. Abutting surfaces between the soleplate and the discharge head shall be machined to provide 100% surface contact with the discharge head base. The center opening diameter shall be of sufficient size to permit installation and removal of the complete pump assembly. The soleplate shall be permanently anchored, grouted and leveled within 0.003 inches per foot by the installing contractor.

I. Pump Can: Provide a fabricated steel suction barrel. Pump manufacturer and supplier shall be responsible for supplying the pump suction can. Can shall be manufactured in accordance with the Hydraulic Institute guidelines. Steel shall meet specifications of ASTM A53 Grade B or ASTM A120 and steel plates shall meet specifications of ASTM A36. Barrel shall be the diameter and length as required by manufacturer. Barrel shall be equipped with a square base plate which shall be machined and tapped to match the discharge head base flange. The base shall be drilled to allow the barrel to be secured in place with anchor bolts.

1. The pump can shall have anti-vortex baffles welded to the bottom and sides of the interior of the can to prevent the pump from vortexing.
2. The manufacturer of the can shall employ qualified welders of performance of the welding requirements. Each welder shall be qualified in accordance with the American Welding Society requirements. Welders must present to the Engineer certified qualification papers indicating within the proceeding six-month period to perform work on the project. All seams must be fully welded inside and out.
3. Can shall have a certified hydrostatic test at the factory.
4. All surfaces of the can shall be sandblasted SSPC-SP10 and painted as follows.
   a. Interior: Primer TNEMEC Series 66 Hi-Build Epoxiline or approved equal, 3 mil thickness; 2 finish coats of TNEMEC Series 66 Hi-Build Epoxiline or approved equal, 4 mils per coat.

      All paints in contact with potable water must be NSF 61 approved.

   b. Exterior: Primer TNEMEC Series 66 Hi-Build Epoxiline or approved equal, 3 mil thickness; 2 finish coats of TNEMEC Series 46H-413 Hi-Build Tneme-Tar or approved equal, 7-8 mils per coat

2.02 MOTOR

A. Provide totally enclosed, fan cooled premium efficient motor for operation in conformance with NEMA standards for type motor specified and shall meet the following requirements:
   1. Vertical hollowshaft with non-reverse ratchet.
   2. Service factor of 1.15.
   3. Horsepower, RPM, voltage and phase shall be as specified in the paragraph, System Description. Nameplate horsepower rating shall not be exceeded by the brake horsepower requirements of the specified head and capacity conditions.
   4. Class F insulation.
   5. Class B temperature rise.

6. 120 volt space heaters to activate when the pump is shut down. Space heaters shall be powered by the pump control circuit.
7. Two normally closed automatic reset thermostats shall be imbedded in the motor windings to open on excessive heat stopping the motor.
8. Motor shall not overload throughout the pump-operating curve.
9. Motor shall be provided with insulated bearings.

2.03 CONTROL SYSTEM

A. See Division 16.

2.04 PRESSURE GAUGES

A. Pressure gauges shall meet the following requirements:
   1. Use: Pressure reading for sanitary sewer force main.
   2. Liquid fill: Glycern
   3. Dial: White aluminum with black markings.
   4. Dial size: 4 inch minimum.
   5. Case & Ring: Aluminum
   6. Accuracy: 1/2 % of full scale (Grade 2A).
   7. Stem connection: Bottom.
   8. Gauge quantity: three
   9. Gauge reading: Combination reading in psi and feet of water (ft) with range of 0-200 psi (0-460 ft)

B. Provide a 1/4-inch tap on each discharge pipe for pressure gauge.

2.05 PRESSURE TRANSDUCER

A. Provide two (2) pressure transducers, one duty and one as a spare. Transducers shall include the following:
   1. Sensor Body: Titanium.
   2. Measurement Diaphragm: Internal – Titanium, External – Teflon coated Nitrile Rubber.
   3. Pressure Connection: Flush elastomeric diaphragm with titanium retaining ring.
   4. Operating Range: 0 – 200 psi.
   5. Transduction Principle: Piezoresistive micromachined silicon strain gauge.
   6. Combined Non-linearity, Hysterisis and Repeatability: < +/- 0.25% FS BSL.
   7. Temperature Effects: +/- 1.5% FS TEB 10 psig and up.
   8. Resolution: Infinite.
   9. Insulation Resistance: 100 megOhms @ 500 Vdc.
   10. Relative Humidity: 0 to 100%.
   11. Operating Temperature Range: -5 deg. F to + 140 deg. F.
   12. Electrical Characteristics: 2-wire, 4-20 mA, 9-32 Vdc excitation.
   13. Safety Classification: UL listed, intrinsically safe, Class I, Div. 1, Groups A, B, C & D.

2.06 LIMIT SWITCHES

A. Provide a limit switch mounted on each pump check valve. The switch shall be wired to the pump controls such that after a fixed time after pump start the switch should activate, indicating pumping. If the switch does not activate then the pump shall be automatically shut down and an alarm sounded. Provide all wiring and controls for a complete system.

B. The limit switch shall be installed as shown on the Drawings. Switches shall have a minimum rated capacity of 7 amp 125 volt and shall be actuated by the check valve

arm. Limit switches shall be enclosed in a NEMA 4X enclosure and shall be UL listed.

PART 3 EXECUTION

3.01 FACTORY TEST

A. Certified Performance Test shall be performed on each pump at the pump manufacturer's facility. Certified testing of these pumps at another testing facility will not be acceptable or permitted.

B. The pump manufacturer's testing facility shall be in compliance with Hydraulic Institute standards as defined in the latest edition of HI.

C. The certified test shall be witnessed and certified by a P.E. that is employed by the manufacturer of the bowl and pump assembly.

3.02 INSTALLATION

A. Install pumps in accordance with manufacturer's installation instructions.

B. Level base.

C. Provide electrical work in accordance with Division 16. Coordinate electrical service to site with local power company.

D. Mount pressure gauges as described above.

3.03 START UP SERVICES

A. Provide the services of manufacturer's representative to check the pump station installation, supervise initial start up, and instruct Owner's personnel in proper operation and maintenance of the pumps and appurtenances. A minimum of two separate trips to the site will be required, each consisting of a minimum of one 8 hour working day. Regardless of the time spent at the site, services will not be considered complete until the pump station operates as intended for a minimum of one (1) week of operation.

B. Operate pump station under actual field service to demonstrate that the all equipment performs to the specified criteria flow capacity and head conditions. During the field test, make adjustments as necessary for proper operation.

C. Manufacturer's recommended start up tests shall be performed according to the installation schedule. Start up tests shall include the following as a minimum:
   1. Data for each pump under operating conditions:
      a. Amperage reading.
      b. Pressure head reading.
      c. Drawdown flow test.
   2. Test alarm condition for high flow.
   3. Test auxiliary contacts.
   4. Test float control system.

D. Submit copy of tests and checks performed in the field, complete with recordings, where applicable, to the Engineer.

3.04 PAINTING

A. Provide touch up of exterior paint system as appropriate.

END OF SECTION

SECTION 11065

SUBMERSIBLE SUMP PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide complete submersible sump pumps for the following locations:
   1. R.O. Building Trench Sump
   2. Raw Water Meter and Sample Vault
   3. Finished Water Chemical Feed and Sample Vault
   4. System Water Meter, Chemical Feed and Sample Vault

B. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational pump system:
   1. Submersible non-clog centrifugal sump pumps and motors.
   2. Control panel.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Division 16 Electrical

1.03 SYSTEM DESCRIPTION

A. Sump Pumps (RO Pipe Gallery Trench)
   1. Function: Pump wash down water to drain manhole.
   2. Number of Pumps: Two (2) in duplex operation.
   3. Performance Requirements
      a. Capacity: 40 gpm
      b. Total Dynamic Head: 16 ft
      c. Discharge Size: 11/2-inch, min
   4. Motor Characteristics
      a. Maximum Horsepower: 1/2 hp
      b. Maximum Speed: 1750 rpm
      c. Voltage: 115V, 1 phase, 60 Hz
   5. Controls
      a. Automatic duplex pump operation.
      b. Audible and visual alarms.

B. Sump Pump (Raw Water Meter and Sample Vault)
   1. Function: Pump drainage to splash pad.
   2. Number of Pumps: One (1)
   3. Performance Requirements
      a. Capacity: 33 gpm
      b. Total Dynamic Head: 14 ft
      c. Discharge Size: 11/2-inch, min
   4. Motor Characteristics
      a. Maximum Horsepower: 1/3 hp
      b. Maximum Speed: 1550 rpm
      c. Voltage: 115 V, 1 phase, 60 Hz
   5. Controls
      a. Automatic simplex pump operation.

b. Audible and visual alarms.

C. Sump Pumps (Finished Water Chemical Feed and Sample Vault)
   1. Function: Pump drainage to splash pad.
   2. Number of Pumps: One (1)
   3. Performance Requirements
      a. Capacity: 33 gpm
      b. Total Dynamic Head: 14 ft
      c. Discharge Size: 11/2-inch, min
   4. Motor Characteristics
      a. Maximum Horsepower: 1/3 hp
      b. Maximum Speed: 1550 rpm
      c. Voltage: 115 V, 1 phase, 60 Hz
   5. Controls
      a. Automatic simplex pump operation.
      b. Audible and visual alarms.

D. Sump Pump (System Water Meter, Chemical Feed and Sample Vault)
   1. Function: Pump drainage to splash pad.
   2. Number of Pumps: One (1)
   3. Performance Requirements
      a. Capacity: 33 gpm
      b. Total Dynamic Head: 14 ft
      c. Discharge Size: 11/2-inch, min
   4. Motor Characteristics
      a. Maximum Horsepower: 1/3 hp
      b. Maximum Speed: 1550 rpm
      c. Voltage: 115 V, 1 phase, 60 Hz
   5. Controls
      a. Automatic simplex pump operation.
      b. Audible and visual alarms.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Pumps.
   2. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Dimensional mounting detail for pumps.
      b. Electrical diagram(s) for complete operating system.
      c. Layout of control panel face.
   3. Manufacturer's Installation Procedures.
   4. Test Reports: Upon testing of the installed system, field test reports shall be submitted in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
   5. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the total system as indicated below.
   6. Parts: Provide a parts list for each piece of equipment.

B. Submit Operation and Maintenance Instructions in accordance with Section 01330, Submittals and the following:
   1. Pump equipment shall be submitted in one or more binders as appropriate and shall include associated electrical components.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service for each piece of equipment.
      b. Pump and motor plate data.
   3. After the front page provide the pump curve and field test report.

1.05 QUALITY ASSURANCE

A. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.
   1. Product manufacturer shall have a minimum of five (5) years of experience.
   2. In lieu of the required experience, the manufacturer may provide a cash deposit or bond equal to the cost of the product. The cash deposit or bond shall guarantee replacement in the event of failure of the product. The cash deposit shall be held, or the bond remains in effect for a period equal to 5 years less the number of years in which the manufacturer's product has been in use.
   3. Equipment shall be as manufactured by Myers, Hydromatic, Zoeller or equal.
   4. All pumps shall be of the same manufacturer.

B. Pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

C. Submit the name, address, and phone number of the firm that will provide required repair or replacement during the warranty period.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pumps and controls to the job site in as large of units as practical to require the minimum amount of field connection and assembly.

1.07 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of substantial completion of pump station.

PART 2 PRODUCTS

2.01 PUMP

A. The pump shall be capable of handling a 1/2-inch solid at a minimum. The pumps shall be capable of handling liquids with temperatures to 120˚F intermittent and shall be capable of running dry without damage to the seals or bearings.

B. Impeller: The pump impeller shall be of the two vane enclosed type. The impeller shall be constructed of engineered thermoplastic or optional bronze. A stainless steel wear ring shall be molded into the neck of the plastic impeller to provide a sealing surface. A replaceable Buna-N sealing cup shall affect a seal between the volute and impeller in order to maintain high efficiency and prevent recirculation. The impeller shall be threaded onto the 416 stainless steel pump/motor shaft.

C. Shaft Seal: The motor shall be protected by a rotating mechanical shaft seal. The seal shall have carbon and ceramic seal faces lapped to a tolerance of one light band. Metal parts and springs for seals shall be 300 series stainless steel.

D. Pump and Motor Castings: All castings shall be of high tensile strength Class 30 gray cast iron. Castings shall be treated with phosphate and chromate rinse and painted with high quality air dry alkyd enamel.

2.02 MOTOR

A. The pump motor shall be the submersible type rated Hp as required. Motor shall operate at the speed and voltage indicated in Section 1.03 above. Stator winding shall be of the open type with Class B insulation. The winding housing will be filled with clean dielectric oil to lubricate bearings, seals, and transfer heat from the windings to the outer shell. The motor assembly shall be of the standard frame design and shall be secured in place by four threaded fasteners allowing for easy field serviceability.

B. The motor shall be capable of operating over the full range of the performance curve without overloading the motor and causing any objectionable noise or vibration. The motor shall have two bearings to support the rotor; an upper bearing (ball type) to accommodate radial loads and a lower ball bearing to take thrust and radial loads. Ball bearings shall be designed for a B-10 life of 50,000 hours.

C. A heat sensor thermostat and overload shall be attached to the top end of the motor windings and shall be wired in series with the windings to stop the motor if the motor winding temperature reaches 221˚F. The overload thermostat shall reset automatically when the motor cools to a safe operating temperature.

2.03 POWER CORD

A. The motor power cord shall be of the positive sealing, quick disconnect type. The cord jacket shall be sealed at the motor entrance by means of a rubber compression washer and compression nut. A heat shrink tube filled with epoxy shall seal the outer cable jacket and the individual leads to prevent water from entering the motor housing. The cord shall be of sufficient length to extend to the pump control panel.

2.04 CONTROL SYSTEM

A. Automatic pump control activated by mercury float switches. The controls shall start each pump alternately when the liquid level rises to the pump on elevation. In the event either pump fails to function, the other will automatically start. If during the operation of one of the pumps, the liquid level continues to rise, the other pump will start operating at the second pump on elevation and continue to operate until the water level drops to the all pumps off elevation. If the water level continues to rise, the alarm horn and light shall be initiated at the high water alarm elevation. Either one or both pumps shall shut off at the all pumps off elevation.

B. Control panel shall be a NEMA 4X stainless steel enclosure with a dead front with a hinged inner door. Panel shall be UL labeled, as a complete unit, following assembly. Panel shall include, but not be limited to, the following items:
   1. Enclosure shall be supplied with fast operating latches for outer door.
   2. Panel shall include motor starter and circuit breaker disconnect for each motor.
   3. Surge arrester.
   4. Surge capacitor.
   5. Transformer sized for control circuit loads and additional 120 V circuits as specified. Transformer size shall be adequate to provide 150 percent of the

control circuit requirements, a minimum of 3.5 amperes for the receptacle and 100 percent of other auxiliary 120-volt loads. Provide fused primary and secondary and bond unfused leg of secondary to enclosure.

6. Separate circuit breaker with handle to project through inner door for the following:
   a. Each pump motor
   b. Control circuit.
   c. Door mounted duplex receptacle.
7. Alternator relay to alternate pumps between successive starts.
8. Mount the following devices on inner door:
   a. Hand-off-automatic (H-O-A) control switch for each pump.
   b. Non-resettable elapsed time meter for each pump. Meter shall read in tenth of hours through 99,999 hours total time.
   c. GFCI type duplex receptacle.
9. Mount operating and warning lights on inner door for the following. Color indicates required lens color.
   a. Power on (white).
   b. High water level (red).
   c. For each pump.
      1) Running (green).
      2) Seal failure (red).
      3) Thermal overload (red).
   d. Phase monitor (red).
10. Alarm horn and light (red) mounted on exterior of building. Horn sound level shall be a minimum of 100 decibels at 10 feet. Provide horn silence switch on inside panel. Alarm horn and light shall be activated by the following alarms: high water level, pump thermal overload, phase loss.
11. Auxiliary contacts for remote signal for the following:
    a. Pump run status for each pump.
    b. High water alarm.
    c. Pump failure alarm for both pumps on thermal overload.
    d. Loss of power.
    e. Loss of phase to indicate over / under voltage, phase loss, or phase reversal.
12. In the event of a thermal overload or loss of phase condition, the pump shall automatically shut down and signal an alarm.
13. Provide laminated plastic labels to identify all control components.
14. Provide a plastic laminated electric diagram with wire / terminal numbers and color codes permanently fastened to inside of enclosure door.

C. Switches, push buttons, and indicator lights shall be oil tight / watertight units. Lights shall be push-to-test type.

D. Wire shall be sized as required for load and application according to NEC. Wiring shall be neatly bundled and continuous from point to point. Wiring shall be totally accessible with permanent marking on each end to match the schematic drawing. Control and signal wire shall be a minimum of #14 AWG, stranded, 90 degree insulated and color-coded. Color coding shall be as follows:

1.	Red	AC control
2.	Blue	DC control
3.	Yellow	External source control
4.	White	AC neutral
5.	Green	Ground

E. Provide UL listed mercury float switches encapsulated in buoyant waterproof housing with sufficient cable to extend to control panel. Float and cable shall be designed and manufactured for use in a sewage wet well environment. Sensor levels shall be field adjustable.

F. Conduits running into wet well shall have a positive seal in accordance with NFPA 70.

2.05 PRESSURE GAUGES

A. Pressure gauges shall meet the following requirements:
   1. Use: Pressure reading for sanitary sewer force main.
   2. Liquid fill: Glycern
   3. Dial: White aluminum with black markings.
   4. Dial size: 4 inch minimum.
   5. Case & Ring: Aluminum
   6. Accuracy: 1/2 % of full scale (Grade 2A).
   7. Stem connection: Back.
   8. Gauge reading: Combination reading in psi and feet of water (ft) with range of 0-30 psi.
   9. Equipped with a stopcock and a diaphragm isolator for use with sewage.
   10. Mounted on piping in the valve box. Provide accessories as necessary so gauge shall face up with numbers reading towards access hatch.

B. Provide a 1/4-inch tap on each effluent pipe for pressure gauge.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pumps in accordance with manufacturer's installation instructions.

B. Provide electrical work in accordance with Division 16. Coordinate electrical service to site with local power company.

C. Mount pressure gauges as described above.

3.02 START UP SERVICES

A. Provide the services of manufacturer's representative to check the pump installation, supervise initial start up, and instruct Owner's personnel in proper operation and maintenance of the pumps and appurtenances. A minimum of two separate trips to the site will be required, each consisting of a minimum of one 8 hour working day. Regardless of the time spent at the site, services will not be considered complete until the pump station operates as intended for a minimum of one (1) week of operation.

B. Operate pump station under actual field service to demonstrate that the all equipment performs to the specified criteria flow capacity and head conditions. During the field test, make adjustments as necessary for proper operation.

C. Manufacturer's recommended start up tests shall be performed according to the installation schedule. Start up tests shall include the following as a minimum:
   1. Data for each pump under operating conditions:
      a. Amperage reading.
      b. Pressure head reading.
      c. Drawdown flow test.

2. Test alarm condition for high flow.
3. Test auxiliary contacts.
4. Test float control system.

D. Submit copy of tests and checks performed in the field, complete with recordings, where applicable, to the Engineer.

3.03 PAINTING

A. Provide touch up of exterior paint system as appropriate.

END OF SECTION

SECTION 11068

SUBMERSIBLE WELL PUMP

PRELIMINARY – DO NOT USE FOR CONSTRUCTION

BASED ON ESTIMATED WELL CHARACTERISTICS. FINAL SPECIFICATIONS WILL BE PROVIDED FOLLOWING WELL CONSTRUCTION

PART 1 GENERAL

1.01 SCOPE

A. Ten (10) water supply wells located on five (5) well sites (two wells per site) will supply raw water to the water treatment plant. One well site and two wells (Well Site #1 and Wells 1PD and 1BC were constructed under a previous project. The remaining four well sites and eight wells will be constructed under Contract 1.

B. **Well pump and motor sizes, pump setting depths, and column lengths specified herein are preliminary and based on theoretical yields and well depths.** Theoretical values were estimated based upon the previously constructed wells 1PD and 1BC, and are subject to change. Final pump sizes, setting depths, and column lengths will be provided following the completion of well construction. Contractor shall base his bid on the preliminary specifications provided herein; however, no materials shall be ordered until final specifications are provided by the Engineer. Any required adjustment to pump size or column length based on actual well characteristics shall be negotiated as a change to the contract price.

C. Provide the pump(s), motor(s), and controls as indicated on the Drawings and specified herein.

D. Work specified under this section includes, but is not limited to, the following:
   1. One (1) Deep Well Pump for Well No. 1PD
   2. One (1) Deep Well Pump for Well No. 1BC
   3. One (1) Deep Well Pump for Well No. 2PD
   4. One (1) Deep Well Pump for Well No. 2BC
   5. One (1) Deep Well Pump for Well No. 3PD
   6. One (1) Deep Well Pump for Well No. 3BC
   7. One (1) Deep Well Pump for Well No. 4PD
   8. One (1) Deep Well Pump for Well No. 4BC
   9. One (1) Deep Well Pump for Well No. 5PD
   10. One (1) Deep Well Pump for Well No. 5BC

1.02 SYSTEM DESCRIPTION

A. Water Supply Well No. 1PD

1.	Pump Capacity/Head	600 gpm @ 306 feet TDH
2.	Pump Setting	250 feet minimum (below top of casing)
3.	Static Water Level	25 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4.	Minimum Pump Efficiency	70% @ design point

5. Number of Stages — 4
6. Impeller Type — Type 316 Stainless Steel
7. Pump Column — 6-inch schedule 40 type 316 stainless steel
8. Pump Check Valve — 6-inch, stainless steel body, 1-required on column riser at the pump
9. Discharge Outlet — 6-inch
10. Shaft — Type 416 Stainless Steel
11. Motor Horsepower — 75 HP
12. Maximum Motor Speed — 3600 rpm
13. Motor Operating Voltage — 460 volt, 3 phase, 60 Hz
14. Motor shall be non-overloading over the entire pump curve.

B. Water Supply Well No. 1BC

1. Pump Capacity/Head — 900 gpm @ 337 feet TDH
2. Pump Setting — 281 feet minimum (below top of casing)
3. Static Water Level — 14 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4. Minimum Pump Efficiency — 70% @ design point
5. Number of Stages — 2
6. Impeller Type — Type 316 Stainless Steel
7. Pump Column — 6-inch schedule 40 type 316 stainless steel
8. Pump Check Valve — 6-inch, Ductile iron body, 1-required on column riser at the pump
9. Discharge Outlet — 4-inch
10. Shaft — Type 416 Stainless Steel
11. Motor Horsepower — 125 HP
12. Maximum Motor Speed — 3600 rpm
13. Motor Operating Voltage — 460 volt, 3 phase, 60 Hz
14. Motor shall be non-overloading over the entire pump curve.

C. Water Supply Well No. 2PD

1. Pump Capacity/Head — 600 gpm @ 306 feet TDH
2. Pump Setting — 250 feet minimum (below top of casing)
3. Static Water Level — 25 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4. Minimum Pump Efficiency — 70% @ design point
5. Number of Stages — 4
6. Impeller Type — Type 316 Stainless Steel
7. Pump Column — 6-inch schedule 40 type 316 stainless steel
8. Pump Check Valve — 6-inch, stainless steel body, 1-required on column riser at the pump
9. Discharge Outlet — 6-inch
10. Shaft — Type 416 Stainless Steel
11. Motor Horsepower — 75 HP
12. Maximum Motor Speed — 3600 rpm
13. Motor Operating Voltage — 460 volt, 3 phase, 60 Hz

14. Motor shall be non-overloading over the entire pump curve.

D. Water Supply Well No. 2BC

1.	Pump Capacity/Head	900 gpm @ 337 feet TDH
2.	Pump Setting	281 feet minimum (below top of casing)
3.	Static Water Level	14 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4.	Minimum Pump Efficiency	70% @ design point
5.	Number of Stages	2
6.	Impeller Type	Type 316 Stainless Steel
7.	Pump Column	6-inch schedule 40 type 316 stainless steel
8.	Pump Check Valve	6-inch, Ductile iron body, 1-required on column riser at the pump
9.	Discharge Outlet	4-inch
10.	Shaft	Type 416 Stainless Steel
11.	Motor Horsepower	125 HP
12.	Maximum Motor Speed	3600 rpm
13.	Motor Operating Voltage	460 volt, 3 phase, 60 Hz
14.	Motor shall be non-overloading over the entire pump curve.	

E. Water Supply Well No. 3PD

1.	Pump Capacity/Head	600 gpm @ 306 feet TDH
2.	Pump Setting	250 feet minimum (below top of casing)
3.	Static Water Level	25 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4.	Minimum Pump Efficiency	70% @ design point
5.	Number of Stages	4
6.	Impeller Type	Type 316 Stainless Steel
7.	Pump Column	6-inch schedule 40 type 316 stainless steel
8.	Pump Check Valve	6-inch, stainless steel body, 1-required on column riser at the pump
9.	Discharge Outlet	6-inch
10.	Shaft	Type 416 Stainless Steel
11.	Motor Horsepower	75 HP
12.	Maximum Motor Speed	3600 rpm
13.	Motor Operating Voltage	460 volt, 3 phase, 60 Hz
14.	Motor shall be non-overloading over the entire pump curve.	

F. Water Supply Well No. 3BC

1.	Pump Capacity/Head	900 gpm @ 337 feet TDH
2.	Pump Setting	281 feet minimum (below top of casing)
3.	Static Water Level	14 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4.	Minimum Pump Efficiency	70% @ design point
5.	Number of Stages	2
6.	Impeller Type	Type 316 Stainless Steel
7.	Pump Column	6-inch schedule 40 type 316 stainless steel
8.	Pump Check Valve	6-inch, Ductile iron body, 1-required on column riser at the pump
9.	Discharge Outlet	4-inch
10.	Shaft	Type 416 Stainless Steel
11.	Motor Horsepower	125 HP
12.	Maximum Motor Speed	3600 rpm
13.	Motor Operating Voltage	460 volt, 3 phase, 60 Hz
14.	Motor shall be non-overloading over the entire pump curve.	

G. Water Supply Well No. 4PD

1.	Pump Capacity/Head	600 gpm @ 306 feet TDH
2.	Pump Setting	250 feet minimum (below top of casing)
3.	Static Water Level	25 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4.	Minimum Pump Efficiency	70% @ design point
5.	Number of Stages	4
6.	Impeller Type	Type 316 Stainless Steel
7.	Pump Column	6-inch schedule 40 type 316 stainless steel
8.	Pump Check Valve	6-inch, stainless steel body, 1-required on column riser at the pump
9.	Discharge Outlet	6-inch
10.	Shaft	Type 416 Stainless Steel
11.	Motor Horsepower	75 HP
12.	Maximum Motor Speed	3600 rpm
13.	Motor Operating Voltage	460 volt, 3 phase, 60 Hz
14.	Motor shall be non-overloading over the entire pump curve.	

H. Water Supply Well No. 4BC

1.	Pump Capacity/Head	900 gpm @ 337 feet TDH
2.	Pump Setting	281 feet minimum (below top of casing)
3.	Static Water Level	14 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4.	Minimum Pump Efficiency	70% @ design point
5.	Number of Stages	2
6.	Impeller Type	Type 316 Stainless Steel
7.	Pump Column	6-inch schedule 40 type 316 stainless steel
8.	Pump Check Valve	6-inch, Ductile iron body, 1-required on column riser at the pump
9.	Discharge Outlet	4-inch
10.	Shaft	Type 416 Stainless Steel
11.	Motor Horsepower	125 HP
12.	Maximum Motor Speed	3600 rpm

13. Motor Operating Voltage 460 volt, 3 phase, 60 Hz
14. Motor shall be non-overloading over the entire pump curve.

I. Water Supply Well No. 5PD

1. Pump Capacity/Head 600 gpm @ 306 feet TDH
2. Pump Setting 250 feet minimum (below top of casing)
3. Static Water Level 25 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4. Minimum Pump Efficiency 70% @ design point
5. Number of Stages 4
6. Impeller Type Type 316 Stainless Steel
7. Pump Column 6-inch schedule 40 type 316 stainless steel
8. Pump Check Valve 6-inch, stainless steel body, 1-required on column riser at the pump
9. Discharge Outlet 6-inch
10. Shaft Type 416 Stainless Steel
11. Motor Horsepower 75 HP
12. Maximum Motor Speed 3600 rpm
13. Motor Operating Voltage 460 volt, 3 phase, 60 Hz
14. Motor shall be non-overloading over the entire pump curve.

J. Water Supply Well No. 5BC

1. Pump Capacity/Head 900 gpm @ 337 feet TDH
2. Pump Setting 281 feet minimum (below top of casing)
3. Static Water Level 14 feet +/- (below top of casing)

Note: Final pump setting shall be a minimum of 50 feet below the pumping water level.

4. Minimum Pump Efficiency 70% @ design point
5. Number of Stages 2
6. Impeller Type Type 316 Stainless Steel
7. Pump Column 6-inch schedule 40 type 316 stainless steel
8. Pump Check Valve 6-inch, Ductile iron body, 1-required on column riser at the pump
9. Discharge Outlet 4-inch
10. Shaft Type 416 Stainless Steel
11. Motor Horsepower 125 HP
12. Maximum Motor Speed 3600 rpm
13. Motor Operating Voltage 460 volt, 3 phase, 60 Hz
14. Motor shall be non-overloading over the entire pump curve.

1.03 QUALITY ASSURANCE

A. Quality assurance shall be as required in Section, Quality Control and the following requirements.
   1. The pumps shall be as manufactured by American-Marsh, Grundfos, J-Line, Goulds, or approved equal.
   2. Product manufacturer shall have a minimum of five (5) years of experience.

1.04 REFERENCED STANDARDS

A. Publications are referred to in the text by basic designation only.
   1. AIEE
   2. North Carolina Administrative Code, Title 15A (NCAC)
   3. American Society for Testing and Materials (ASTM)
   4. American Water Works Association (AWWA)
   5. ANSI
   6. NEMA

1.05 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Manufacturers Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Individual components of the submersible turbine pump.
      b. Air Valve
      c. Check Valves
   2. Shop Drawings: Submit project specific shop drawings for the following:
      a. Base Plate Connection
      b. Water level measurement device
      c. Electrical diagram(s) for complete operating system.
   3. Operation and Maintenance Manuals for all equipment (e.g., pumps, etc.) and spare parts catalog.
   4. Spare Parts: Provide one set of spare parts normally required for one year's operation for the pump, properly packaged for storage and marked for usage. Include spare parts catalog.
   5. Certification:
      a. Submit certified pump curves after approval of Manufacturer's Data and Shop Drawings and prior to purchase.
      b. Provide certification of installed and properly operating adjustable frequency drive.

1.06 PRODUCT DELIVERY AND STORAGE

A. The pumps and controls shall be delivered to the job site in as large of units as practical to require the minimum amount of field connection and assembly.

B. The equipment shall be protected and stored on the job in accordance with the manufacturer's recommendations. As a minimum, the equipment shall be stored off the ground and adequately protected from the weather.

C. Product shall be handled in accordance with Section, Product Requirements.

PART 2 PRODUCTS

2.01 WELL PUMP

A. Pump Construction:
   1. Bowl Assembly: The bowls shall be made of type 316 stainless steel. Castings shall be free from blowholes, sand holes and shall be accurately machined and fitted to close dimensions. Bowls shall be designed with smooth passages to ensure efficient operation. The casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head whichever is greater.

2. Impellers: Impellers shall be type 316 stainless steel. They shall be of one-piece construction, single suction, enclosed vane, and radial flow design. The waterways through the impeller shall have extremely smooth contours, devoid of sharp corners, so as to promote maximum efficiency. The impeller is to be balanced and secured to the shaft. Impellers shall be adjustable by means of a top shaft-adjusting nut.
3. Impeller Shaft: The Impeller shaft shall be of sufficient diameter to withstand the maximum allowable combined shear stress under any operating condition at the smallest net diameter. Impeller shaft shall be of type 416 stainless steel construction conforming to ASTM A582. The shaft shall be supported by bronze bearings located on both sides of each impeller. Impeller shaft coupling shall be of type 416 stainless steel construction conforming to ASTM A582. The size of the shaft shall be no less than that as determined by AWWA E101. The motor coupling shall be constructed of Type 416 stainless steel ether keyed or spliced as needed to fit the motor shaft.
4. Submersible Motor: The motor Horsepower, RPM, voltage, and phase shall be as specified in paragraph, System Description above with an outside diameter not to exceed 8" inches. It shall be a submersible type designed for continuous underwater operation and with a service factor of 1.15 minimum. The motor shall be of the water-filled type and fitted with a segmented plate type thrust bearing capable of 3500 pounds continuous downthrust. Motor leads shall be of sufficient length so that they may be spliced above the bowl assembly and the leads shall be protected by a stainless steel cable guard for the entire bowl length. The motor rating shall be selected so that the load at design is not greater than the nameplate rating at 1.0 service factor and at no point on the curve shall the load exceed the nameplate rating plus 10 percent.

B. Surface (Base) Plate: The surface plate shall be fabricated from steel with a flat face base flange to match the well casing flange, short radius 90 degrees ductile iron elbow terminating in raised faced steel discharge flange. The surface plate shall be fitted with properly sized electrical junction box to allow for splicing surface cables and well cables. It shall also be tapped for a well vent and air line to the size as indicated on the Drawings and shall be provided with lifting lugs of sufficient strength to lift the entire pump and motor assembly including the riser pipe. A 12 inches nipple shall extend below the surface plate for connection to the riser pipe.

C. Discharge Column: The discharge column shall be schedule 40S type 316 stainless steel pipe of the length indicated. The column pipe shall be of the diameter and weight indicated in the respective pump data. The pipe shall be furnished in interchangeable sections not over 21 feet in length. The sections shall be connected with threaded, sleeve-type couplings as indicated. The pipe shall be intended for potable water use and shall be certified for conformance with NSF61. Contractor shall confirm, prior to ordering pipe, that the pipe with couplings and other items (e.g., pump cable) can be installed in the existing well casing.

D. Motor Adapter: A motor adapter of stainless steel with rabbeted fits shall be supplied to connect the submersible motor to the bowl assembly. It shall include the motor adapter bearing assembly and a corrosion resistant metal strainer whose free area shall be at least three times the impeller suction eye area. The maximum strainer opening shall not be more than 75 percent of the minimum opening or water passage through the bowl or impeller.

E. Power Cable: The power cable shall be heavy-duty double jacketed wire. Cables shall be designed specifically for submersible pump service and shall consist of either single conductors individually insulated or multiple conductors individually insulated and the whole covered with an outer jacket.

2.02 SURGE RELIEF VALVE

A. Provide surge relief valve as specified in Section, Specialty Valves.

2.03 RISER CHECK VALVE

A. Provide 6-inch spring loaded line check valves on the pump discharge riser pipe at the pump. Check valves shall be stainless steel and threaded male and female ends. Valve shall be Model 80S6 as manufactured by Flowmatic Corp. or approved equal.

2.04 CONTROLS

1. See Division 16

2.05 AIR VALVES

A. Provide air valves in conformance with AWWA C512 and the following:
   1. Valve type shall be an Air Vacuum valve with a double acting throttling device for well applications.
      a. Inlet size: 1-inch
   2. Valve shall be designed for the following automatic operation:
      a. Release large quantities of accumulated air during well pump start-up and allow large quantities of air to re-enter during pump shutdown.
   3. Valve shall be designed for a system pressure 250 psi.
   4. Provide threaded inlet.
   5. Provide stainless steel, center guided, ball float and internal trim.
   6. Provide isolating bronze ball valve for connection to main line.
   7. Valve shall be APCO Series 140DAT as manufactured by Valve and Primer Corporation, Val-matic "Well Service" Air valve as manufactured by Val-matic Valve and Manufacturing Corporation or approved equal.

PART 3 EXECUTION

3.01 DISINFECTION

A. During pump installation, well shall be disinfected before they are placed into service in accordance with AWWA C654 and as specified herein.

B. Disinfect equipment and material just prior to installation in the well by dusting exposed areas with calcium hypochlorite powder or by spraying with a solution having a chlorine residual of not less than 200 ppm.

C. Add chlorine to the well in sufficient quantities to produce a chlorine residual of at least 100 ppm in the well. Agitate water in the well to insure thorough dispersion of chlorine. Maintain chlorine solution in the well for at least 24 hours.

D. After 24 hours pump well to waste until a zero chlorine residual is obtained.

3.02 DISPOSAL OF CHLORINATED WATER

A. During flushing of highly chlorinated water, utilize de-chlorination unit(s) with chlorine reducing agent, or other acceptable means as approved by Engineer, to

limit discharge of highly chlorinated water from well. De-chlorination method must be appropriate for the observed chlorine residual.

3.03 BACTERIOLOGICAL AND CHLORINE RESIDUAL SAMPLING AND TESTING

A. Test for free chlorine residual at required bacteriological test locations immediately after induction of highly chlorinated water and again after 24-hours, prior to flushing of the highly chlorinated water from the potable water system.

B. Obtain two samples at each location specified after the chlorination procedure is completed, and prior to placing the well in service. Take the first sample immediately after flushing of the chlorinated water and again in 24-hours. A set of samples shall be taken as a minimum at the following locations:
   1. Wells
      a. From the well head.

C. Care in sampling. No hose shall be used for the collection of samples. Take samples from an approved sample tap consisting of a corporation stop installed in the main with a copper tube gooseneck assembly. Operation shall be such as to ensure that the sample collected is actually from water that has been in the new system.

D. Test samples for the presence of coliform organisms in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater. Testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique.

E. A laboratory certified for the required testing by the State of North Carolina shall perform testing.

F. If samples show the presence of coliform, procedure 1 or 2 described below shall be followed, with the approval of the Owner, before placing the unit or facility in service.
   1. Take repeat samples at least 24 hours apart until consecutive samples do not show the presence of coliform.
   2. Again subject the system to chlorination and sampling as described in this section.

G. If samples are free of coliform, and with the approval of the Owner, the well may be placed in service (i.e., once Owner has received final approval letter from NC Public Water Supply).

3.04 INSTALLATION

A. Pump(s) shall be provided as indicated on the drawings, plumbed and leveled.

B. Pressure gauges shall be mounted on the discharge as required for the respective pump installation.

C. Stilling tube for measuring the well water level shall be installed with the pump and column. The tube shall be 1-inch diameter, Schedule 40 PVC with solvent welded joints, and shall be installed such that removal of the stilling tube can be accomplished without removal of the column pipe. Tube shall hang vertically and shall not spiral inside the well casing. The connections at the ground must be air tight.

D. Pressure Transducer Drop Tube: A 1-1/4-inch SS drop tube will be installed outside of the well casing by the well driller under Contract 1. This drop tube shall house the pressure transducer to be provided and installed under this Contract.

3.05 START-UP SERVICES

A. The services of factory representatives of the equipment manufacturers shall be provided to check each piece of equipment after installation and to supervise initial start-up. A minimum of one trip to the site will be required, consisting of a minimum of one 8 hour working day.

B. Regardless of the time spent at the site, services will not be considered complete until the pump operates as intended for a minimum of one (1) week of operation.

C. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

D. Coordinate with the Owner to have manufacturer's representative available at the site to confirm installation of AFD is appropriate and operating properly. Obtain certification to this affect from the representative.

3.06 PAINTING

A. The surface preparation and painting shall be in accordance with Section, Painting of these specifications. The equipment shall be delivered to the job site with the shop coat primer applied. Contractor shall be responsible for touch-up painting any or all equipment paint damaged or removed during installation.

3.07 TEST

A. Certified Performance Test over the range of speeds shall be performed on the pump.

B. The pump shall be run under actual field service to demonstrate that the pump installed performs to the criteria set forth in this specification. During the field test, adjustments shall be made to correct the problems noted. All adjustments or parts renewal shall be at the Contractor's expense.

END OF SECTION

SECTION 11094

SUBMERSIBLE MIXER

PART 1 GENERAL

1.01 SCOPE

A. Provide submersible mixers in the locations as indicated on the Drawings and specified herein.

B. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational system:
   1. Submersible mixer
      a. Motor
      b. Gear drive and propeller
      c. Power and control cables
   2. Control Panel.
   3. Mixer mast mount

1.02 SYSTEM DESCRIPTION – BACKWASH HOLDING BASIN

A. Backwash Holding Basin

1. Service	2.0% solids
2. Liquid	Calcite Contactors Backwash
3. Basin Size	
a. Diameter	35'-0"
b. Side Water Depth	10'-0"
c. Center Water Depth	11'-3"
4. Propeller Design	Shielded
5. Propeller Material	Stainless Steel
6. Min. Propeller Diameter	14 inches
7. Propeller Speed	855 RPM
8. Thrust produced	812 N

B. Motor Characteristics:

1. Motor Horsepower	4 Hp
2. Voltage	460V, 3 phase, 60 cycle

C. Controls
   1. Manual on / off pushbutton.
   2. Thermal overload cut-off.

D. Assembly Accessories:
   1. Power Cable: #6 AWG four conductor with #10 AWG & conductor in single cable, 25 ft
   2. Lifting Cable: 1/4 inch dia., 25 ft.

E. Mixer(s) must be able to be raised and lowered on the mixer mast with the provided crane and be easily removed from the basin. Entire weight of mixer unit shall be guided by a single bracket which must be able to handle thrust created by the mixer. Mixer, with its appurtenances and cable, shall be capable of continuous operation underwater without loss of watertight integrity.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:

1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
   a. Submersible mixer.
   b. Power assisted crane.
   c. Mixer mount.
2. Shop Drawings: Submit Project specific shop drawings for the following:
   a. Mixer mount with all mounting details indicating position of equipment with respect to each other.
   b. Control panel layout and wiring diagram.
3. Manufacturer's Installation Procedures.
4. Test Reports: Submit for the following:
   a. Factory test.
   b. Field start up report by manufacturer representative.
5. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the total system.
6. Spare Parts: Provide one set of spare parts normally required for one-year's operation for each mixer, properly packaged for storage and marked for usage.

1.04 QUALITY ASSURANCE

A. Mixer manufacturer shall have been engaged in producing submersible mixers for a minimum of five years. This experience shall consist of installations where equipment of same size and design has been in operation successfully in a similar process for a minimum of three years.

B. In lieu of the experience the equipment supplier or manufacturers may provide a cash deposit or bond to guarantee replacement in the event of failure of the equipment during the first three years after acceptance of the work. Equipment which does not meet the experience clause but is being proposed under these conditions must meet technical requirements.

C. Mixer shall be as manufactured by Wilo USA or equal.

PART 2 PRODUCTS

2.01 MIXER CONSTRUCTION

A. General
   1. The mixers shall be the submersible type and shall be installed in location as shown in the plans.
   2. All mating surfaces of the major castings requiring a watertight seal shall be machined and fitted with FPM (Viton) O-rings.
   3. All nuts, bolts, washers, and other fastening devices supplied with the mixers shall be AISI 316 stainless steel.

B. Mixer Housing
   1. All major components of the mixing unit (i.e. stator housing, seal housing, and cable entry) shall be manufactured from close-grained ASTM A48 Class 35 or higher (GG25) cast iron.

C. Propeller
   1. Propellers shall be manufactured from closed cell polyurethane (PUR). No welded steel or stainless steel propeller shall be accepted.

2. The propeller shall have a swept-back profile and at least 3 blades. The propeller blades shall be thicker on the leading edge than the trailing edge and thicker towards the hub than at the tip to allow the propeller to free itself from rags as it turns. The blades shall be smooth, finished throughout, and shall be free from sharp edges.
3. Propellers shall be statically and dynamically balanced.
4. Propellers shall be slip fit and securely held to the shaft by a stainless steel washer and bolt assembly that is enclosed in a separate hub chamber. The hub chamber is fitted with an O-Ringed cap that seals the entrance of the propeller hub chamber device. The output shaft shall be splined to mate with the matching spline insert of stainless steel that forms the hub of the propeller.

D. Propeller Shaft
1. The shaft connecting the propeller to the gear reducer shall be constructed of AISI 329 (1.4462) stainless steel.
2. Minimum propeller shaft diameter (D), measured at the outermost bearing shall be: 1.77 inches (45 mm).
3. The propeller shaft shall be supported such that the length (L) from the outermost bearing to the hub of the propeller shall not exceed 3.88 inches (98.5 mm). The shaft overhang ratio of the distance from the bearing to the hub of the propeller (L) divided by diameter of the shaft at the bearing shall not exceed 2.2.

E. Bearings
1. Each mixer shall be furnished with a minimum of four (4) sets of bearings spaced to minimize shaft deflection to offer maximum bearing life. At a minimum, at least two sets of the bearings shall be of double row design. Designs with fewer than four (4) sets of bearings shall not be allowed.
2. A minimum of two sets of bearings shall support the propeller shaft (shaft from gear box to the propeller). Designs where the propeller shaft is supported solely by the gearbox shall not be acceptable.
3. Mixer shaft overhang and bearing design shall provide a minimum B10 life of 100,000 minimum at design point. Manufacturer shall provide certified bearing life calculations stamped by a registered Professional Engineer.
4. Bearings shall be sealed, grease lubricated and maintenance-free.

F. Mechanical Seals
1. Each submersible mixer shall be provided with two separate seal chambers. The inner chamber shall be located between the dry stator chamber and the gear reduction chamber and shall contain a minimum of 1.1 liters of oil. The outboard seal chamber shall be located between the gear reduction chamber and the outside of the mixer at the hub of the propeller and shall contain a minimum of 1.2 liters of oil.
2. Each seal chamber shall be provided with an independent set of mechanical seals and a lip seal running in an oil bath. The inboard set of seals shall be mounted in the chamber between the motor and gearbox. The outboard set of seals shall be mounted between the gearbox and the propeller.
3. Each mechanical seal set shall be provided with solid sintered silicon carbide seal face material on both the stationary and rotating components. Both the inboard mechanical seal set and the outboard mechanical seal set shall be silicon carbide.

4. The outboard mechanical seal shall be protected from debris, rags and stringy materials by an AISI 316 stainless steel deflection ring. Designs without a stainless steel deflection ring shall not be acceptable.
5. The metal components of the mechanical seal case shall be constructed of AISI 316 stainless steel.
6. A moisture sensor probe shall be furnished in both (or "the outboard", or "the inboard") of the seal oil chambers of each mixer. Each sensor shall be wired to the control panel and shall activate an alarm light upon seal failure. This alarm light shall indicate the seal failure location, either inboard or outboard.
7. The outboard seal sensor probe shall be externally located and accessible for maintenance without the need to disassemble the mixer for service or replacement.

G. Gear Reducer
1. The motor shall drive the submersible mixer propeller through a planetary gear reduction drive system that locates the motor shaft in line with the propeller shaft.
2. The motor shaft shall be fitted with a keyed sun gear that uses high efficiency straight cut teeth to engage the planetary gear section.
3. The sun gear system shall be custom matched to the planetary gear system to allow for propeller speed changes in the field by a simple exchange of the sun gear and the planetary gear plate.
4. The planetary gear section shall consist of three identical gears mounted on a stainless steel backing plate designed to withstand 100% lock stress from the propeller without gear or bearing damage.
5. Each planetary gear shall be supplied with precision needle bearings, which are lubricated by the gear lubricant in the gear chamber. The gear chamber shall contain a minimum of 0.5 liters of oil.
6. There shall be a minimum of three planetary gears spaced 120 degrees around the central sun gear.
7. The planetary gear section shall be easily removed and shall be interchangeable with other ratios and for simplified spare parts inventory.
8. The planetary gear section shall also engage a ring gear mounted in the outer surface of the gear chamber which shall cause the motor rotation to also rotate the planetary gear plate which shall be fitted to the output propeller shafting by the use of a straight splined connection.
9. The planetary gear plate shall be retained on the output propeller shaft by the use of a snap ring and snap ring groove in the output shaft.
10. The planetary design shall be designed such that with regular oil changes, no further maintenance should be required during the life of the submersible mixer in the installation. The gears shall have a minimum L-10 life of not less than 100,000 hours at the rated duty.
11. Gear oil changes shall be easily made using external stainless steel pipe plugs that are sealed via nylon washers.
12. Standard 80 to 90-weight gear oil either normal or synthetic shall lubricate the gear section.

2.02 MOTORS

A. Submersible Motors
1. Each mixer shall be furnished with a squirrel cage, induction motor enclosed in a watertight housing suitable for use and compatible with all variable frequency drive systems.

2. The motors shall be air-filled and constructed with moisture resistant NEMA Class F insulation and Class F slot liners and constructed to NEMA B design standards. The copper wound stator shall be dipped in epoxy enamel and hardened to withstand a temperature of 155 degrees Centigrade as defined in NEMA Standard MG-1. Each winding phase or layer shall be laced with Class F glass lined paper. The use of cable ties to restrain windings shall not be allowed. The rotor shall be statically and dynamically balanced after fabrication. The rotor shall utilize aluminum amortisseur bars and short circuit rings. The constructed motor shall be certified for continuous duty with a service factor of 1.15.
3. Motors shall be capable of sustaining 15 starts per hour (unlimited starts with VFD) at an ambient temperature of 40°C.
4. Motors shall be capable of uninterrupted operation with a voltage drop of 10%.
5. Thermal switches shall be furnished to monitor stator temperatures. The stator shall be equipped with two(2) thermal switches. Thermal switches shall automatically de-energize the motor when its temperature exceeds a preset limit as recommended by the manufacturer.
6. The motor shall bear the FM (Factory Mutual) explosion-proof label certifying its use in a Class 1, Division 1, Groups C & D hazardous location.
7. The manufacturer's nameplates shall be engraved, laser etched or stamped on stainless steel and fastened to the motor casing.

B. Shafts
1. Motor shafts shall be AISI 420 (1.4021) stainless steel. Carbon steel shafts or shafts with sleeves of any type are not acceptable. The shaft shall be one piece construction without joints or stubs attached.
2. Minimum shaft diameter shall be 1-3/8 inches (35 mm) at the double bearing motor shaft bearing.

C. Power and Control Cables
1. Power and control cables shall be furnished in lengths to run un-spliced from the mixer to the control panel or disconnect as shown on the Contract Drawings and as specified herein. Cables shall terminate with conductor sleeves that bundle the entire group of strands of each phase to improve termination at the pump control panel. The sleeves shall be provided to confirm that all strands of each conductor is terminated properly.
2. Cables shall be of the "NSSHOU" type and shall be approved by the MSHA for use in hazardous locations and shall conform to industry standards for loads, resistance under submersion against sewage, and be of stranded construction. The cables shall enter the mixer motor through a heavy duty galvanized cast iron entry assembly which shall be provided with an external clamp assembly to protect against tension once secured providing a strain relief function as part of standard construction.
3. The cables for each mixer motor shall pass through the galvanized cast iron strain relief component and then through a series of stainless steel disks and Buna-n grommet that is sandwiched between the disks to control compression of the grommet. The cable entry design shall be of the type recommended in the Factory Mutual Research Corporation specifications for Explosion Proof Certification. The entry shall be comprised of the cast iron fitting that will include the Buna-N strain relief grommet coupled with a poured conductor section. In the poured section, only Factory Mutual approved sealant shall be used to wick into each conductor strand that has the insulation removed in this area to provide a positively leak proof seal for the power and sensor cords.

2.03 REMOVAL SYSTEM

A. Guide Rail System
   1. A guide rail system shall be used to mount each mixer during operation and to guide the units during installation and removal for service. The system shall consist of a bottom assembly, mixer support assembly, 4-inch by 4-inch (100 mm by 100 mm) guide pipe, upper support and positioning device. The system to be fixed at the bottom of the tank in a pivot which shall allow horizontal rotation of the mast through not less than 120 degrees. All guides and brackets shall be constructed of AISI 316 stainless steel. The mast bearings shall be constructed of Hostaform (POM). Power/control cable holders shall be provided every five feet.
   2. The bottom assembly shall be bolted to the floor of the tank, and provide support for the guide pipe. It shall also include a hole to accept the guide pipe bottom plug. The bottom console and guide pipe shall be constructed of AISI 316Ti stainless steel.
   3. The assembly shall be strong enough to support the weight of the mixer, the guide pipe and the mixer preload force. The assembly shall be positioned in such a manner so as to prevent the mixer blade tips from hitting the basin floor. The mixer support shall be constructed of AISI 316Ti stainless steel.
   4. The upper guide holder assembly shall secure the system to the tank edge or platform. It shall also provide the lateral support for the guide pipe. The assembly shall contain a location to secure the electrical motor cable holder.
   5. Mixer support frame (including angular adjustment brackets) shall be manufactured from: AISI 316Ti Stainless Steel as detailed in the submersible mixer tabulated data listing above.

B. Hoist Assembly
   1. A hoist system shall be used for lifting and lowering of the mixer on the guide rail during installation and maintenance. The system shall be capable of 360 degree-rotation. Each hoist assembly shall be rated at a minimum of 500 pounds. All crane and receiving boxes shall be constructed of AISI 304 stainless steel. The sleeves and the bearings in the receiving box shall be constructed of Nylon (PA).

2.04 SHOP PAINTING

A. Primer and Finish Paint-Shop apply to all exterior ferrous surfaces of the mixer and motor.
   1. Solids by volume: 97%
   2. Type: Solvent-free ceramic coating, impregnated with aluminum oxides
   3. Total Dry Film Thickness: 400 microns (15 mils) minimum
   4. Minimum Adhesion: 15 Newtons per square millimeter (2,030 psi) per ISO 4624.
   5. Minimum Hardness: 110 on Buchholz Indentation scale
   6. Resistance: Level 1 (continuous duty) for sewage with pH of 6-11, Level 1 for saltwater, Level 3 (not recommended) for 10% hydrochloric acid.

2.05 ELECTRICAL ACCESSORIES

A. Electric Cable: Each mixer shall be furnished with the required length (25 ft. minimum) of 4 conductor Type "GC" chloroprene rubber jacketed type SPC power cable. Install, connect, and support cable in a manner satisfactory to the Engineer. Provide woven stainless steel sleeves to protect cable from chaffing at motor and panel connection, wall crossing, and other locations as required.

2.06 CONTROL PANEL

A. Controls for submersible mixers shall be in accordance with the Division 16 Electrical Specifications.

2.07 SPARE PARTS

A. Provide the following spare parts:
   1. One set of o-rings per mixer.
   2. One set of seals and bearings for each mixer type.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install mixer unit in accordance with manufacturer's instructions.

B. Power Cable: Secure power cables at both the mixer unit and the basin wall or top of mixer mount. Provide sufficient slack.

3.02 FIELD TESTING

A. Vibration and natural frequency tests shall be performed by the mixer manufacturer during the field testing. Values in excess of those listed in the Hydraulic Institute Standards shall be corrected prior to acceptance of the installation. Values shall also be compared to shop/factory testing results and shall not deviate by more than 10%.

3.03 START-UP SERVICE

A. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of one trip to the site will be required consisting of a minimum of one 8-hour working day.

B. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) month of plant operation.

C. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

END OF SECTION

SECTION 11100

QUARTERTURN ELECTRIC MOTOR ACTUATOR

PART 1 GENERAL

1.01 SCOPE

A. Section includes, but is not limited to, providing electrically operated actuator for valves as indicated on the Drawings.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02510 Water Distribution System
   2. Section 13203 Horizontal Calcite Contactor System

1.03 SYSTEM DESCRIPTION

A. The following shall be a general description for each electric motor operating valve or gate:
   1. Location: See electrically operated valve/gate list.
   2. Function: open, close, or modulate the respective valve or gate as identified on the valve/gate list.
   3. Valve size: Varies, see valve/gate list.
   4. Controls
      a. Hand-Off-Remote selector switch
      b. Hand Mode: Operate valve/gate manually.
      c. Remote Mode: Open, close or modulate valve remotely from SCADA System signal. Open or close knife gate remotely from calcite filter control panel.
      d. Provide open/closed status confirmation to SCADA System.
   5. Voltage: 480 V, 3 phase, 60 Hz
   6. Operator mounted on flow control butterfly valve or knife gate as shown on the Drawings.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the actuator. Equipment to be furnished for the Project shall be clearly indicated including options to be provided.
   2. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for actuator.

1.05 SPARE PARTS

A. Spare Parts: One spare actuator of the smalles size and one spare actuator of the largest size shall be held in stock by the actuator service representative. Two spare encoders shall also be held in stock. This stock shall be held exclusively for the use of Martin County, NC during the warranty period to ensure rapid availability of spare parts if needed.

PART 2 PRODUCTS

A. General
   1. Actuators shall be capable of fully opening and closing the valve under the maximum load. Actuator is to be self locking under normal operating conditions in order to hold the valve in an intermediate position. Actuator shall be designed for indoor or outdoor service and capable of mounting in any position. Actuators should include in one integral unit the motor, power gearing, travel limit switches, torque limit switches, handwheel, terminals for motor power and controls and separable worm gear operator. Valves larger than 12 inch shall have multi-turn actuators coupled with detachable worm gearboxes.
   2. All actuators shall be of the non-intrusive design. Units which require removal of covers or adjustment of mechanical devices to set limits or confirgure other parameters shall not be acceptable. Actuators shall as manufactrued by Limitorque MX/QX, Rotork IQ-3/IQT-3, or non-intrusive Auma Model SA/SAR with automatic controls that meet all specification requirements.
   3. Closing Time: Actuators shall be selected to open or close the valve in approximately 60 seconds.
   4. Certifications: The actuators shall have the following non-hazardous (Weatherproof / Submersion) certifications:
      a. IEC 529 protection code IP68; 15 meters for 96 hours continuous
      b. USA & CSA; NEMA 3, 4, NEMA 4X, NEMA 6

B. Actuator: The actuator shall consist of an electric motor, mechanical gear reduction, absolute position encoder with redundancy, electronic torque sensor, solid state motor controller, electronic control, protection, and monitoring package, manual override handwheel, valve interface bushing, 32-character graphical Liquid Crystal Display (LCD), and local control switches all contained in an enclosure that is sealed to NEMA 4, 4X, 6, IP68 to 20M for 168 hours. Actuator design life shall be at least one million drive sleeve turns.

C. Power Transmission: The power transmission shall be completely bearing-supported, and consist of a hardened alloy steel worm and alloy worm gear, and spur gear reduction, all immersed in an oil-bath lubricated using a synthetic oil designed specifically for extreme pressure worm and worm gear transmission service.

D. Motor: The motor shall be able to energize on either single phase/60 Hertz (110/125) or single phase/50 Hertz (220/250) or three-phase / 60-Hertz (208, 230, 360, 440, 460, 575 V) or three-phase / 50-Hertz (380, 400, 440, 415, 525 V), or 24-48 Vdc incoming power. Advanced brushless DC motors shall be standard. Brushed DC motors are not permitted. Motor must permit a global range of voltages (single-phase and three-phase ACV and DCV) to be connected without modification. The motor must have as a minimum class F insulation and a thermistor embedded within the motor windings to prevent damage due to over-load. The motor shall be easily removed through the use of a plug-in connector and shaft coupling located in the motor chamber. Single phase motors using capacitors shall not be allowed.

E. Valve Positioning: The valve position shall be sensed by an absolute position encoder, employing system-on-chip technology using a contactless magnet that excites Hall effect devices to provide redundant, 12-bit resolution over 360 degrees. Position shall be 100% repeatable. Each of the position sensing circuits shall be redundant, permitting up to 50% fault tolerance before the position is incorrectly reported. The BIST feature shall discern which failures signal a warning only and

which require a warning plus safe shutdown of the actuator. Open and closed positions shall be stored in permanent, nonvolatile memory. The encoder shall measure valve position at all times, including both motor and handwheel operation, with or without power present, and without the use of a battery. The absolute encoder will be capable of resolving down to 0.1% of output shaft position over 360 degrees.

F. Handwheel: A handwheel shall be permanently attached for manual operation. A positive declutch mechanism shall engage the handwheel when required. Handwheel shall not rotate during motor operation. A fused or inoperable motor shall not prevent manual operation. Motor operation shall always take precedence over manual operation.

G. Electronic Torque Sensor: An electronic torque sensor shall be included. The torque limit may be adjusted from 40 to 100% of rating in 1% increments. The motor shall be deenergized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating and during extreme arctic temperature operation (down to -60°C), and a "Jammed Valve" protection feature, with automatic retry sequence, shall be incorporated to de-energize the motor if no movement occurs. Designs measuring torque through compression of mechanical springs shall not be allowed.

H. Control Module: The control module shall include logic circuit boards mounted to a steel plate and attached in the control compartment with captive screws. The use of O-rings or other such devices to secure the control boards shall not be permitted. The module shall be easily removed through the use of plug-in connectors. The module shall also include a solid state motor controller board, local control switches, 32-character graphical LCD, and LED indicators. It shall also be Bluetooth ready. All internal wiring shall be flame-resistant, rated 105°C, and UL/CSA listed. Voltage shall be software detectable and configurable.

I. Motor Controller: The motor controller shall perform as the motor reverser and shall be solid state with no moving mechanical parts. Mechanical contactors shall not be used. The control module shall also include an auto reversal delay to inhibit high current surges caused by rapid motor reversals.

J. Discrete Remote Control: Discrete remote control may be configured as two, three, or four wires for open-stop-close control. Remote control functions may be powered by external 24 VDC, 125 VAC, or the actuator's internal 24 VDC supply. The voltage values for signal threshold shall be 19.2 VAC/VDC and 5.0 VAC/VDC, respectively. The maximum load for 24 VDC is 2 mA. The internal supplies shall be protected against over current and short circuit faults by utilizing optical isolation to minimize electromagnetic interference. Discrete control shall have an isolated common.

K. Multi-Mode Remote Control: Multi-mode remote control shall be included which permits discrete two, three, or four wires, or network (Fieldbus) for open-stop-close control. The actuator shall be capable of also distinguishing analog control for modulating applications. The actuator shall respond to the last signal received. Remote control functions may be powered by external 24 VDC, 125 VAC, or the actuator's internal 24 VDC supply. The voltage values for signal threshold shall be 19.2 VAC/VDC and 5.0 VAC/VDC, respectively. The maximum load for 24 VDC is 2 mA. The internal supplies shall be protected against over current and short circuit faults and utilizes optical isolation to minimize electromagnetic interference. Discrete control shall have an isolated common.

L. Terminals: Terminals shall be included to connect the electronic controls package, including display, to a backup 24 VDC power source. As an optional alternative, the actuator shall have the ability to maintain the status and alarm contacts in order to update status to the control room and also provides status visibility on the LCD screen without main power applied. It should be configurable for at least one hour and, once main power is restored, be available for the next unforeseen power outage. The use of an integral battery is prohibited. A pad lockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The control switches shall not penetrate the controls cover and shall be designed to electrically isolate the actuator internal components from the external environment. The OPEN-CLOSE switch may be configured for maintained or push-to-run (inching) control.

M. Status Contacts: Four (4) latched status contacts rated 125 VAC, 0.5 A and 30 VDC, 2 A shall be provided for remote indication of valve position, configured as 1-N/O and 1-N/C for both the open and closed positions. Two contacts may be configured to represent any other actuator status; mid-travel position, switched to local, over torque, motor over temperature, manual operation, switched to remote, switched to stop, valve moving, close torque switch, open torque switch, hardware failure, ESD active, inhibits active, valve jammed, analog IP (input) lost, lost phase, and network controlled. The other two will be complementary.

N. Monitor Relay: A monitor relay shall be included and shall trip when the actuator is not available for remote operation. Both N/O and N/C contacts shall be included, rated 125 VAC, 0.5 A and 30 VDC, 2 A. The monitor relay shall be configurable for three additional fault indications: lost phase, valve jammed, and motor over temperature. The yellow LED shall blink when the monitor relay is active. The monitor relay configuration shall provide provision to be disabled.

O. Actuator Control Panel: The Actuator Control Panel cover and module shall use solid-state Hall-effect devices for local communication and configuration. The use of reed switches on the module is prohibited. A 32-character, graphical LCD shall be included to display valve position as a percent of open, 0-100%, and current actuator status. "STATUS OK" shall be displayed for an operable actuator. If the actuator is not operable, the appropriate alarm shall be displayed. The alarm shall be continuously displayed until the actuator is operable. Red, green, and yellow LEDs shall be included for open, close, stopped, and moving indication. The Red and Green LEDs shall be reversible. A padlockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The control switches shall not penetrate the controls cover and shall be designed to electrically isolate the actuator's internal components from the external environment. The OPEN-CLOSE switch may be configured for maintained or push-to-run (inching) control.

P. Non-Intrusive Design: The device shall be non-intrusive. All calibration/configuration and product software updates shall be accomplished without removing any covers. All calibration shall be performed in clear text languages; no icons shall be used. The languages shall be English, Spanish, French, German, Portuguese, Italian, Mandarin, Russian, Malay, and Katakana. All calibration shall be performed by answering the "YES" and "NO" questions displayed on the LCD. "YES" is signaled by using the OPEN switch and "NO" by using the CLOSE switch, as indicated adjacent to the switches. A configurable password option shall be available to prevent unauthorized changes.

Q. Terminal Compartment and Terminal Block: All customer connections shall be located in a terminal chamber that is separately O-ring sealed from all other actuator components, gasket or foam seals shall not be allowed. Site wiring shall not expose actuator components to the environment. The internal sealing within the terminal chamber is suitable for NEMA 4, 6, and IP68 to 20M for 168 hours. The terminal block shall include screw-type terminals, three for power and 54 for control, for site connections. It shall also have provisions for the addition of a safety shield to be attached over the incoming power terminals.

R. Conduit Entries: Four (4) conduit entries shall be provided as follows: (1) -1.25" NPT and (3)-1.0" NPT shall be located in the terminal chamber.

S. Coatings: The actuator shall be coated with a polymer powder coat. The coating system shall be suitable for an ASTM B117 salt spray test of 1500 hours. External fasteners shall be stainless steel. The fasteners shall be suitable for an ASTM B117 salt spray test of 500 hours.

T. Handwheel and Declutch Lever: A handwheel and declutch lever shall be provided for manual operation. The handwheel shall not rotate during electric operation nor can a seized motor prevent manual operation. Changing from motor to manual operation is accomplished by engaging the declutch lever. Energizing the motor shall return the actuator to motor operation. The lever shall be padlockable to permit motor operation only.

U. Analog Position Transmitter: A non-contacting, internally powered, electrically isolated position transmitter shall be included to provide a 4-20 mA signal that is proportional to valve position.

V. Controller for Actuators for Modulating Service: A controller that alters valve position in proportion to a 4-20 mA analog command signal shall be included. Positioning shall be accomplished by comparing the command signal to an internal position feedback. The internal feedback shall be of the non-contacting type. An automatic pulsing feature to prevent overshoot at the setpoint shall be included. Proportional bands, deadband, signal polarity, motion inhibits time, and fail position shall be adjustable through the LCD. Deadband shall be adjustable to 0.5% full span.

W. Diagnostics: Diagnostic facilities shall be included to accumulate and report the performance of the motor, encoder, contactor, cycle time, handwheel operations, actuator ID, firmware revision, and output turns. In addition, a torque profile of the reference baseline valve stroke and the last valve stroke shall be included. A feature for reset shall be provided. All diagnostic information shall be displayed on the LCD. Diagnostics shall also include a Frequency Domain Analysis (FDA) feature. The FDA methodology shall capture torque, position or speed values at regular time intervals while the actuator is motoring, and calculate the resulting data set with a Fast Fourier Transform (FFT). The resulting information shall be used to isolate any components in the mechanical drive train that may exhibit excessive wear or may affect normal actuator operation. FDA and resultant fault indications shall be displayed via the graphical LCD. The actuator shall contain the ability for diagnostics information to be downloaded to a PC or PDA via both IRDA and Bluetooth ports in the actuator.

X. Lost Power Buffer: After the actuator has been powered by line power for one hour, it shall automatically withstand most power outages while maintaining the correct state of the S status contacts, even if the user repositions the actuator manually with the handwheel. To maximize its self-power time while the line power is lost, the

actuator will place itself in its lowest possible power usage mode. The LCD will darken (sleep mode) until it is needed to be viewed. The LCD can be activated by moving the black knob to OPEN (YES) or by moving the actuator with the handwheel. After 10 seconds of inactivity, the LCD will return to sleep mode. The use of batteries to perform this function shall be prohibited.

Y. Factory Testing: Every actuator shall be factory dynamometer tested to verify: rated output torque, output speed, handwheel operation, local control, control power supply, valve jammed function, all customer inputs and outputs, motor current, motor thermistor, LCD and LED operation, direction of rotation, microprocessor checks, and position-sensor checks. A report confirming successful completion of testing shall be included with each actuator.

PART 3 EXECUTION

3.01 INSTALLATION

A. Actuators shall be sized, installed, and calibrated by a manufacturer's factory trained and authorized service representative. Service representative shall have at least four full years of experience in similar field automation and shall maintain a fully stocked service facility within three hundred miles of the job site.

END OF SECTION

Electrically Operated Valve/Gate List						
Control Valve Designation	Valve Type	Type Operator	Size (inches)	Service	Location/Description	Supplier
MOV-1106	Butterfly	Open/Closed	12	Water	Well Site No. 1 Combined Blow-off Valve	Contractor
MOV-1113	Butterfly	Open/Closed	12	Water	Well Site No. 1 Combined Discharge Valve	Contractor
MOV-1206	Butterfly	Open/Closed	12	Water	Well Site No. 2 Combined Blow-off Valve	Contractor
MOV-1213	Butterfly	Open/Closed	12	Water	Well Site No. 2 Combined Discharge Valve	Contractor
MOV-1306	Butterfly	Open/Closed	12	Water	Well Site No. 3 Combined Blow-off Valve	Contractor
MOV-1313	Butterfly	Open/Closed	12	Water	Well Site No. 3 Combined Discharge Valve	Contractor
MOV-1406	Butterfly	Open/Closed	12	Water	Well Site No. 4 Combined Blow-off Valve	Contractor
MOV-1413	Butterfly	Open/Closed	12	Water	Well Site No. 4 Combined Discharge Valve	Contractor
MOV-1506	Butterfly	Open/Closed	12	Water	Well Site No. 5 Combined Blow-off Valve	Contractor
MOV-1513	Butterfly	Open/Closed	12	Water	Well Site No. 5 Combined Discharge Valve	Contractor
MOV-108	Butterfly	Open/Closed	24	Water	Raw Water Feed Valve	Contractor
MOV-109	Butterfly	Open/Closed	12	Water	Raw Water Bypass Valve	Contractor
MOV-112	Butterfly	Open/Closed	6	Water	Permeate Tank Inlet Valve	Contractor
MOV-201-1	Butterfly	Open/Closed	12	Water	RO Train No. 1 Raw Water Feed Valve	ROEM
MOV-202-1	Butterfly	Open/Closed	4	Water	RO Train No. 1 Flush Water Feed Valve	ROEM
MOV-207-1	Butterfly	Open/Closed	8	Water	RO Train No. 1 Inlet Valve	ROEM
MOV-215-1	Butterfly	Open/Closed	4	Water	RO Train No. 1 Concentrate Valve	ROEM
MOV-201-2	Butterfly	Open/Closed	12	Water	RO Train No. 2 Raw Water Feed Valve	ROEM
MOV-202-2	Butterfly	Open/Closed	4	Water	RO Train No. 2 Flush Water Feed Valve	ROEM
MOV-207-2	Butterfly	Open/Closed	8	Water	RO Train No. 2 Inlet Valve	ROEM
MOV-215-2	Butterfly	Open/Closed	4	Water	RO Train No. 2 Concentrate Valve	ROEM
MOV-4111	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 1) Permeate Influent Valve	Contractor
MOV-4121	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 1) Treated Water Effluent Valve	Contractor
MOV-4131	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 1) Backwash Influent Valve	Contractor
MOV-4141	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 1) Backwash Water Effluent Valve	Contractor
MOV-4211	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 2) Permeate Influent Valve	Contractor
MOV-4221	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 2) Treated Water Effluent Valve	Contractor
MOV-4231	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 2) Backwash Influent Valve	Contractor
MOV-4241	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 2) Backwash Water Effluent Valve	Contractor
MOV-4311	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 3) Permeate Influent Valve	Contractor
MOV-4321	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 3) Treated Water Effluent Valve	Contractor
MOV-4331	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 3) Backwash Influent Valve	Contractor
MOV-4341	Butterfly	Open/Closed	10	Water	Calcite Filter No. 1 (Cell 3) Backwash Water Effluent Valve	Contractor
MOV-4112	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 1) Permeate Influent Valve	Contractor
MOV-4122	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 1) Treated Water Effluent Valve	Contractor

MOV-4132	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 1) Backwash Influent Valve	Contractor
MOV-4142	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 1) Backwash Water Effluent Valve	Contractor
MOV-4212	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 2) Permeate Influent Valve	Contractor
MOV-4222	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 2) Treated Water Effluent Valve	Contractor
MOV-4232	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 2) Backwash Influent Valve	Contractor
MOV-4242	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 2) Backwash Water Effluent Valve	Contractor
MOV-4312	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 3) Permeate Influent Valve	Contractor
MOV-4322	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 3) Treated Water Effluent Valve	Contractor
MOV-4332	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 3) Backwash Influent Valve	Contractor
MOV-4342	Butterfly	Open/Closed	10	Water	Calcite Filter No. 2 (Cell 3) Backwash Water Effluent Valve	Contractor
MOV-440	Butterfly	Modulating	10	Water	Calcite Rinse Water Valve	Contractor
MOG-441	Knife Gate	Open/Closed		Water	Calcite Filter 1 (Cell 1) Inlet Gate	Contractor
MOG-442	Knife Gate	Open/Closed		Water	Calcite Filter 1 (Cell 2) Inlet Gate	Contractor
MOG-443	Knife Gate	Open/Closed		Water	Calcite Filter 1 (Cell 3) Inlet Gate	Contractor
MOG-444	Knife Gate	Open/Closed		Water	Calcite Filter 2 (Cell 1) Inlet Gate	Contractor
MOG-445	Knife gate	Open/Closed		Water	Calcite Filter 2 (Cell 2) Inlet Gate	Contractor
MOG-446	Knife Gate	Open/Closed		Water	Calcite Filter 2 (Cell 3) Inlet Gate	Contractor

SECTION 11223

WAFER STYLE INJECTION MIXERS

PART 1 GENERAL

1.01 SCOPE

A. Provide wafer style injection mixers in the locations indicated on the Drawings and specified herein. This section includes the furnishing, installation, and testing of wafer style mixers for the injection of water treatment chemicals into water treatment plant site pipelines.

B. Work shall include, but not be limited to the following items and necessary accessories for two (2) mixer:
   1. Wafer static mixer and injection assembly for injection of 25% to 50% sodium hydroxide.
   2. Wafer static mixer and injection assembly for injection of ammonium sulfate.

1.02 RELATED SECTIONS

A. The following sections specify equipment and accessories that are directly related to this section. This does not relieve the contractor of his responsibility for the proper co-ordination of the equipment to be supplied.
   1. Section 02510 Water Distribution System

1.03 SYSTEM DESCRIPTION

A. Injection Mixer 1

1.	Service	Post Calcite Contactors
2.	Chemical Injected in Mixer	25% Sodium Hydroxide
3.	Number of Units	1
4.	Minimum Flow	900 GPM
5.	Maximum Flow	5,550 GPM
6.	Line Pressure	<30 psi
7.	Mixer Plate Material	PVC
8.	Number of injection ports	2 (one operation, one spare)
9.	Pipe diameter	24"
10.	Connecting Pipe type	C900 PVC
11.	Connections	Transition couplings
12.	Max. pressure drop	3 psi

B. Injection Mixer 2

1.	Service	Finished Water (Chloramine)
2.	Chemical Injected in Mixer	40% by wt Ammonium Sulfate
3.	Number of Units	1
4.	Minimum Flow	2,250 GPM
5.	Maximum Flow	9,000 GPM
6.	Line Pressure	75 psi
7.	Mixer Plate Material	316 Stainless Steel
8.	Number of injection ports	2 (one operation, one spare)
9.	Pipe diameter	24"
10.	Connecting Pipe type	Ductile Iron
11.	Connections	Transition couplings
12.	Max. pressure drop	3 psi

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
      a. Static Mixer for Caustic Soda, Polyphosphate, and Sodium Hypochlorite.
   2. Shop Drawings: Submit Project specific dimensioned shop drawings for each mixer service
   3. Manufacturer's installation instructions.
   4. Operation and Maintenance Instructions: Submit complete operation and maintenance manuals

1.05 QUALITY ASSURANCE

A. Wafer Injection Mixer manufacturer shall have been engaged in producing mixers for a minimum of five (5) years. This experience shall consist of installations where equipment of same size and design has been in operation successfully in a similar process for a minimum of three (3) years.

B. Manufacturer of static mixer shall be Westfall or equal. Manufacturer of injection assembly shall be Safe-T-Flo or equal.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver static mixers as complete units for installation in the pipeline.

1.07 WARRANTY

1. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of substantial completion of the project.

PART 2 PRODUCTS

2.01 WAFER STYLE STATIC MIXERS

A. The wafer style injection mixer shall be of a compact ring body design for mounting between two standard pipe 150 lb flanges. The ring body shall be a minimum thickness of 2.875 inches and shall be fabricated from PVC. Ring type NSF-61 EPDM gaskets shall be furnished and adhered to both sides of the mixer body. The body shall include two (2) ¾" injection ports that will have PVC housing. The second injection port is a spare and shall have a leak proof PVC plug.

B. Mixer Plate
   1. PVC. The mixer plate shall be computer designed to provide a geometric shape which will create the mixing vortices to effectively mix the injected fluid with the main process fluid. The average variation in the process stream of the injected fluid, shall be within 5% of the mean value at 10 pipe diameters downstream of the mixer. The mixing plate shall be no less than 0.75 inches thick and shall be formed from PVC. The mixer plate shall be mounted in a machined cavity on the upstream side of the ring body.
   2. 316 Stainless Steel. The mixer plate shall be computer designed to provide a geometric shape which will create the mixing vortices to effectively mix the injected fluid with the main process fluid. The average variation in the process

stream of the injected fluid, shall be within 5% of the mean value at 10 pipe diameters downstream of the mixer. The mixing plate shall be no less than 0.375 inches thick and shall be formed from 316 Stainless Steel. The mixer plate shall be mounted in a machined cavity on the upstream side of the ring body.

C. Provide chemical injection assembly that consists of retractable injector rated at 150 psi. Provide ball valve and check valve, solution tube, tube adaptor, and packing nut in CPVC material and provide stainless steel restraining hook and limit chain. Provide 3/4" main male connection to injector body, 3/8" solution tube and 1/2" male inlet to assembly. Solution tube to be minimum 6 inches long.

PART 3 EXECUTION

END OF SECTION

SECTION 11240

CAUSTIC FEED SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Provide a complete caustic feed system for feeding a 25 percent caustic (sodium hydroxide) solution. System shall include all necessary accessories and appurtenances as shown on the drawings and specified herein. System shall include, but not be limited to:
   1. Bulk Storage Tank
   2. Large Bubble Compressed Air Mixing System (for Caustic Tank)
   3. Chemical Feed Skid with Metering Pumps and Piping and Appurtenances

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 13420 Instrumentation
   2. Section 13445 Supervisory Control & Data Acquisition (SCADA) System

1.03 SYSTEM DESCRIPTION

A. Feed system and tanks shall provide total system to store and feed to the following locations:
   a. Chemical Feed Vault Upstream of Storage Tank

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330 Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Bulk Storage Tank and Accessories
      b. Large Bubble Compressed Air Mixing System
      c. Metering Pumps
      d. Chemical Feed Skid with Metering Pumps
   2. Certification: Statement that the tank supplied is suitable for 25 percent and 50 percent caustic by weight storage. Tank and paint system materials shall be suitable for in-tank dilution of 50 percent caustic with water to 25 percent.
   3. Shop Drawings: Submit project specific shop drawings for the following:
      a. Bulk Storage Tank and Accessories
      b. Large Bubble Compressed Air Mixing System
      c. Metering Pumps
      d. Chemical Feed Skid with Metering Pumps
   4. Operation and Maintenance Manuals: Submit complete operation and maintenance manual for the total System, which shall include, but not be limited, to the following:
      a. Bulk Storage Tank and Accessories
      b. Large Bubble Compressed Air Mixing System
      c. Metering Pump
      d. Chemical Feed Skid with Metering Pumps
   5. Warranty: Submit all warranty documentation.

1.05 QUALITY CONTROL

A. For the purpose of establishing quality assurance, experience, and system reliability, the products described herein are based on the following manufactured products:
   1. Large Bubble Compressed Air Mixing System: Pulsed Hydraulics, or equal
   2. Chemical Feed Skid with Metering Pumps: ProMinent Fluid Controls, Pulsafeeder, or equal.

B. All pumps shall be shop-tested for capacity and pressure prior to shipment with documented results provided.

C. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.
   1. The system supplied in this specification shall be an integrated system supplied by one Chemical Feed System Supplier. The supplier shall have a minimum of 10 years of experience in supplying complete chemical feed system including all tanks, pumps, skids, fittings, and accessories to make the system complete and operational.
   2. These specifications cover the intended function of the equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. The Chemical Feed System Supplier shall supply all devices and appurtenances necessary to provide a complete, operable and satisfactory system as indicated or specified.
   3. The system specified herein is based on Prominent Fluid Controls. Being a named pump supplier does not relieve the manufacturer from meeting the technical requirements of this specification.

1.06 WARRANTY

A. Tank manufacturer shall warrant the tank to be free from defects in materials and workmanship and to be suitable for the application and chemical as specified in this section. Provide one-year warranty on storage tank.

B. The large bubble compressed air mixing system manufacturer shall guarantee the performance of the mixing system, and shall guarantee the equipment for a period for 18 months against defects in materials and workmanship and against problems attributable to ordinary wear under normal operation of the equipment.

C. The compressor equipment shall have a one (1) year guarantee against defects in materials and workmanship and against problems attributable to ordinary wear under normal operation of the equipment.

D. The air dryer equipment shall have a two (2) year guarantee against defects in materials and workmanship and against problems attributable to ordinary wear under normal operation of the equipment.

E. The chemical metering pump manufacturer shall provide a two-year warranty on the metering pump mechanical drive and one year on the liquid end. Provide one-year warranty on floor mounted pump skid.

PART 2 PRODUCTS

2.01 GENERAL

A. Products with surfaces intended to be in contact with the chemical shall be certified and listed in accordance with NSF 61 for potable drinking water.

2.02 BULK STORAGE TANK

A. System Description: Bulk caustic storage facilities shall have the following major components, operational capabilities, and capacities:
   1. Tank Construction:
      a. Number Required: 1
      b. Nominal Total Capacity: 6,500 gallon
      c. Tank shall be steel, single-wall construction, minimum steel plate thickness of 3/8" for sidewalls and top, minimum steel plate thickness of 1/2" for bottom, A-36 carbon steel
      d. Dimensions:
         1) Inside Diameter: 10 feet
         2) Height: 12 feet sidewall
      e. Maximum Service Temperature: 160 degrees Fahrenheit
      f. Bottom: Flat with tie-down lugs
      g. Top: Closed, dished with 24-inch diameter hinged man-way cover. 4-inch projection
      h. Fittings and Nozzles
         1) Manway: 24-inch diameter cover, flanged connection to tank roof, 4-inch projection
         2) Tank Fill Inlet: 3-inch, flanged connection to tank roof, Schedule 40 seamless pipe, 6-inch projection
         3) Tank Outlet: 3-inch, flanged connection to tank on sidewall 6-inches above bottom of tank, Schedule 40 seamless pipe, 6-inch projection with 90 degree elbow situated a minimum of 3/4" above tank floor
         4) Tank Overflow: 3-inch, flanged connection to tank on sidewall 6-inches below top of tank, Schedule 40 seamless pipe, 6-inch projection
         5) Tank Vent: 6-inch, flanged connection to tank roof, Schedule 40 seamless pipe, 6-inch projection
         6) Dilution Water Inlet: 2.5-inch, flanged connection to tank roof, Schedule 40 seamless pipe, 6-inch projection
         7) Air Line Fitting: Double ended 2-inch flanged connection for 6-inch projection to tank roof, Schedule 40 seamless pipe.
         8) Ultrasonic Level Indicator Fitting: 6-inch flanged connection, Schedule 40 seamless pipe, projection length shall be determined by Chemical Feed System Supplier suitable for proper functioning of Ultrasonic Level Indicator.
      i. Lifting Lugs: As required by manufacturer
      j. Interior Surface: Cleaned free of rust, slag, and other foreign matter
      k. Exterior Surface: Clean surface free of rust, slag, and other foreign matter. Near-white sandblasted and painted with one coat of Sherwin Williams Epophen 7.0-9.9 Mils Dry Film Thickness, Color - Gray
   2. Piping and Valves
      a. Provide the piping and valves as indicated on the drawings

B. General: Bulk storage tank shall be designed for the storage of liquid caustic at 50% (1.53 specific gravity) by weight concentration and designed for the heat of dilution to 25%. Tank shall be designed for a maximum service temperature of 160 degrees Fahrenheit. Tank shall be designed for indoor service. Design and fabrication shall be in accordance with the applicable section of API 650.

C. Tank Construction: The tank shall be welded steel tank of the capacity indicated. The steel plate shall be a minimum 3/8" thickness on all surfaces. All welds shall be

butt welds achieving full penetration. Provide stress relief at all welds and bends. The tank accessories shall be located as shown on the plans and indicated below.

D. Tank Accessories
   1. Ultrasonic Level Sensor:
      a. An ultrasonic level sensor shall be provided at the top of the chemical storage tank. Sensor shall be of the self-contained type, with 4-20 mA signal output proportional to the tank level. Sensor shall have a range of 1' to 20 ft. Sensor shall have a NEMA 4X PVC housing with 20 ft. of sensor cable.
      b. Full scale accuracy shall be better than 0.25% with no temperature gradient.
      c. Digital Indicator: Sensor shall display data on a local indicator of the digital LCD type. Indicator shall be housed in a NEMA 4X, UL listed enclosure. Indicator shall be menu driven and provide a 4-20 mA output signal for remote monitoring. Indicator shall have two adjustable set points for level alarms.
      d. Mounting: Sensor shall be mounted on the top of the bulk storage tank via a flange faced nozzle connection. Mount a minimum of 18 inches towards the center of the tank from any tank wall. Provide suitable non-metallic threaded NPT flanged coupler connection with PVC bolts/nuts and chemical resistant flange gasket for 50% caustic exposure.
   2. Lifting Lugs: Lifting lugs shall be of the number required and designed to permit safe handling of the empty tank.
   3. Tie Down: Tie downs shall be steel welded to the tank walls. A minimum of three required.
   4. Nozzles: Nozzles shall be of the size and location indicated. Installation shall maintain structure of tank and continuity of the corrosion barrier. Provide flanged faces drilled to connect to pipe service indicated on the drawing.
   5. Man-way: Man-way shall be of the location and size indicated, hinged and lipped to prevent water entry.
   6. Ladder: Provide a painted carbon steel access ladder in accordance with the latest OSHA recommendations as indicated on the drawings which is chemically compatible with caustic attached to the tank for access to the man-way hatch.
   7. Dilution Water Line: A two-inch Schedule 80 PVC dilution water line shall be provided. The dilution water line shall terminate flush with the top of the tank in the location shown on the drawings.
   8. Overflow: Bulk storage tank shall have an overflow fitted with a duckbill valve. Exterior overflow piping shall be a minimum of 3-inch diameter Schedule 80 PVC.

E. Pipe and Valving
   1. Valves:
      a. PVC ball valves shall be Schedule 80 PVC bodied with corrosion resistant assemblies, and shall be true union type with Teflon seats.
   2. Piping:
      a. Pipe penetration through the containment wall shall be sealed link-sealed and grouted with chemical resistant grout.
      b. Pipe material and size shall be as shown on the drawings.
      c. Schedule 80 PVC pipe joints shall be solvent welded with heavy duty PVC cement and cleaned and primed with purple primer. **Glue shall be IPS 724 or equivalent, rated for caustic service and shall not contain silica.**

Pipe and fittings shall be prepared and joined in accordance with manufacturer's requirements and ASTM D 2855.

d. Interior piping shall be installed by the tank manufacturer prior to shipment of the tank.

2.03 LARGE BUBBLE COMPRESSED AIR MIXING SYSTEM

A. General

1. The large bubble compressed air mixing system will be used to mix 50% caustic delivered to the water treatment plant with dilution water to produce a final 25% by weight solution caustic solution.
2. The large bubble compressed air mixing system shall be furnished by a single manufacturer who is fully experienced, reputable and qualified in manufacture of the equipment to be furnished. The air pulsing equipment and bubble forming plate shall be designed, constructed and installed in accordance with the best practices and methods and shall be as manufactured by Pulsed Hydraulics or approved equal.
3. The mixing system shall not include any components located in the tank that pivot, rotate, oscillate, or otherwise move to create the mixing action.

B. System Description

1. The large bubble compressed air mixing system shall be accomplished by injection of compressed air through a piping system to specifically located bubble forming plate anchored to the bottom of the caustic tank. A factory programmed controller operates the injection process
2. Compressed air is to be injected as a very short duration pulse or burst in order to form an air mass or bubble, which, as it rises to the surface, forms a complete mixing action within the tank. The injection valve shall be connected to the bubble forming plate.
3. The mixing system provided in this project shall consist of the air source, the air pulsing components, and the bubble forming plate.

C. Equipment

1. Air Pulsing Components
   a. The pulsing valve will be solenoid controlled and pilot air assisted. They shall be capable of achieving pulse durations (opening/closing cycles) at operator selectable settings between 20 milliseconds and 80 milliseconds at supply air pressures between 40 and 80 psig. Valves shall have a manifold base and a valve body made of anodized aluminum. They shall be positive sealing poppet valves designed to be self-compensating for war and non-lubed service.
   b. An air filter with a 50-micron element and an auto-drain shall be provided to remove particulates and water to protect the regulator and pulsing valves.
   c. A manually adjustable pressure regulator with pressure gauge shall provide constant pressure for proper air flow to the pulsing valve. It shall allow air pressure adjustment between 40 and 80 psig. The compressed air supplied to this regulator from the air source shall not exceed 125 psig.
   d. Components shall be pre-piped with stainless steel pipe and fittings and shall be tested for leaks and function. Pipe unions shall be provided to facilitate servicing of air components.
   e. A factory programmed controller shall be provided
   f. A NEMA 4X enclosure shall house the air pulsing components.
   g. The enclosure requires a 20 amp, 115 Volt, single phase, 60 Hz service.
2. Bubble Forming Plate

a. Bubble forming plate shall be constructed of 316 stainless steel. A bubble forming plate consists of two disks separated approximately ½ inch apart by internal spaces. Air is injected through a 1-inch NPT threaded nipple in the top disk to the space between the disks where it is forced laterally to form the air mixing air mass. Three 3/8-inch diameter, equally spaced pre-drilled holes are used for bolting the bubble forming plate to the tank bottom or to a ballast block when a physical connection to the tank bottom is not possible.

3. Compressed Air Piping
   a. Compressed air piping to the bubble forming plates shall be 1-inch and be rated for 175 psig. The pipes shall be made of 316 stainless steel. All the piping from the mixing valve controller to the bubble forming plate must be leak fee for proper mixing. Piping shall be tested by Contractor prior to filling the tank.
   b. Air delivery piping from the compressor to the mixing valve controller must be 1-inch inner diameter to the Mixing Valve Controller. Piping must be made of 316 stainless steel. Delivery piping must be leak free. Delivery piping to be tested for leaks prior to filling tank.
4. Air Compressor Module and Receiver
   a. Air compressor shall be a splash lubricated, two-stage, air cooled reciprocating compressor as manufactured by Gardner Denver, or equal.
   b. The compressor module shall be completely factory assembled requiring only field connection of electrical power and constructed of heavy duty cast iron.
   c. Compressor shall be rated for 7.5 HP and 23.1 CFM at 125 psig, 990 rpm. Compressor motor shall have electrical service of 460V/3Ph/60Hz.
   d. Compressor shall be fitted with an air inlet filter and silencer.
   e. Pump and motor shall be mounted on receiver.
   f. Air receiver shall be an 80-gallon vertical tank. The receiver shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp. The receiver shall include ASME safety relief valve rated for the capacity of the compressor.
5. Air Dryer
   a. The air dry shall be a high temp refrigerated type and shall produce a 50°F pressure dew point for dry air at the dryer exit when operating continuously at the design conditions as manufactured by Gardner Denver, or equal.
   b. The dryer shall be capable of continuously drying the maximum discharge capacity of the air compressor.
   c. The dryer shall be provided with moisture separator with no-air loss condensate drain with reliable pneumatic operation.
   d. The dryer shall be rated for 35 scfm at 125 psig. Inlet pressure shall be 100 psig and max working pressure rated at 250 psig.
   e. Electrical service shall be 115V/1Ph/60Hz and CSA Certified.

2.04 CHEMICAL METERING SKID

A. Chemical Feed Skid
   1. The chemical metering skid shall be floor mounted and include piping, electrical, valving, calibration tube, inlet piping manifold, three outlet discharge pipes (one for each pump), control panel functions for three metering pumps. However, only two metering pumps are to be installed on this project. A third metering pump may be installed at a later date for future finished water pH adjustment.

2. Number of pumps: 2 (one duty, one stand-by)
3. Chemical Service: Caustic (25%)
4. Type of Metering Pumps: Microprocessor-controlled, solenoid driven, reciprocating, diaphragm type.
5. Liquid Head: Standard
6. Adjustment range: 40,000:1
7. Voltage: 120 Volt with US plug
8. Maximum Feed Rate: 3.75 gph
9. Minimum Feed Rate: 0.33 gph
10. Maximum Pump Discharge Pressure: 58 psig
11. Maximum Pump Capacity Each: 6.5 gph
12. Maximum System Discharge Backpressure: 40 psig
13. Normal Operating Discharge Backpressure: 25 – 30 psig

B. General
1. Chemical metering pump shall be microprocessor controlled, solenoid driven, reciprocating, diaphragm type. The pump shall have a corrosion resistant housing with a minimum IP65 protection rating.
2. All pumping function shall be set by membrane switch keypad and click wheel sand status shall be displayed on an illuminated LCD. The keypad shall allow for simple scrolling and display of programmed parameter.
3. The pump shall be fully tested by the manufacturer prior to shipment to meet rated flow and pressure.
4. The power supply shall be 120VAC, 60 Hz, single phase. The microprocessor is to automatically compensate for supply voltage variations within 10% of the rated voltage such that the frequency of the pump remains constant.
5. The diaphragm shall be constructed of a solid core, vulcanized into nylon-reinforced EPDM, with a PTFE-faced fluid contact surface. The diaphragm shall have a convex design fitting into a concave liquid end to minimize dead volume and promote the flow of solids in suspension. The pump shall also have a diaphragm failure detector with a visible indicator of a diaphragm rupture. There shall also be an option for a fault indication or pump shut down in the case of a diaphragm rupture.
6. The liquid end shall be physically separated from the drive unit by a back plate with weep hole creating an air gap. An elastomer shaft wiper seal shall prevent contamination of the drive if the primary diaphragm fails.
7. The liquid end shall be 316 stainless steel as required by the application. Pumps liquid ends shall be NSF 61 Certified for use with standard water treatment chemicals. Pumps with 316 stainless steel liquid ends shall have suction and discharge valves made of 316 stainless steel with Teflon seals and stainless steel valve balls. Liquid end material selection shall be based on the best compatibility with 50% caustic.
8. Stroke length control shall be electronically adjustable by means of the click wheel, in increments of 1%, from 1% to 100% of stroke length. Stroke length shall be controlled by the pump solenoid without the use of mechanical stops and provide accurate feedback to the electronics of the pump for calibration for LCD display of stroke length.
9. Stroke frequency shall be adjustable via the click wheel and membrane switch keypad from 1 to 12,000 strokes per hour (0.0167 to 200 strokes per minute).
10. It shall be possible to selectively slow the discharge and/or the suction stroke speed of the pump to accommodate application requirements and process fluid viscosity and off-gassing conditions.

11. Provision shall be made to allow for input of chemical concentrations for simple adjustment with volume proportional metering applications.
12. Utilizing the electronic solenoid the pump shall monitor discharge pressure and adjust pump flow accordingly to compensate for changes in the downstream pressure of the system. In addition, the pump shall detect hydraulic defects such as over pressure, under pressure, vapor lock, loss of prime, etc. and facilitate alarm indication.
13. The system shall be equipped with an output relay which shall be programmable for any of the following indications:
    a. Fault Indication
    b. Fault Indication and pacing relay
    c. mA Output – The current output signal indicates the pump's actual calculated metering volume.
14. For simplified operator monitoring the pump shall be equipped with a three LED Display (Red, Yellow & Green) to locally indicate normal operation, fault conditions and warning conditions. The indicator lights shall be visible 360 degrees around the pump.
15. Operating Modes – The pump shall have the following operating modes available:
    a. Manual operating mode permitting the operation of the pump stroke and speed controls manually.
    b. Contact operating mode providing the option of controlling the pump externally by means of potential-free contacts (e.g. by means of contact water meter). The number of pump strokes per input contact can be scaled by a factor ranging from 0.01 to 99.99 to tailor the pump feed rate to the application.
    c. Bach operating mode providing the option of working with large factors (up to 99,999). Metering can be triggered either by pressing the Click wheel or by pulse received via the "External control" terminal or through a contact or a semiconductor switching element. It is possible to pre-select a metering volume (batch) or a number of strokes using the Click wheel in the Settings menu.
    d. Analog operating mode allows the capacity and/or stroke rate to be controlled via an analog (4-20mA) current signal the "External control" socket. The processing of the current signal can be preselected via the control unit.
    e. To facilitate easy pump installation, removal, service and replacement the pump unit shall have a removable mounting plate into which the pump positively locks.
    f. The chemical metering pumps shall be manufactured by ProMinent Fluid Controls, Pulsafeeder, or equal.

C. Control Panel
1. A control panel shall be provided to process inputs and outputs between the chemical feed pump and SCADA. Each panel shall interface and process signals from the pumps. The control panel shall provide control for the **three** metering pumps (two current and one future).
2. The metering pumps shall interface with the SCADA System through a control panel that will process all required inputs and outputs. Supplier of the metering pumps shall be responsible for design and fabrication of the panel, with fabrication performed in a UL 508A certified shop.

3. The panel shall consist of a NEMA 4X polycarbonate enclosure and will be powered by 120VAC, 1 phase, 60 Hz.
   a. Main circuit breaker, rated to 30A for triplex skid.
   b. Circuit breaker for each pump, rated to 20A.
4. The panel shall incorporate Hand-Off-Auto (HOA) selector switches for each pump.
5. The panel shall incorporate alarm indication lights (amber) for each pump.
6. The panel shall be configured with a P-16 Red Lion digital process controller, or equal, for each pump which will display stroking rate and analog output from the pump.
7. Miscellaneous terminals and relays shall be designed as required to operate the metering pump skid as described.
8. Inputs
   a. 4-20 mA analog speed command for each pump.
   b. Digital on/off run command for each pump.
9. Outputs
   a. Digital on/off run status for each pump.
   b. Digital on/off alarm status for each pump.
   c. Digital on/off "in-remote" status for control panel.
   d. 4-20 mA analog speed indication for each pump.
   e. 4-20 mA analog flow rate indication for chemical flow meter

D. Accessories To Be Included as Part of the Pumping System
1. The pumps shall be mounted on a black, UV-protected polypropylene/304 stainless support stand suitable for floor mounting. A single chemical metering pump manufacturer shall be responsible for supplying and assembling all components of the skid, in addition to testing the skid-mounted metering system prior to shipment. The stand shall be designed for **three** pumps (two current, one future). The stand shall include the following accessories, pre-piped;
2. Skid shall be properly sized and installable for the project, taking into account the size and location of entry doors, locations of equipment and other building features as shown on the drawings.
3. A Y-strainer, constructed of materials compatible with chemical to be used, shall be provided with each pump.
4. A universal control cable with 5-pole round plastic connector and 5-wire cable with loose ends shall be provided with each pump.
5. An adjustable discharge flow monitoring device, compatible with chemical to be used, shall be provided with each pump. The flow monitor shall be capable of signaling a fault condition to the pump.
6. A diaphragm failure detector shall be provided to ((open/close)) a contact for alarm in the event of a diaphragm failure.
7. An adjustable-pressure, diaphragm-type backpressure/anti-siphon valve, constructed of materials compatible with chemical to be used, shall be provided in each feed system discharge line.
8. An in-line, adjustable-pressure, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
9. An air-charged, bladder-type pulsation dampener, constructed with materials compatible with chemical to be used, shall be provided with each pump. The pulsation dampener shall be sized to reduce pulsations by at least 90% at full pump capacity.

10. A clear PVC calibration column with FNPT fitting on top and bottom shall be provided with each pump. The column shall be sized to provide at least 2 minutes draw down at maximum pump capacity.
11. Magnetic flow meter on pumping discharge line with local indicator-totalizer, power supply for meter and 4/20 mA output signal.
12. The metering system shall incorporate 4.5" liquid filled pressure gauges on each system discharge. Each gauge shall be protected by a glycerin filled gauge protector that is capable of operation from 0 to 160 psig. The casings of the gauge shall be phenolic and accuracy shall be 2% of better.
13. Chemical feed system design shall be such that the wetted end of the pump and pump controller interface are oriented at the open end of the framework for easy access. Systems designed with the wetted end of the pump or the metering pump control interface facing the vertical back wall or the side of the skid will not be accepted.

E. ACCESSORIES
1. Provide corporation stop and saddle with insert tube type in-line diffuser of PVC with built in check valve. The corporation stop shall be manufactured by Saf-T-Flo or equal.

F. PIPE AND VALVING
1. Pipe Insulation:
   a. Piping and valves located outside of a heated areas shall be insulated with 1-inch thickness of fiberglass insulation. The outside cover for the insulation shall be covered with an asphalt saturated weather-proof jacket for all weather protection.
   b. Piping and valve shall be wrapped with FPE heat tape, rated at 6 watts per foot. The tape used shall have an automatic, preset thermostat set at the factory. The tape shall be run parallel to the pipe with the thermostat being in contact with the pipe. Freeze protection shall be to -5 F ambient temperature.
2. Valves: Shall be PVC bodied with corrosion resistant assemblies. Ball valves shall be vented, true union type with teflon seats.
3. Piping: Suction and discharge piping shall be rigid Schedule 80 PVC. Joints shall be solvent welded with heavy duty PVC cement per Part 2.02 (F)(2)(c). of this specification. Pipe and fittings shall be prepared and joined in accordance with manufacturer's requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Handle and install all equipment and appurtenances in accordance with manufacturers written instructions.

B. Install tank and pipe fitting connections with flexible connections in accordance with manufacturer's requirements.

3.02 START UP SERVICES

A. The entire system shall be tested following installation using potable water prior to bulk chemical delivery.

B. Startup services shall include testing using potable water as well as the initial bulk delivery.

C. Owner shall coordinate chemical delivery for testing and initial startup of the system Notify Engineer in writing three (3) weeks prior to the date chemical shall be necessary for testing. Once chemical delivery is scheduled, Contractor shall reimburse Owner for costs incurred due to cancelled or rescheduled delivery.

D. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up and bulk chemical delivery, instruct Owner's personnel in proper operation and maintenance of equipment, and provide certificate of proper installation. A minimum of two trips to the site will be required, consisting of a minimum 8-hour working day per trip.

E. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one week of plant operation following initial bulk chemical delivery.

F. Submit copies of tests and checks performed in the field, complete with meter readings and recording, where applicable, to the Engineer.

END OF SECTION

SECTION 11242

CORROSION INHIBITOR FEED SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Provide a complete chemical system suitable for receiving, storing and feeding Carus 8500 (or similar) poly orthophosphate blend corrosion inhibitor. System shall include all necessary accessories and appurtenances as shown on the drawings and specified herein. System shall include, but not be limited to:
   1. Storage Tank and tank accessories
   2. Chemical Feed Skid with Metering Pumps with Piping and Appurtenances
   3. Piping, Valves, and associated devices.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 13420 Instrumentation
   2. Section 13445 Supervisory Control & Data Acquisition (SCADA) System

1.03 SYSTEM DESCRIPTION

A. Feed system and tanks shall provide total system to store and feed chemical to the following locations:
   1. Chemical Feed Vault Upstream of Storage Tanks

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330 Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Storage Tank and Accessories
      b. Chemical Feed Skid with Metering Pumps
   2. Certification: Statement that the tank supplied is suitable for corrosion inhibitor poly orthophosphate blend.
   3. Shop Drawings: Submit project specific shop drawings for the following:
      a. Storage Tank and Accessories
      b. Chemical Feed Skid with Metering Pumps
   4. Operation and Maintenance Manuals: Submit complete operation and maintenance manual for the total System, which shall include, but not be limited, to the following:
      a. Storage Tank and Accessories
      b. Chemical Feed Skid with Metering Pumps
   5. Warranty: Submit all warranty documentation.

1.05 QUALITY CONTROL

A. For the purpose of establishing quality assurance, experience, and system reliability, the products described herein are based on those metering pumps manufactured by ProMinent Fluid Controls, Inc, Pulsafeeder, Inc. or equal.

B. All pumps shall be shop-tested for capacity and pressure prior to shipment with documented results provided.

C. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.
   1. The system supplied in this specification shall be an integrated system supplied by one Chemical Feed System Supplier. The supplier shall have a minimum of 10 years of experience in supplying complete chemical feed system including all tanks, pumps, skids, fittings, and accessories to make the system complete and operational.
   2. These specifications cover the intended function of the equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. The Chemical Feed System Supplier shall supply all devices and appurtenances necessary to provide a complete, operable and satisfactory system as indicated or specified.

1.06 WARRANTY

A. The chemical metering pump manufacturer shall provide a two-year warranty on the metering pump mechanical drive and one year on the liquid end.

B. Tank manufacturer shall warrant the tank to be free from defects in materials and workmanship and to be suitable for the application and chemical as specified in this section. Warranty shall be for a period of five (5) years from the date of installation.

C. The system specified herein is based on Prominent Fluid Controls. Being a named pump supplier does not relieve the manufacturer from meeting the technical requirements of this specification.

PART 2 PRODUCTS

2.01 GENERAL

A. Products with surfaces intended to be in contact with the chemical shall be certified and listed in accordance with NSF 61 for potable drinking water.

2.02 STORAGE TANK

A. General: Bulk storage tank shall be designed for the storage of the chemical specified in this section.

B. Tank Construction:
   1. Number Required: 1
   2. Nominal Total Capacity: 5,000 gallons
   3. Tank shall be molded from Metallocene High Density Crosslinked Polyethylene. Resin used shall be Paxon 7004.
   4. Outer Diameter: 8 feet 6 inches
   5. Height: 12 feet 10 inches
   6. Tank interior shall have an anti-oxidant resistant LLDPE liner.
   7. Tank shall be constructed by the rotational molding process.
   8. Minimum wall thickness shall be 1/4-inch.
   9. Tank manufacturer shall have a minimum of five (5) years of experience in the manufacturing of high density cross linked polyethylene storage tanks for the specified chemical storage.
   10. Outlet:
      a. At base of tank (flooded suction)
      b. Flexible connection

11. Tank shall be manufactured by PolyProcessing Co., Snyder Industries Inc., Assmann Corp or equal.

C. Tank Accessories
   1. Ultrasonic Level Sensor:
      a. An ultrasonic level sensor shall be provided at the top of the chemical storage tank. Sensor shall be of the self-contained type, with 4-20 mA signal output proportional to the tank level. Sensor shall have a range of 1' to 20 ft. Sensor shall have a NEMA 4X PVC housing with 20 ft. of sensor cable.
      b. Full scale accuracy shall be better than 0.25% with no temperature gradient.
      c. Digital Indicator: Sensor shall display data on a local indicator of the digital LCD type. Indicator shall be housed in a NEMA 4X, UL listed enclosure. Indicator shall be menu driven and provide a 4-20 mA output signal for remote monitoring. Indicator shall have two adjustable set points for level alarms.
      d. Mounting: Sensor shall be mounted on the top of the bulk storage tank via a flange faced nozzle connection. Mount a minimum of 18 inches towards the center of the tank from any tank wall. Provide suitable non-metallic threaded NPT flanged coupler connection with PVC bolts/nuts and chemical resistant flange gasket for corrosion inhibitor (30% phosphate) exposure.
   2. Lifting Lugs: Lifting lugs shall be of the number required and designed to permit safe handling of the empty tank.
   3. Nozzles: Nozzles shall be of the size and location indicated. Installation shall maintain structure of tank and continuity of the corrosion barrier. Provide flanged faces drilled to connect to pipe service indicated on the drawing. Nozzles 4-inches and larger shall be conically gussetted for strength.
   4. Pipe Supports: Pipe supports shall be provided for vertically mounted pipe. Numbers as required to prevent stress at tank connection and vibration of the pipe. A minimum of two supports shall be required for each pipe installation. Pipe supports shall be independent of the tank.
   5. Vent: Provide a vent location and size indicated. Installation shall be similar to the nozzles.
   6. Drain: Drain shall be designed to completely drain the tank contents and shall be integrally molded flanged outlet.
   7. Contractor shall provide precautionary labeling attached to tank as recommended by the Manufacturing Chemists Association for the chemical to be stored.

2.03 METERING PUMP

A. Application
   1. Quantity: Two (2)
   2. Chemical Service: Carus 8500 (or similar) 50:50 Poly Orthophosphate Blend
   3. Type of Metering Pumps: Microprocessor-controlled, solenoid driven, reciprocating, diaphragm type
   4. Liquid Head: Standard
   5. Adjustment Range: 40,000:1
   6. Voltage: 120 Volt with US Plug
   7. Maximum Feed Rate: 1.75 gph
   8. Minimum Feed Rate: 0.022 gph

9. Maximum Pump Discharge Pressure: 60 psig
10. Maximum Pump Capacity Each: 2.0 gph
11. Maximum System Discharge Backpressure: 40 psig
12. Normal Operating Discharge Backpressure: 25 – 30 psig

B. Manufacturers:
1. ProMinent Fluid Controls, Inc.
2. Pulsafeeder
3. Or equal

C. General
1. The chemical metering pumps shall be microprocessor-controlled, solenoid driven, reciprocating, diaphragm type. The pump shall have a corrosion resistant housing with a minimum IP65 protection rating.
2. All pumping functions shall be set by membrane switch keypad and click wheel and status shall be displayed on an illuminated LCD. The keypad shall allow for simple scrolling and display of programmed parameters.
3. The pump shall be fully tested by the manufacturer prior to shipment to meet rated flow and pressure.
4. The power supply shall be 120 VAC, 60 Hz, single phase. The microprocessor is to automatically compensate for supply voltage variations within 15% of the rated voltage such that the frequency of the pump remains constant.
5. The diaphragm shall be constructed of a solid core, vulcanized into nylon-reinforced EPDM, with a PTFE-faced fluid contact surface. The diaphragm shall have a convex design fitting into a concave liquid end to minimize dead volume and promote the flow of solids in suspension. The pump shall also have a diaphragm failure detector with a visible indicator of a diaphragm rupture. There shall also be an option for a fault indication or pump shut down in the case of a diaphragm rupture.
6. The liquid end shall be physically separated from the drive unit by a back plate with weep hole creating an air gap. An elastomer shaft wiper seal shall prevent contamination of the drive if the primary diaphragm fails.
7. The liquid end shall be either virgin PVDF or 316 stainless steel as required by the application. Pumps with PVDF liquid ends shall be NSF 61 Certified for use with standard water treatment chemicals. Pumps with 316 stainless steel liquid ends shall have suction and discharge valves made of 316 stainless steel with Teflon seals and stainless steel valve balls. Liquid end material selection shall be based on the best compatibility with the chemical application.
8. Stroke length control shall be electronically adjustable by means of the click wheel, in increments of 1%, from 1% to 100% of stroke length. Stroke length shall be controlled by the pump solenoid without the use of mechanical stops and provide accurate feedback to the electronics of the pump for calibration for LCD display of stroke length.
9. Stroke frequency shall be adjustable via the click wheel and membrane switch keypad from 1 to 12,000 strokes per hour (0.0167 to 200 strokes per minute).
10. It shall be possible to selectively slow the discharge and/or the suction stroke speed of the pump to accommodate application requirements and process fluid viscosity and off-gassing conditions.
11. Provision shall be made to allow for input of chemical concentrations for simple adjustment with volume proportional metering applications.
12. Utilizing the electronic solenoid, the pump shall monitor discharge pressure and adjust pump flow accordingly to compensate for changes in the downstream pressure of the system. In addition, the pump shall detect hydraulic defects

such as over pressure, under pressure, vapor lock, loss of prime, etc. and facilitate alarm indication.

13. The system shall be equipped with an output relay which shall be programmable for any of the following indications:
    a. Fault indication
    b. Fault indication and pacing relay
    c. mA Output – The current output signal indicates the pump's actual calculated metering volume.
14. For simplified operator monitoring the pump shall be equipped with a three LED Display (Red, Yellow & Green) to locally indicate normal operation, fault conditions and warning conditions. The indicator lights shall be visible 360 degrees around the pump.
15. Operating Modes – The pump shall have the following operating modes available:
    a. Manual operating mode permitting the operation of the pump stroke and speed controls manually.
    b. Contact operating mode providing the option of controlling the pump externally by means of potential-free contacts (e.g. by means of a contact water meter). The number of pump strokes per input contact can be scaled by a factor ranging from 0.01 to 99.99 to tailor the pump feed rate to the application.
    c. Batch operating mode providing the option of working with large factors (up to 99,999). Metering can be triggered either by pressing the Click wheel or by a pulse received via the "External control" terminal or through a contact or semiconductor switching element. It is possible to pre-select a metering volume (batch) or a number of strokes using the Click wheel in the settings menu.
    d. Analog operating mode allows the capacity and/or stroke rate to be controlled via an analog (4-20 mA) current signal via the "External control" socket. The processing of the current signal can be preselected via the control unit.
16. To facilitate easy pump installation, removal, service and replacement the pump unit shall have a removable mounting plate into which the pump positively locks.
17. The chemical metering pumps shall be manufactured by ProMinent Fluid Controls, Pulsafeeder, or equal.

D. Control Panel
    1. A control panel shall be provided to process inputs and outputs between the chemical feed pump and SCADA. Each panel shall interface and process signals from the pumps.
    2. The metering pumps shall interface with the SCADA System through a control panel that will process all required inputs and outputs. Supplier of the metering pumps shall be responsible for design and fabrication of the panel, with fabrication performed in a UL 508A certified shop.
    3. The panel shall consist of a NEMA 4X polycarbonate enclosure and will be powered by 120VAC, 1 phase, 60 Hz.
        a. Main circuit breaker, rated to 20A for duplex skid.
        b. Circuit breaker for each pump, rated to 15A.
    4. The panel shall incorporate Hand-Off-Auto (HOA) selector switches for each pump.
    5. The panel shall incorporate alarm indication lights (amber) for each pump.

6. The panel shall be configured with a P-16 Red Lion digital process controller, or equal, for each pump which will display stroking rate and analog output from the pump.
7. Miscellaneous terminals and relays shall be designed as required to operate the metering pump skid as described.
8. Inputs
   a. 4-20 mA analog speed command for each pump.
   b. Digital on/off run command for each pump.
9. Outputs
   a. Digital on/off run status for each pump.
   b. Digital on/off alarm status for each pump.
   c. Digital on/off "in-remote" status for control panel.
   d. 4-20 mA analog speed indication for each pump.
   e. 4-20 mA analog flow rate indication for chemical flow meter

E. Accessories To Be Included as Part of the Pumping System
1. The pumps shall be mounted on a black, UV-protected/olypropylene/304 stainless skid suitable for floor mounting. A single chemical metering pump manufacturer shall be responsible for supplying and assembling all components of the skid, in addition to testing the skid-mounted metering system prior to shipment. The stand shall include the following accessories, pre-piped:
2. Skid shall be properly sized and installable for the project, taking into account the size and location of entry doors, locations of equipment and other building features as shown on the drawings.
3. A Y-strainer, constructed of materials compatible with chemical to be used, shall be provided with each feed system.
4. An injection valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
5. A universal control cable with 5-pole round plastic connector and 5-wire cable with loose ends shall be provided with each pump.
6. An adjustable discharge flow monitoring device, compatible with chemical to be used, shall be provided with each pump. The flow monitor shall be capable of signaling a fault condition to the pump.
7. A diaphragm failure detector shall be provided to ((open/close)) a contact for alarm in the event of a diaphragm failure.
8. An adjustable-pressure, diaphragm-type back pressure/anti-siphon valve, constructed of materials compatible with chemical to be used, shall be provided in each feed system discharge line.
9. An in-line, adjustable-pressure, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
10. An air-charged, bladder-type pulsation dampener, constructed with materials compatible with chemical to be used, shall be provided with each pump. The pulsation dampener shall be sized to reduce pulsations by at least 90% at full pump capacity.
11. Magnetic flow meter on pumping discharge line with local indicator-totalizer, power supply for meter and 4/20 mA output signal.
12. A clear PVC calibration column with FNPT fitting on top and bottom shall be provided with each pump. The column shall be sized to provide at least 2 minutes draw down at maximum pump capacity.
13. The metering system shall incorporate 4.5" liquid filled pressure gauges on each system discharge. Each gauge shall be protected by a glycerin filled

gauge protector that is capable of operation from 0 to 160 psig. The casings of the gauge shall be phenolic and accuracy shall be 2% or better.

14. Chemical feed system design shall be such that the wetted end of the pump and pump controller interface are oriented at the open end of the framework for easy access.

2.04 ACCESSORIES

A. Provide corporation stops and saddle with insert tube type in-line diffuser of PVC with built in check valve. The corporation stop shall be manufactured by Saf-T-Flo or equal.

2.05 PIPE AND VALVING

A. Pipe Insulation:
   1. Piping and valves located outside of a heated area shall be insulated with 1-inch thickness of fiberglass insulation. The outside cover for the insulation shall be covered with an asphalt saturated weather-proof jacket for all weather protection.
   2. Piping and valve shall be wrapped with FPE heat tape, rated at 6 watts per foot. The tape used shall have an automatic, preset thermostat set at the factory. The tape shall be run parallel to the pipe with the thermostat being in contact with the pipe. Freeze protection shall be to -5 F ambient temperature.

B. Valves: Shall be PVC bodied with corrosion resistant assemblies. Ball valves shall be true union type with teflon seats.

C. Piping: Suction and discharge piping shall be rigid Schedule 80 PVC. Joints shall be solvent welded with heavy duty PVC cement and cleaned and primed with purple primer. Pipe and fittings shall be prepared and joined in accordance with manufacturer's requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Handle and install all equipment and appurtenances in accordance with manufacturers written instructions.

B. Install tank and pipe fitting connections with flexible connections in accordance with manufacturer's requirements.

3.02 FIELD TESTING

A. Tank and connecting piping shall be tested by filling with water. Tank and fittings shall hold water without loss or evidence of weeping for a period of 24 hours prior to acceptance.

B. Clean and dry tank after testing.

3.03 START UP SERVICES

A. Owner shall provide chemical for testing and initial start up of the system. Notify Engineer in writing two (2) weeks prior to the date chemical shall be necessary for testing.

B. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of two trips to the site will be required,

consisting of a minimum of five (5) days. One additional trip will be provided 6-9 months after start-up, at the Owner's discretion, for system check and additional operator training consisting of one day.

C. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) week of operation.

D. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

END OF SECTION

SECTION 11243

HYDROFLUOROSILICIC ACID FEED SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Provide a complete chemical system suitable for receiving, storing, storing and feeding hydrofluorosilicic acid (HFS). System shall include all necessary accessories and appurtenances as shown on the drawings and specified herein. System shall include, but not be limited to:
   1. Storage Tank and tank accessories.
   2. Chemical Day Tank and tank accessories
   3. Chemical Transfer Pump and associated piping
   4. Chemical Metering Pumps
   5. Chemical Feed Skid with Metering Pumps and Piping and Appurtenances

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 13420 Instrumentation
   2. Section 13445 Supervisory Control & Data Acquisition (SCADA) System
   3. Section 13602 Fiberglass Reinforced Plastic Building

1.03 SYSTEM DESCRIPTION

A. Metering pumps and tank shall provide total system to store and feed chemical to the following locations:
   1. Chemical Feed Vault Upstream of Storage Tank

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330 Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Storage Tank
      b. Chemical Day Tank
      c. Chemical Transfer Pump
      d. Chemical Feed Skid with Metering Pumps
   2. Certification: Statement that the tank and chemical metering pumps supplied is suitable for storing and pumping hydrofluorosilicic acid, 25% H_2SiF_6 by weight.
   3. Shop Drawings: Submit project specific shop drawings for the following:
      a. Storage Tank
      b. Chemical Day Tank
      c. Chemical Transfer Pump
      d. Chemical Feed Skid with Metering Pumps
   4. Operation and Maintenance Manuals: Submit complete operation and maintenance manual for the complete, which shall include, but not be limited, to the following:
      a. Storage Tank
      b. Chemical Day Tank
      c. Chemical Transfer Pump
      d. Chemical Feed Skid with Metering Pumps

5. Warranty: Submit all warranty documentation.

1.05 QUALITY CONTROL

A. For the purpose of establishing quality assurance, experience, and system reliability, the products described herein are based on those metering pumps manufactured by ProMinent Fluid Controls, Inc., Pulsafeeder, Inc., or equal.

B. All pumps shall be shop-tested for capacity and pressure prior to shipment with documented results provided.

C. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.
   1. The system supplied in this specification shall be an integrated system supplied by one Chemical Feed System Supplier. The supplier shall have a minimum of 10 years of experience in supplying complete chemical feed system including all tanks, pumps, skids, fittings, and accessories to make the system complete and operational.
   2. These specifications cover the intended function of the equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. The Chemical Feed System Supplier shall supply all devices and appurtenances necessary to provide a complete, operable and satisfactory system as indicated or specified.
   3. The system specified herein is based on Prominent Fluid Controls. Being a named pump supplier does not relieve the manufacturer from meeting the technical requirements of this specification.

1.06 WARRANTY

A. The chemical metering pump manufacturer shall provide a two-year warranty on the metering pump mechanical drive and one year on the liquid end.

B. Tank manufacturer shall warrant the tank to be free from defects in materials and workmanship and to be suitable for the application and chemical as specified in this section. Warranty shall be for a period of five (5) years from the date of installation.

C. The chemical transfer pump manufacturer shall provide a two-year warranty on all materials and workmanship

PART 2 PRODUCTS

2.01 GENERAL

A. Products with surfaces intended to be in contact with the chemical shall be certified and listed in accordance with NSF 61 for potable drinking water.

2.02 STORAGE TANK

A. General: Bulk storage tank shall be designed for the storage of the chemical specified in this section.

B. Tank Construction:
   1. Number Required: 1
   2. Nominal Total Capacity: 405 gallons
   3. Outer Diameter: 4 feet 0 inches
   4. Height: 5 feet 9 inches
   5. Tank interior shall have an anti-oxidant resistant coating.
   6. Tank shall be constructed by the rotational molding process.

7. Minimum wall thickness shall be 1/8 to 1/4-inch.
8. Tank shall be rotationally-molded, high density cross-linked polyethylene (XLPE), double walled, and flat bottom designed for secondary containment.
9. Tank manufacturer shall have a minimum of five (5) years of experience in the manufacturing of high density cross-linked polyethylene storage tanks for the specified chemical storage.
10. Tank assembly shall consist of one cylindrical, inner primary tank and one cylindrical, secondary containment outer tank (double wall tank). Tank top shall be integrally molded and cover both the inner and outer tanks. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories.
11. High density cross-linked polyethylene resin used in the tank manufacture shall be Poly CL, Exxon Paxon 7000 XL, or Schulink XL 350.
12. Outlet:
    a. At base of tank (flooded suction)
    b. Flexible connection
13. Tank shall be manufactured by PolyProcessing Co., Snyder Industries Inc., Assmann Corp or equal.

C. Tank Accessories
1. Ultrasonic Level Sensor:
    a. An ultrasonic level sensor shall be provided at the top of the chemical storage tank. Sensor shall be of the self-contained type, with 4-20 mA signal output proportional to the tank level. Sensor shall have a range of 1' to 20 ft. Sensor shall have a NEMA 4X PVC housing with 20 ft. of sensor cable.
    b. Full scale accuracy shall be better than 0.25% with no temperature gradient.
    c. Digital Indicator: Sensor shall display data on a local indicator of the digital LCD type. Indicator shall be housed in a NEMA 4X, UL listed enclosure. Indicator shall be menu driven and provide a 4-20 mA output signal for remote monitoring. Indicator shall have two adjustable set points for level alarms.
    d. Mounting: Sensor shall be mounted on the top of the bulk storage tank via a flange faced nozzle connection. Mount a minimum of 18 inches towards the center of the tank from any tank wall. Provide suitable non-metallic threaded NPT flanged coupler connection with PVC bolts/nuts and chemical resistant flange gasket for HFS exposure.
2. Lifting Lugs: Lifting lugs shall be of the number required and designed to permit safe handling of the empty tank.
3. Nozzles: Nozzles shall be of the size and location indicated. Installation shall maintain structure of tank and continuity of the corrosion barrier. Provide flanged faces drilled to connect to pipe service indicated on the drawing. All nozzle materials shall be compatible with Hydrofluorosilicic Acid.
4. Pipe Supports: Pipe supports shall be provided for vertically mounted pipe. Numbers as required to prevent stress at tank connection and vibration of the pipe. A minimum of two supports shall be required for each pipe installation. Pipe supports shall be independent of the tank and shall be chemically resistant to Hydrofluorosilicic Acid.
5. Vent: Provide a vent location and size indicated. Installation shall be similar to the nozzles.

6. Drain: Drain shall be designed to completely drain the tank contents or shall have a siphon pipe on the bottom drain fitting.
7. Contractor shall provide precautionary labeling attached to tank as recommended by the Manufacturing Chemists Association for the chemical to be stored.

2.03 CHEMICAL DAY TANK

A. General: Chemical day tank shall be designed for the storage of the chemical specified in this section.

B. Tank Construction:
1. Number Required: 1
2. Nominal (minimum) Total Capacity: 105 gallons (Snyder 120 gallon, Assmann has 120 gallon)
3. Maximum Outer Diameter: 36 inches
4. Tank interior shall have an anti-oxidant resistant coating.
5. Minimum wall thickness shall be 1/8 to 1/4-inch.
6. Tank shall be rotationally-molded, high density cross-linked polyethylene (XLPE) double walled, and flat bottom designed for secondary containment.
7. Tank manufacturer shall have a minimum of five (5) years of experience in the manufacturing of high density cross-linked polyethylene storage tanks for the specified chemical storage.
8. Tank assembly shall consist of one cylindrical, inner primary tank and one cylindrical, secondary containment outer tank (double wall tank). Tank top shall fit and cover both the inner and outer tanks. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories.
9. High density cross-linked polyethylene resin used in the tank manufacture shall be Poly CL, Exxon Paxon 7000 XL, or Schulink XL 350.
10. Outlet:
    a. At base of tank (flooded suction)
    b. Flexible connection
11. Tank shall be manufactured by PolyProcessing Co., Snyder Industries Inc., Assmann Corp or equal.

C. Tank Accessories
1. Lifting Lugs: Lifting lugs shall be of the number required and designed to permit safe handling of the empty tank.
2. Nozzles: Nozzles shall be of the size and location indicated. Installation shall maintain structure of tank and continuity of the corrosion barrier. Provide flanged faces drilled to connect to pipe service indicated on the drawing. All nozzle materials shall be compatible with Hydrofluorosilicic Acid.
3. Pipe Supports: Pipe supports shall be provided for vertically mounted pipe. Numbers as required to prevent stress at tank connection and vibration of the pipe. A minimum of two supports shall be required for each pipe installation. Pipe supports shall be independent of the tank and shall be chemically resistant to Hydrofluorosilicic Acid.
4. Vent: Provide a vent location and size indicated. Installation shall be similar to the nozzles.
5. Drain: Drain shall be designed to completely drain the tank contents or shall have a siphon pipe on the bottom drain fitting.
6. Contractor shall provide precautionary labeling attached to tank as recommended by the Manufacturing Chemists Association for the chemical to be stored.

2.04 CHEMICAL TRANSFER PUMP

A. Description. The Chemical Transfer Pump shall be used to transfer Hydrofluorosilicic Acid from the storage tank to the chemical day tank.

B. Application
   1. Quantity: One (1)
   2. Chemical Service: Hydrofluorosilicic Acid, 25% as H_2SiF_6
   3. Type of Metering Pumps: centrifugal type, magnetic drive close-coupled pump.
   4. Suction & Discharge: 1.5" x 1.5"
   5. Pumping Rate: up to 55 gpm
   6. Pump Discharge Pressure: 5 psig
   7. Motor size: 0.75 HP @ 60 Hz
   8. Voltage: 3 phase 208 Volt

C. Manufacturers:
   1. Iwaki America Model MX-F 400 CFV X
   2. Or equal.

D. General
   1. All pump materials in contact with the pumped fluid shall be compatible/resistant to the listed chemical service above.
   2. Pumps shall be non-metallic magnetic drive type, closed impeller design, Male NPT suction and discharge connections (flanged as option), close-coupled design with patented impeller mounting system and non-contact bearing/magnet system, or approved equal.
   3. Pumps shall be overhung design with close-coupled drivers.
   4. Pumps, drivers and accessories shall be suitable for continuous operation at the specified operating conditions, and at flows ranging from the specified minimum flow to end-of-curve conditions.
   5. Pumps shall comply with the latest editions of the following codes and standards as specified herein: Hydraulic Institute Standards, National Electric Code (NEC), OSHA Rules and Regulations.
   6. Shop Tests:
      a. All pressure casings shall be hydrostatically tested to manufacturer's standards.
      b. All pumps shall be given manufacturer's standard performance test.
      c. Performance tests shall be conducted according to Hydraulic Institute Standards, level B acceptance criteria. Certified test reports shall be provided to the Engineer.

E. Casing
   1. Front casings shall be single piece, injection molded designs with male NPT suction and discharge connections and will utilize an o-ring for sealing between pump casing and containment shell. Front casing shall include integrally molded front shaft support with three individual support members. Support members shall have rounded edges and circular shape for maximum strength and minimum resistance to inlet flow. Front casings form two-piece molded volute casing in conjunction with containment shell to maximize hydraulic efficiency. Pump pressure casings shall be designed for specified casing design pressures, temperatures and hydrostatic test pressures. Pressure casings include front casing and rear casings. Front casings shall have options for threaded o-ring sealed flanges. Front and rear casings shall be CFRETFE material and o-ring shall be FKM (viton).

2. Casing bolts and hardware to be 304 SS.

F. Impellers
   1. Impellers shall be closed and include provisions for replaceable front, axial thrust rings. Impeller shall be splined and/or pinned to inner magnet assembly allowing for individual replacement of impeller, inner magnet or driven magnet assembly.

G. Bearings
   1. The bearing shall be a one-piece design press fit into driven or inner magnet. The outside diameter of the bearing shall have an anti-rotation shape. The inside diameter of the bearing shall have rifled lubrication/flush grooves. Bearing material shall be high density carbon and shall be compatible with chemical service fluid(s) being pumped.
   2. The front thrust bearing system shall consist of a two-collar design with a replaceable axial thrust surface located on the impeller. The thrust collars shall be positioned on the adjoining mounting surfaces of the impeller and casing cover. Inboard thrust bearing material shall be PTFE, or approved equal, outboard thrust collar material shall be high purity Alumina Ceramic, or approved equal.
   3. The rear thrust bearing system shall consist of a one-piece design with a replaceable axial thrust collar. The thrust collar shall be positioned on the containment shell adjoining the magnet capsule bearing. Rear thrust bearing material shall be CFRETFE or approved equal.

H. Driven Magnet
   1. The driven magnet shall be fully encapsulated with CFRETFE as specified. The bore of the inner magnet shall have an anti-rotation/positioning flat that corresponds to the shape of the press fit radial bearing. The driven magnet shall accept splinned and/or pinned impeller. The driven magnet shall have two heat dispersion holes to aid internal cooling during adverse pump operation. Magnet material shall be encapsulated Ferrite or Neodymium.

I. Drive Magnet
   1. The drive or outer magnet shall be dynamically balanced and be capable of mounting directly to standard NEMA motors. Magnet material shall be Ferrite or Neodymium.

J. Pump Motor
   1. Motor shall be 3/4HP, 3-phase, 208V, 60Hz, IP55, 3600 rpm, TEFC, MTR5010 Motor

K. Pump Base
   1. Pump base shall be polypropylene.

L. Pump Control Panel/Switch
   1. The pump shall be operated manually by the system operator via a push button ON/OFF switch on the face of the panel. The pump push button shall be depressed 2 to 3 minutes to fill the chemical day tank. When manually depressed the spring loaded ON switch shall operate the pump as long as the switch continues to be pressed manually. The switch shall automatically return to OFF by the spring when the button is released.
   2. Supplier of the chemical transfer pump shall be responsible for design and fabrication of the switch, with fabrication performed in a UL 508A certified shop.
   3. Pump starter shall be in the panel.

4. The pump panel shall consist of a NEMA 4X FRP enclosure and will be powered by 208V, 3 phase, 60 Hz.
   a. Main circuit breaker, rated to 40A.
5. Inputs
   a. None.
6. Outputs
   a. None.

2.05 ELECTRONIC SCALE

A. General: Scale to be the electronic load cell type and measure the weight of Chemical Day Tank and tank contents and display the weight on a digital display mounted on the outside wall of the fluoride building as shown on the Drawings.

B. Application
   1. Quantity: One (1) electronic scale with platform, load cell, cable, and indicator.
   2. Chemical service: Hydrofluorosilicic Acid, 25% as H_2SiF_6
   3. Item to be weighed: Stationary Day Tank with liquid chemical.

C. Manufacturers
   1. Force Flow (Concord, CA) CHEM-SCALE® Model 40-DR 20 LP and Solo G2 Model SRG2-1.
   2. Or equal.

D. Scale
   1. The scale of shall have a 2,000 lbs. weigh capacity and a 40" x 40" scale platform size to accept a 36-inch diameter tank. Four (4) adjustable hold down lugs shall secure the vessel to the platform. Platform scale coating shall be a minimum dry thickness of 80 mils and be resistant to moisture, chemicals, abrasion, impact and UV light (TUF-COAT™ Environmental Armor or equal). Full scale accuracy shall be ¼ of 1%. Flexible cable shall connect the load cell to the indicator to allow easy remote installation of the readout. A cable length of 20 feet shall be supplied. Load cell cable shall have chemical resistant jacketing suitable for the chemical service.
   2. Indicator shall monitor 1 channel. The remote mounted LCD indicator shall carry CE marking and shall be housed in a NEMA 4X, UL approved enclosure. All operations shall be keypad operated and menu driven to avoid compromising the NEMA 4X seal. The alphanumeric LCD readout shall have backlighting for readability in low light conditions. Power requirement shall be 120 VAC. Indicator shall have minimum display increments of 0.1 pounds.
   3. A 6-digit numerical display shall give operator the ability to monitor chemical by weight (lb or kg) or volume (gallons or liters). A bar graph display shall read 0-100% for the net contents. A dual mode TARE key shall allow user to enter the tare weight of the vessel or enter the net weight of the chemical depending on application needs. A diagnostics menu shall allow recalibration without the need to apply field test weights. A user adjustable filter function shall stabilize display in the event of vibration from pumps or mixers in the immediate vicinity of the scale.
   4. Indicator shall output net weight via a 4-20mA signal and full-scale output shall be user adjustable via the keypad. Indicator shall have four adjustable set points to display low or high weight or volume conditions on the indicator. Set points shall activate up to two ½ Amp dry contact relay (high and low).
   5. Indicator shall be suitable for outdoor mounting on the outside wall of the fluoride building and shall be mounted in accordance with manufacturer's

instructions. A sun shield shall be provided for the indicator such that the display can be read at all times.

6. Scale shall carry a Full Five (5) Year Factory Warranty

2.06 METERING PUMPS

A. Application
   1. Quantity: Two (2)
   2. Chemical Service: Hydrofluorosilicic Acid, 25% as H_2SiF_6
   3. Type of Metering Pumps: Microprocessor-controlled, solenoid driven, reciprocating, diaphragm type
   4. Liquid End: Auto-Degassing suitable for chemical application
   5. Adjustment Range: 40,000:1
   6. Voltage: 120 Volt with US Plug
   7. Maximum Feed Rate: 0.52 gph
   8. Minimum Feed Rate: 0.17 gph
   9. Maximum Pump Discharge Pressure: 101 psig
   10. Maximum Pump Capacity Each: 1.5 gph
   11. Maximum System Discharge Backpressure: 40 psig
   12. Normal Operating Discharge Backpressure: 25 – 30 psig

B. Manufacturers:
   1. ProMinent Fluid Controls, Inc.
   2. Pulsafeeder
   3. Or equal.

C. General
   1. The chemical metering pumps shall be microprocessor-controlled, solenoid driven, reciprocating, diaphragm type. The pump shall have a corrosion resistant housing with a minimum IP65 protection rating.
   2. All pumping functions shall be set by membrane switch keypad and click wheel and status shall be displayed on an illuminated LCD. The keypad shall allow for simple scrolling and display of programmed parameters.
   3. The pump shall be fully tested by the manufacturer prior to shipment to meet rated flow and pressure.
   4. The power supply shall be 120 VAC, 60 Hz, single phase. The microprocessor is to automatically compensate for supply voltage variations within 15% of the rated voltage such that the frequency of the pump remains constant.
   5. The diaphragm shall be constructed of a solid core, vulcanized into nylon-reinforced EPDM, with a PTFE-faced fluid contact surface. The diaphragm shall have a convex design fitting into a concave liquid end to minimize dead volume and promote the flow of solids in suspension. The pump shall also have a diaphragm failure detector with a visible indicator of a diaphragm rupture. There shall also be an option for a fault indication or pump shut down in the case of a diaphragm rupture.
   6. The liquid end shall be physically separated from the drive unit by a back plate with weep hole creating an air gap. An elastomer shaft wiper seal shall prevent contamination of the drive if the primary diaphragm fails.
   7. The liquid end shall virgin PVDF. Pumps with PVDF liquid ends shall be NSF 61 Certified for use with standard water treatment chemicals. Liquid end material selection shall be based on the best compatibility with the chemical application.

8. Stroke length control shall be electronically adjustable by means of the click wheel, in increments of 1%, from 1% to 100% of stroke length. Stroke length shall be controlled by the pump solenoid without the use of mechanical stops and provide accurate feedback to the electronics of the pump for calibration for LCD display of stroke length.
9. Stroke frequency shall be adjustable via the click wheel and membrane switch keypad from 1 to 12,000 strokes per hour (0.0167 to 200 strokes per minute).
10. It shall be possible to selectively slow the discharge and/or the suction stroke speed of the pump to accommodate application requirements and process fluid viscosity and off-gassing conditions.
11. Provision shall be made to allow for input of chemical concentrations for simple adjustment with volume proportional metering applications.
12. Utilizing the electronic solenoid, the pump shall monitor discharge pressure and adjust pump flow accordingly to compensate for changes in the downstream pressure of the system. In addition, the pump shall detect hydraulic defects such as over pressure, under pressure, vapor lock, loss of prime, etc. and facilitate alarm indication.
13. The system shall be equipped with an output relay which shall be programmable for any of the following indications:
    a. Fault indication
    b. Fault indication and pacing relay
    c. mA Output – The current output signal indicates the pump's actual calculated metering volume.
14. For simplified operator monitoring the pump shall be equipped with a three LED Display (Red, Yellow & Green) to locally indicate normal operation, fault conditions and warning conditions. The indicator lights shall be visible 360 degrees around the pump.
15. Operating Modes – The pump shall have the following operating modes available:
    a. Manual operating mode permitting the operation of the pump stroke and speed controls manually.
    b. Contact operating mode providing the option of controlling the pump externally by means of potential-free contacts (e.g. by means of a contact water meter). The number of pump strokes per input contact can be scaled by a factor ranging from 0.01 to 99.99 to tailor the pump feed rate to the application.
    c. Batch operating mode providing the option of working with large factors (up to 99,999). Metering can be triggered either by pressing the Click wheel or by a pulse received via the "External control" terminal or through a contact or semiconductor switching element. It is possible to pre-select a metering volume (batch) or a number of strokes using the Click wheel in the settings menu.
    d. Analog operating mode allows the capacity and/or stroke rate to be controlled via an analog (4-20 mA) current signal via the "External control" socket. The processing of the current signal can be preselected via the control unit.
16. To facilitate easy pump installation, removal, service and replacement the pump unit shall have a removable mounting plate into which the pump positively locks.
17. The chemical metering pumps shall be manufactured by ProMinent Fluid Controls, Pulsafeeder, or equal.

D. Control Panel
   1. A control panel shall be provided to process inputs and outputs between the chemical feed pumps and SCADA. Each panel shall interface and process signals from the pumps.
   2. The metering pumps shall interface with the SCADA System through a control panel that will process all required inputs and outputs. Supplier of the metering pumps shall be responsible for design and fabrication of the panel, with fabrication performed in a UL 508A certified shop.
   3. The panel shall consist of a NEMA 4X FRP enclosure and will be powered by 120VAC, 1 phase, 60 Hz.
      a. Main circuit breaker, rated to 20A for duplex skid.
      b. Circuit breaker for each pump, rated to 20A.
   4. The panel shall incorporate Hand-Off-Auto (HOA) selector switches for each pump.
   5. The panel shall incorporate alarm indication lights (amber) for each pump.
   6. The panel shall be configured with a P-16 Red Lion process controller, or equal, for each pump which will display stroking rate and analog output from the pump.
   7. Inputs
      a. 4-20 mA analog speed command for each pump.
      b. Digital on/off run command for each pump.
   8. Outputs
      a. Digital on/off run status for each pump.
      b. Digital on/off alarm status for each pump.
      c. Digital on/off "in-remote" status for control panel.
      d. 4-20 mA analog speed indication for each pump.
      e. 4-20 mA analog flow rate indication for chemical flow meter

E. Accessories To Be Included as Part of the Pumping System
   1. The pumps shall be mounted on a black, UV-protected/polypropylene coated/304 stainless skid suitable for floor mounting. A single chemical metering pump manufacturer shall be responsible for supplying and assembling all components of the skid, in addition to testing the skid-mounted metering system prior to shipment. The stand shall include the following accessories, pre-piped.
   2. Skid shall be properly sized and installable for the project, taking into account the size and location of entry doors, locations of equipment, and other building features as shown on the drawings.
   3. A Y-strainer, constructed of materials compatible with chemical ot be used, shall be provided with each feed system.
   4. An injection valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
   5. A universal control cable with 5-pole round plastic connector and 5-wire cable with loose ends shall be provided with each pump.
   6. An adjustable discharge flow monitoring device, compatible with chemical to be used, shall be provided with each pump. The flow monitor shall be capable of signaling a fault condition to the pump.
   7. A diaphragm failure detector shall be provided to (open/close) a contact for alarm in the event of a diaphragm failure.
   8. An adjustable-pressure diaphragm-type back pressure/anti-siphon valve, constructed of materials compatible with chemical to be used, shall be provided in each feed system discharge line.

9. An in-line adjustable-pressure, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
10. An air-charged, bladder-type pulsation dampener, constructed with materials compatible with chemical to be used, shall be provided with each pump. The pulsation dampener shall be sized to reduce pulsations by at least 90% at full pump capacity.
11. Magnetic flow meter on pumping discharge line with local indicator-totalizer, power supply for meter and 4/20 mA output signal.
12. A clear PVC calibration column with FNPT fitting on top and bottom shall be provided with each pump. The column shall be sized to provide at least 2 minutes draw down at maximum pump capacity.
13. The metering system shall incorporate 4.5" liquid filled pressure gauges on each system discharge. Each gauge shall be protected by a glycerin filled gauge protector that is capable of operation from 0 to 160 psig. The casings of the gauge shall be phenolic and accuracy shall be 2% or better.
14. Chemical feed system design shall be such that the wetted end of the pump and pump controller interface are oriented at the open end of the framework for easy access.

2.07 ACCESSORIES

A. Provide corporation stops and saddle with insert tube type in-line diffuser of PVC with built in check valve. The corporation stop shall be manufactured by Saf-T-Flo or equal.

2.08 PIPE AND VALVING

A. Pipe Insulation:
   1. Piping and valves located outside of a heated area shall be insulated with 1-inch thickness of fiberglass insulation. The outside cover for the insulation shall be covered with an asphalt saturated weather-proof jacket for all weather protection.
   2. Piping and valve shall be wrapped with FPE heat tape, rated at 6 watts per foot. The tape used shall have an automatic, preset thermostat set at the factory. The tape shall be run parallel to the pipe with the thermostat being in contact with the pipe. Freeze protection shall be to -5 F ambient temperature.

B. Valves: Shall be PVC bodied with corrosion resistant assemblies. Ball valves shall be true union type with teflon seats.

C. Piping: Suction and discharge piping shall be rigid Schedule 80 PVC. Joints shall be solvent welded with heavy duty PVC cement and cleaned and primed with purple primer. Pipe and fittings shall be prepared and joined in accordance with manufacturer's requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Handle and install all equipment and appurtenances in accordance with manufacturers written instructions.

B. Install tank and pipe fitting connections with flexible connections in accordance with manufacturer's requirements.

3.02 FIELD TESTING

A. Tank and connecting piping shall be tested by filling with water. Tank and fittings shall hold water without loss or evidence of weeping for a period of 24 hours prior to acceptance.

B. Clean and dry tank after testing.

3.03 START UP SERVICES

A. Owner shall provide chemical for testing and initial start up of the system. Notify Engineer in writing two (2) weeks prior to the date chemical shall be necessary for testing.

B. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of two trips to the site will be required, consisting of a minimum of five (5) days. One additional trip will be provided 6-9 months after start-up, at the Owner's discretion, for system check and additional operator training consisting of one day.

C. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) week of operation.

D. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

END OF SECTION

SECTION 11265

ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work shall include the work necessary to furnish the equipment and materials required for the On-site Sodium Hypochlorite Generation System (OSHGS) as specified herein and shown on the Drawings.

B. The OSHGS Supplier shall furnish an entire OSHGS consisting of the following major components
   1. One (1) Sodium hypochlorite generation unit.
   2. One (1) Control cabinet, PLC, VFD's, networking communication components, and associated equipment.
   3. Two (2) Hydrogen dilution blowers (one duty and one standby) and air flow sensors.
   4. One (1) Water cartridge filters and softener.
   5. One (1) Salt/brine tank and accessories.
   6. Two (2) Sodium hypochlorite solution storage tanks.
   7. One (1) Commercial strength hypochlorite dilution panel.
   8. One (1) Feed pump and motor.
   9. One (1) Acid cleaning cart.
   10. Spare parts.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Section 13445 SCADA System

1.03 SYSTEM DESCRIPTION

A. On-site Sodium Hypochlorite Generation System (OSHGS)
   1. Each On-site Sodium Hypochlorite Generation System (OSHGS) shall consist of rack-mounted sodium hypochlorite generation cells, solenoid control valves, an electrical control panel, a transformer rectifier, a water softener, brine tank, sodium hypochlorite storage tank, feed pump, and hydrogen dilution system. The OSHGS shall generate an aqueous solution of a minimum concentration of 0.8 percent (±0.05%) by weight sodium hypochlorite expressed as chlorine. The minimum capacity shall be demonstrated to be equal to the capacity specified for each installation while not exceeding the maximum aggregate raw material quantities specified below.
   2. System Component Sizing
      a. Generator Capacity
         1) Pounds per day (PPD) free available chlorine (FAC) 200 lbs/d
         2) Hours storage capacity 48 hrs
      b. Electrolytic cells
         1) No of electrolytic cells per generator unit 5
         2) Pounds of salt per pound of chlorine equivalent output 3 lbs
         3) Cell shall consume 2.0 AC kilowatt-hours of electricity per pound of chlorine equivalent output.

c. Solar Salt Requirements:

COMPONENT	WEIGHT
Sodium Chloride (dry basis)	99.45% minimum
Insolubles	0.15% maximum
Surface Moisture	0.20% maximum

i) Solar salt shall contain no additives (organic binders, flow control agents, resin cleaning material, etc.)

d. Generator Source Water
1) Current required 3 to 5 gpm
2) Water consumption of 14.0-17.0 gallons per pound of chlorine equivalent output.
3) Supply water required temperature 55 °F to 78 °F.
4) Minimum softener inlet pressure 50 psi
5) The raw water supply to the softener must meet or exceed the following specifications:

COMPONENT	SPECIFICATION
pH	6.5 – 8.5
NaCl	25 g/l minimum
Total Silica (as SiO2)	2 ppm by wt. maximum
Ba	100 ppb by wt. maximum
Fe	200 ppb by wt. maximum
Mn	10 ppb by wt. maximum
Al	1 ppm by wt. maximum
Ni	20 ppb by wt. maximum
F^-	2 ppm by wt. maximum
Cu	5 ppb by wt. maximum
Organics (as grease or oil)	2 ppm by wt. maximum
TOC	1 ppm by wt. maximum

3. Sodium Hypochlorite Tanks
a. No of tanks 2
b. Volume, each 2,500 gallons

B. Generator performance is to be measured as a function of total consumption for salt and power. Consumption for salt will be 2.5-3.5 pounds of salt and 1.8-2.4 KWH per pound of equivalent chlorine (PE). Product concentrations will be in the range of 0.80% ± 0.05%.
a. Performance will be measured as the sum of the unit measurements for salt (PPE) and power (KWHPPE) and will not exceed 6.0 consumable

units. Example: salt consumption at 3.0 PPE and 2.0 KWHPPE will measure 5.0 consumable units and will be considered proper performance.

b. Electrolytic cells shall operate an initial acclimation period of approximately 300 operational hours prior to performance measurement. Water softener salt consumption and or chiller or heater power consumption shall be excluded from performance calculations.

2. The only liquid waste product allowed from the OSHGS will be the periodic backwash discharge from the water softener

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:

1. Process and instrumentation diagram for the systems.
2. Shop drawings and catalog literature showing dimensional information and details of piping, fabrication, and erection of all materials and equipment furnished under this section, including:
   a. Detailed drawings of tank nozzle orientations provided.
   b. Detailed drawings of equipment installations provided.
3. Scaled drawing of general layout, general arrangements, and major system components, including:
   a. Dimensions, including those for system connections.
   b. Anchor bolt layout.
4. Drawings showing fabrication, assembly, installation, and wiring diagram. Wiring diagrams for the electrical control panel and rectifier transformer shall consist of, at a minimum, control schematics, including coordination with other electrical devices operating in conjunction with the OSHGS.
5. Manufacturer's literature, illustrations including weight and dimensions, specifications, materials of construction, and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with the technical Specifications. Major system components include:
   a. Water softener
   b. Brine pump
   c. Hydrogen dilution blower
   d. Miscellaneous instrumentation, valves, and accessories
6. Performance data: for each pump and blower furnish a performance certification indicating:
   a. Pressure
   b. Capacity
   c. Efficiency
   d. Horsepower
7. Motor data: for each motor furnish a certified motor data sheet for the actual motor or for a previously manufactured electrically duplicate motor which was tested.
8. Control philosophy including I/O list and loop descriptions.
9. The acceptable range of water pressure for proper system operation. If a pressure or flow regulator is required, it shall be provided.
10. A list of all parameters, ratings or other characteristics where the proposed Sodium hypochlorite generator system deviates from the requirements set forth in these Specifications.
11. Installation instructions.

12. Performance testing protocol including a recommended test plan, measurement methods, and sample data sheet showing all pertinent process data to be recorded and the frequency and data readings.
13. Current NSF Standard 61 Certification for the generation skid being offered.
14. References for at least ten similar units that have been installed and have been operational for at least five years of continuous service.

B. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the equipment as supplied for the Project.
   1. Each manual shall be a bound, indexed binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Approved shop drawings.
      b. Control panel wiring diagrams.
      c. Warranty information for each component.
      d. Instructions for startup/shutdown of system and for adjustment of equipment.
      e. Inventory, functional descriptions and operating instructions for equipment.
      f. Recommended routine maintenance procedures for pumps
      g. Recommended preventative maintenance for each major component.
      h. Complete bill of material.
      i. Installation instructions for the specific equipment.
      j. Contact information for contractor capable of performing emergency repairs.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service. for each piece of equipment.
      b. Equipment plate data.
      c. After the front page provide field test report.

1.05 QUALITY ASSURANCE

A. Quality assurance shall meet the following requirements.
   1. The system, as specified herein, shall be furnished by one supplier, with at least 15 years of prior experience in supplying generator systems ranging in capacity from 20 to 300 pounds per day of 100% chlorine equivalent.
   2. The OSHGS supplier shall have at least ten similar OSHGSs in operation for at least five years.
   3. The OSHGS supplier shall current NSF Standard 61 Certification for the generation unit being offered.
   4. Supply units containing all necessary appurtenances and components for a complete and operating system conforming to this specification. The OSHGS shall be pre-assembled, piped, and factory-tested to assure compliance with all operational requirements. The OSHGS shall be shipped as a single unit. Loose hypochlorite generation components shall not be acceptable. No field assembly or wiring will be permitted with the exception of external conduits.
   5. To ensure quality and complete unit responsibility, the OSHGS must be assembled and inspected by the OSHGS Supplier at its facility. The OSHGS Supplier must have a physical plant, technical and design staff, and fabricating personnel to complete the work specified.

6. On-Site Sodium Hypochlorite Generation System shall be manufactured by Microclor equipment and supplied Process Solutions, Inc. Campbell, California, or Engineer approved equal.
    a. Each supplier submitting an alternate to the equipment defined herein shall provide the following submittals. Failure to provide a complete and thorough submittal package shall render the submittal non-responsive. Approval of manufacturers will be at the sole interpretation of the Engineer. The following information is required:
        1) A complete set of drawings.
        2) A reference list of no less than then ten installations of the type and size of system proposed. The installations must have been in service for a minimum of five years. The list shall include the following information: Owner name and accurate contact information, placed in service date, and design conditions including generation capacity. Provide performance data showing that the raw materials consumption levels satisfy the project requirements.
        3) Proposed alternate shall meet all the performance, materials and electrolytic cell partial operating capacity requirements of this specification.
7. Any change in the dimensions or location of equipment or accessories or type of accessories required to accommodate alternate On-Site Hypochlorite Generation feed system shall be at the Contractor's expense.

1.06 WARRANTY

A. Sodium hypochlorite generator system will remain free of defects for a period of three (3) years from the date of final acceptance

B. The electrolytic cells including cell body shall have a three (3) year full replacement warranty and a prorated straight-line replacement warranty for years 4-7 from the date of final acceptance..

PART 2 PRODUCTS

2.01 ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM

A. A transformer rectifier, electrolytic cells, softened water solenoid valve, brine solenoid valve, brine pump, rectifier cabinet, hydrogen dilution blower, chemical storage tanks, chemical metering pumps, and a PLC-based control panel containing system controls, water softener with flow meter, and all necessary interconnecting wiring and hardware shall form a complete on-site sodium hypochlorite generation system. Components of the OSHGS shall comply with this specification. All components of the electrolytic cell skid shall be pre-assembled, piped, wired to input and output, flanged, threaded, etc. connections located at easily accessible points on the skid. The installation contractor shall provide all interconnecting piping and conduit, which shall be Sch 80 PVC. The OSHGS shall be factory-tested prior to shipping as one self-contained unit.

2.02 HYDROGEN SAFETY MANAGEMENT

A. The generators shall have no waste products associated with its use other than hydrogen gas, which is to be vented to the atmosphere. Hydrogen Dilution blowers will be used to purge all residual hydrogen out of the system and storage tanks and dilute the hydrogen concentration 100 to 1 or below 25% of the LEL.

B. The cells must operate at atmospheric pressure and discharge the hydrogen at each cell compartment. The generator must be designed to allow passive venting of the waste hydrogen produced from each cell or cell compartment to eliminate the possibility of inadvertently pressurizing the cell and causing failure. Under no circumstance will pressurized cells be acceptable.

C. Under no circumstance will waste hydrogen be allowed to flow form one cell or cell compartment to the next. All hydrogen must immediately be released from each cell pack.

D. Minimum passive venting capability from each electrolytic cell pack shall be 4.0 square inches for every 100 pounds of chlorine production.

E. The hydrogen dilution system shall dilute the hydrogen concentration to below 25% of the LEL or 1% by volume.

F. Generator skid hydrogen dilution shall include passive vents connected to each cell and blower connected to the vent header. Sodium hypochlorite storage tanks shall be evacuated by blower.

G. Under no circumstance will the Hydrogen Safety Management requirements (Part 2.02) be relaxed or modified as they are critical operator safety features and core to the generator design. NOTE: THIS HYDROGEN SAFETY DESIGN MUST BE MET, REGARDLESS OF ONSITE GENERATOR MANUFACTURER SELECTED, AND WILL BE REQUIRED FOR SUBMITTAL APPROVAL.

2.03 ELECTROLYTIC CELL SKID ASSEMBLY

A. An electrolytic cell skid assembly show be provided with the following overall dimensions:

WIDTH	DEPTH	HEIGHT
75"	18.5"	76"

B. Each electrolytic cell skid assembly shall have the following components and features:
   1. Cartridge filters for brine and water.
   2. 316 Stainless steel brine gear pump, with:
      a. Magnetic drive.
      b. Cavity-style design.
      c. PEEK gear construction.
      d. Integral speed control.
      e. Series GJ by MicroPump.
   3. Water solenoid valve.
   4. Polycarbonate water and brine rotameters.
   5. Electrolytic cells
   6. Transformer rectifier.
   7. Magnetic flow meter.
   8. Optical level switches.
   9. Temperature switches.
   10. Temperature sensor.

11. Teflon and Kynar interconnecting tubing.
12. 304 stainless steel frame, electrolytically polished for passivation, corrosion resistance, and chemical compatibility.
    a. Horizontal and vertical tube sections shall be of .125-inch wall thickness.
    b. All vertical and horizontal frame connections shall be welded.
    c. The completed frame with all mounted components shall comply with the UBC structural requirements for seismic zone four.

C. The generator package shall be mounted in the general location shown on the drawings and shall be factory wired, plumbed and mounted on a self-contained skid assembly.

D. The generator will be designed and built to allow one of the five electrolytic cells to be removed (replaced with a pipe spool) and still run at 80% production capacity.

E. Each electrolytic cell shall be arranged so that it can be completely drained in place.

F. The rack mounted flow control panel will consist of a water rotameter, water sensor, brine rotameter and a positive displacement gear pump with variable speed drive. The variable speed drive will respond to a 0-5 VDC signal generated by the PLC algorithm in order to maintain constant current relative to variable water temperature or flow rate.

G. The process shall operate in a batch environment allowing for consistent hypochlorite concentrations and greatest efficiencies.

H. The generator skid will be supplied with a 4-20 mA electrolyte temperature sensor that will function to return a linear signal proportional to 0-100°C, which will allow continuous operation up to 130°F without interruption. Under no circumstance will bimetallic "snap" switches be permitted as the primary over-temperature sensor.

I. The generator package shall have the following redundant interlocked safety features:
    1. Cell high temperature switch.
    2. Low level switch for each cell.
    3. Water flow sensor.
    4. Transformer high temperature switch.
    5. Automatic current regulation.

J. All electrical equipment and enclosures will be built and certified to UL 508 standards and will possess the appropriate label.

K. The generation system shall be pre-piped and skid-mounted.
    1. The OSHGS skid frame shall be constructed of 304 stainless steel tube for structural strength. Horizontal and vertical tube sections shall be of .125-inch wall thickness and have a depth no greater than twenty four inches by a length not exceeding six feet. The entire skid shall undergo electrolytic polishing for ultimate passivation, chemical compatibility, and corrosion resistance. The completed frame with all mounted components shall comply with the UBC structural requirements for seismic zone four.
    2. The skid frame shall be configured to allow easy access to all components, including the electrolytic cells. All vertical and horizontal frame connections shall be welded. Under no circumstances can water/liquids handling and/or cells be located immediately above the power supplies. The skid frame shall support, as a minimum, the following mounted equipment:
        a. Generator electrolytic cells.

b. Power supply/rectifier
c. Water and brine rotameters
d. Control panel
e. Interconnect pipes valves and fittings
f. Interconnect conduit and wiring
g. Water flow sensor
h. Variable-speed, positive-displacement brine pump

2.04 ELECTROLYTIC CELLS

A. Multiple electrolytic cells shall be provided as follows:

CELL QUANTITY	CELL CAPACITY	ACTIVE SURFACE
5	40 lbs/d	4" x 12"

Any system using fewer electrolytic cells than that specified above must demonstrate its ability to achieve 80% production capacity with one of the cells removed from service.

B. The electrolytic cell bodies shall be constructed of and clear acrylic materials, allowing for front and rear visual inspection of the electrodes from all angles.

C. Each electrolytic cell will be constructed utilizing DSA coated titanium anodes and titanium cathodes. The cells must be configured in a vertical format with a recirculating loop provided for each cell. This recirculating loop will also allow the passive removal of hydrogen from each cell via the upper hydrogen vent. Under no circumstance will hydrogen be allowed to be driven from one cell or cell loop to the next.

D. Each cell loop will also incorporate an optical level sensor so as to preclude any possibility of exposing an active electrode surface.

E. The wetted cell components will consist only of the electrodes and acrylic cell body. No internal baffles, spacers, or connecting hardware will be allowed.

F. Maximum allowable cell current density shall be no more than 1.25 amps per square inch. The OSHGS Supplier shall provide calculations showing all relevant cell data. Data shall include electrode area measurements, and current flows. Electrode service factor shall be expressed as amps per square inch of active electrode surface.

G. Cells shall utilize titanium bolting hardware.

2.05 TRANSFORMER RECTIFIER

A. The 6-pulse D.C. Rectifier will consist of a fully isolated three phase step down transformer and bridge rectifier. D.C. voltage output will be fixed with multiple primary taps for + 5-10% voltage correction. Under no circumstance will switching rectifiers or phase angle fired SCR voltage correction be permitted. D.C. ripple will be less than 4% with a power factor of 99% or better.

B. The transformer rectifier will be a fixed voltage unit where the current will be allowed to float as a function of electrolyte conductivity.

1. Constant current will be achieved via an active feedback loop where rectifier amperage is measured and reported to the PLC. The control algorithm calculates the appropriate amount of brine to mix with the incoming water so as to maintain constant current.
2. SCR-controlled rectifiers will not be allowed.

C. Rectifier efficiency will be 97% or greater.

D. The transformer/rectifier will house a 4-20 mA D.C. current transducer and NEMA 4X digital display of amperage.

E. The rectifier cabinet and base frame will be constructed of 304 Stainless Steel and will be of a modular design. All internal wiring connections and components will be easily accessible by removing the front access panel.

F. The transformer enclosure will be removable from the skid assembly as one piece, allowing for unobstructed access to the transformer.

G. The transformer rectifiers shall be designed for the following operating conditions:

CAPACITY (KVA)	PRIMARY VOLTAGE	SECONDARY VOLTAGE
24	480VAC/3PH/45A	300VDC/80A

H. The stepdown transformer rectifier shall be provided with the following accessories:
1. DC bridge rectifier utilizing three diode assemblies and an aluminum heat sink with 120 VAC cooling fan.
2. Panel-mounted electrical disconnect switch.

2.06 ELECTRICAL CONTROL PANEL

A. The OSHGS Supplier shall provide a NEMA 4X, 304 stainless steel, electrical control panel, which shall include controls for the entire sodium hypochlorite generation and feed system. The panel shall be mounted onto the generator skid and pre-wired at the factory to system components. The control panel shall house the operator interface terminal (OIT), PLC, hydrogen blower controls, and terminal strips to fully support the functions of generator operation, tank level, and metering pump proportional control.

B. All controls and operations logic specified herein and as shown on the Contract P&ID required for the system shall be programmed in a Programmable Logic Controller (PLC). The control cabinet logic will function at the PLC level where operating parameters will be measured, corrected, scaled, reported, and controlled. OSHGS Supplier shall coordinate with SCADA System Integrator for proper integration of the system.

C. The control panel shall display all relevant operating parameters and/or alarm conditions. The OIT will serve as the operator interface, data input screen, and alarm log.

D. At a minimum, the panel shall have the following features, components, and functionality:

1. The generator shall automatically start and stop based on the high and low levels in the sodium hypochlorite storage tank.
2. The generator shall shut down and alarm for the following conditions:
   a. Low electrolyte level in cell.
   b. Hypochlorite temperature exceeds 130°F (55°C).
   c. Inlet flow falls below a preset value.
   d. Rectifier high or low amperage.
   e. Rectifier high temperature.
   f. Hydrogen dilution blower failure.
3. Low-low level alarm for each hypochlorite storage tank.
4. High-high level alarm for each hypochlorite storage tank.
5. Enclosure cabinet, 24" x 24" x 8", with ample interior volume so as to be easily wired and serviced.
6. 6" color touchscreen human-machine interface (HMI) with dedicated screens, including help dialogs covering all basic operations and detailed alarm explanations, for each portion of the process and Ethernet communications for PLC connection.
7. Allen Bradley MicroLogix 1400 programmable logic controller (PLC) with Ethernet communication protocol.
8. Rectifier controls.
9. Blower controls.
10. Metering pump controls
    a. Send and receive discrete and analog inputs to and from the Plant SCADA system as per the Contract P&ID Drawings. OSHGS Panel shall have HAND-OFF-AUTO for each pump. Normal operating mode to be Auto position.
    b. In Auto mode: OSHGS Panel shall receive start/stop and 4-20mA metering pump speed signals form the Plant SCADA system and shall control metering pump on/off and speed from these signals through the VFDs for each metering pump.
       1) Display at panel for each metering pump
          i) Metering Pump speed setting
          ii) VFD Fault
          iii) Run Status
          iv) Metering Pump shutdown alarm.
       2) Send to SCADA system, the following conditions for each metering pump:
          i) VFD fault
          ii) Metering Pump run status via VFD.
       3) A low level alarm condition for **both** sodium hypochlorite tanks occurring simultaneously shall trigger an alarm from the SCADA System to the OSHGS.
    c. In Manual Mode: Metering pump on/off and speed shall be controlled manually at the OSHGS panel.
       1) Display at panel for each metering pump
          i) Metering Pump speed setting
          ii) VFD Fault
          iii) Run Status
          iv) Metering Pump shutdown alarm.
       2) A low level alarm condition for **both** sodium hypochlorite tanks occurring simultaneously shall trigger an alarm at the OSHGS panel.

d. Low level Alarm shall shut down metering pump operation via VFD fault. VFD reset button at each VFD to be used manually to clear fault.

11. Logging and storing alarm history.
12. Security protection.
13. Dedicated 24 VDC power supply for PLC and HMI.
14. Emergency stop pushbutton.
15. Cabinet-mounted electrical disconnect switch.
    a. Start-up shall be accomplished without the need for a laptop computer or proprietary software.

E. The OSHGS Supplier shall be responsible for programming the Generation System package control software. The OSHGS Supplier shall deliver to the Owner all PLC and HMI code for future reference prior to final acceptance.

F. Functional Description
1. The system shall work by feeding softened water into the brine tank to form a saturated salt solution. This brine solution is pumped to a stream of softened water and diluted to approximately 3% salt concentration (a 10:1 ratio of softened water to concentrated brine). This 3% brine solution is fed into the electrolytic cells. DC current from the rectifier is applied to the electrolytic cell, and the brine solution is converted to a 0.8% concentration of sodium hypochlorite. During this conversion, a small amount of hydrogen is produced by the electrolytic process. This hydrogen is released safely through a vent pipe at the top of the electrolytic cell. The hydrogen gas is further diluted at a minimum ratio of 100:1 using a dilution air blower which reduces the hydrogen concentration to less than 25% of the Lower Explosive Limit (LEL) of hydrogen gas.
2. Under normal operation the generator shall automatically start and stop sodium hypochlorite production based upon the hypochlorite storage tank level. The PLC will monitor the hypochlorite level sensor. When the level reaches a preset low level point, a signal is sent to the OSHG controller to turn the generator on. Generation will continue until the storage tank is full and the high level point is reached upon which the system will cease generation. The system will then remain in standby mode, continuously monitoring the tank level until a low level is reached which will start generation again.
3. A variable speed pump alters cell feed rate of the brine, or electrolyte, solution, based on signals from the PLC and a current transducer. This operational strategy allows the system to vary the electrolyte solution conductivity so as to indirectly provide constant current.
4. Instrumentation is included to continuously monitor operational permissives during generator operation (airflow, current draw, water flow, flooded cells, and temperature). If any permissive times out, generator operation interrupted. If the fault clears, generator operation is again called to run. If the fault reoccurs three additional times, the generation system is shut down and an alarm condition is sent to Plant SCADA system.
5. The OIT controls shall include metering pump on/off and speed controls with Local-Off-Remote selection for each metering pump. In Local setting, the metering pump ON/OFF and speed shall be controlled manually at the control panel. In Remote setting, the metering pump ON/OFF and speed shall be controlled by the Plant SCADA system. If a pump or VFD fault occurs, that metering pump unit shall be locked out until an operator manually selects the pump reset button at the OSHGS Control Panel.

2.07 HYDROGEN DILUTION BLOWER

A. A duty and standby hydrogen dilution blower shall be designed for the following operating conditions:

BLOWER I.D.	CAPACITY (ACFM)	STATIC PRESSURE (IN WC)	MOTOR HP	ELECTRICAL SERVICE
Blower 1 and 2	150	4	1/2	240V/1Ph/60Hz

B. The blowers shall be AMCA type B spark resistant of cast aluminum construction. The blower shall be cast with commercial grade 319 cast aluminum, having a 3/16" minimum wall thickness. Housing halves should be attached with tapered lugs having a minimum 45 degree taper from centerline for additional strength. Inlets and outlets shall be round.

C. The blowers wheel hub shall be an integral part of the wheel casting. The wheel shall be a radial-type wheel. The blower shall be statically balanced by removal of material only – no additional weights are to be used in the balancing process.

D. The blowers shall be arrangement 4 with a base of 12 gauge steel (minimum).

E. The hydrogen dilution blower shall be provided with the following accessories:
   1. Inlet guard.
   2. Teflon shaft seal.
   3. Current sensor.
   4. Differential pressure switch positioned in the dilution ductwork vent stack.
   5. Software controlled safety interlocks to detect control system sequence failure.

2.08 WATER FILTER

A. A wall-mounted large-capacity cartridge type filter housing holding a 10" cartridge for dirt, rust, and particulate matter from softener's feed water shall be provided. The filter housing shall be feature NPT inlet and outlet connections and a mounting bracket that must be non-metallic construction. A polypropylene cap with Buna-N O-ring shall be supplied.

B. The filter cartridge shall be a 4-1/2" diameter, 50-micron, disposable cartridge. Cartridge shall be manufactured from a pleated non-woven and reusable polyester fabric with polypropylene core.

C. Two (2) pressure gauges shall be provided to measure the pressure drop across the filter.

2.09 WATER SOFTENER

A. A dual-tank automatic water softening system shall be provided to remove hardness in the feed stream to the OSHGS, plus provides brine water makeup. The softener shall be designed for 4,000 grains exchanged per pound of salt.

B. Softener shall remove hardness to less than ½ gpg. One tank will be on-line during service. A water meter shall automatically initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Water softeners that regenerate on a fixed time will not be acceptable. When the ion exchange capacity of one resin tank is nearly exhausted, the hydraulically-driven, flow-controlled switchover valve will automatically divert flow to the alternate tank while initiating

brine backwashing of the first tank for regeneration of the ion exchange resin. During regeneration cycles, one tank shall provide water to service and to the regenerating tank. Regeneration shall use salt solution from the brine tank.

C. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 25 psi. Pressure shall be used to drive all valve functions. No electric hook-up, electric timers, or gear motors shall be required. Control valve shall incorporate four operational cycles including; service, brine draw, slow rinse, and a combined fast rinse and brine refill. The brine cycle shall flow shall be opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The control valve will prevent the bypass of hard water to service during the regeneration cycle.

D. The tanks shall be designed for a maximum working pressure of 125 psi and hydrostatically tested at 300 psi. Tanks shall be made of polyethylene and reinforced with fiberglass wrapping. Each tank shall include a 2.5 in. threaded top opening. Each tank shall be NSF-approved. Upper and lower distribution system shall be of a slot design. Distributors will provide even flow of regeneration water and the collection of processed water.

E. Each softener shall include a non-solvent, high capacity cation resin having a minimum exchange capacity of 30,000 grains/ft^3 when regenerated with 15.0 lbs/ft^3. The media shall be solid, of a proper particle size and shall contain no plates, shells, agglomerates or other shapes, which might interfere with the normal function of the water softener.

F. The water softener shall be provided with the following accessories:
   1. 1-1/2-inch inlet and outlet pipe connections.
   2. 1/2-inch HDPE tube with in-line check valve for feeding brine for regeneration.
   3. 1/4-inch wastewater discharge to sewer for backwash waste.

2.10 BRINE FILTERS

A. A wall-mounted cartridge type filter housings holding a 10" cartridge for dirt, rust, and particulate matter from the brine stream shall be provided. The filter housing shall be feature NPT inlet and outlet connections and mounting bracket that must be non-metallic construction. A polypropylene cap with Buna-N O-ring shall be supplied.

B. The filter cartridge shall be a 50-micron, disposable cartridge.

2.11 COMMERCIAL STRENGTH HYPOCHLORITE DILUTION PANEL

A. Under emergency conditions commercially available sodium hypochlorite (10-12 percent solution) can be added if required via a commercial strength hypochlorite dilution panel provided by the OSHGS Supplier as part of the OSHGS.

B. The commercial strength sodium hypochlorite dilution panel shall include a wall-mounted PVC panel with the following instruments and accessories:
   1. Venturi eductor, polypropylene construction.
   2. Polysulfone inline potable water rotameter.

3. Polysulfone inline commercial strength sodium hypochlorite rotameter.
4. Two (2) manually-operated flow control valves.
5. Outlet check valve.
6. Sch 80 PVC piping and fitting.

C. A centrifugal magnetically-driven booster pump shall be provided for the concentrated sodium hypochlorite to ensure pressure interruptions will not disrupt the dilution process. Pump shall be Series 3 by March Pump or equal.

2.12 SODIUM HYPOCHLORITE METERING PUMPS

A. Under normal operating conditions, site generated sodium hypochlorite (nominally 0.8% ± 0.05%) will be injected into the process at locations shown on the drawings for disinfection.

B. Three (3) metering pumps shall be supplied and regulate the amount of sodium hypochlorite dosed based on a pre-established set point as follows:

PUMP I.D.	CAPACITY (GPH)	DISCHARGE PRESSURE (PSI)	HP	POWER
Metering Pump 1	154	130	1.0	240/1/60
Metering Pumps 2 and 3	154	130	1.0	240/1/60

C. The metering pump shall be a diaphragm metering pump with a TEFC inverter-duty motor. Pumps shall be provided with a double head assembly. Where multiple pumps are provided, all pumps shall be manufactured by a single manufacturer.

D. The metering pump shall be suitable to operate 24-hours per day.

E. The solution metering pump shall be able to operate with a minimum 25:1 turn down ratio in conjunction with the VFDs.

F. The metering pump shall be provided with a PVC pump stand.

G. The following accessories for the sodium hypochlorite meter pump:
1. PVC calibration column.
2. PVC chargeable pulsation dampener.
3. PVC backpressure relief valve.
4. PVC pressure relief valve.
5. Wye strainer.
6. Pressure gauge with PVC isolator using a Teflon membrane.

H. The OSHGS Supplier shall provide VFDs as part of the control package to control the metering pump. The VFDs shall be provided with an epoxy-coated NEMA 4X enclosure and an easily-replaceable cooling fan. An elapsed timer is required to assist in preventative maintenance. The VFDs shall have an LED five-digit display. VFDs shall be V1000-4X by Yasakawa or equal.

I. Metering pumps shall be Encore® 700 or Engineer approved equal.

2.13 SODIUM HYPOCHLORITE STORAGE TANKS

A. General

1. Two (2) 2,500 gallon 0.8% sodium hydroxide storage tanks shall be supplied. Each tank to be 8'0" diameter with straight side height of 6'9".
2. Each tank to be supplied with ultrasonic level sensor/transmitter for communicating tank liquid level to generator unit control panel. Transmitter shall provide a 4-20 mA level signal for on/off operation of the generation equipment and for alarm initiation. Ultrasonic level sensor/transmitter/controls shall be FlowLine EchoSpan LU80-5101 or Engineer approved equal. Unit shall have suitable dead band for operation with the available freeboard at tank full level.
3. Tanks service to be designed for indoor installation in above freezing conditions for 0.8% sodium hypochlorite storage.
4. Tank manufacturer shall have a minimum of five (5) years of experience in the manufacturing of high density linear polyethylene (HDLPE) storage tanks for the specified chemical storage. Tank shall be manufactured by PolyProcessing Co., Snyder Industries Inc., Assmann Corp or equal.

B. Storage Tank
1. Top mounted 24-inch manway in each tank.
2. Inlet and outlet connections (each tank).
   a. 1-inch size inlet from hypochlorite dilution panel.
   b. 2-inch size inlet, outlet, bottom drain, and overflow connections.
   c. Two 4-inch size hydrogen vent on top of each tank.
   d. Provide 1, 2 and 4-inch PVC Sch. 80 ball valves on each connection for isolation.
   e. Provide braided flexible hose connection to tank outlet to chemical metering pumps.
   f. Flanged connection on top of tank for installation of ultrasonic probe.
3. Lifting Lugs: Lifting lugs shall be of the number required and designed to permit safe handling of the empty tank.
4. Provide three-way valve on the tank inlet line from the generator to allow splitting of flow between the two storage tanks. Valve shall consist of Tru-Union PVC open-center three-way ball valves. Open center three-way valves preclude isolation of sodium hypochlorite from the electrolytic cell. Termination of sodium hypochlorite flow from the electrolytic cell can cause damage to the electrolytic cell.
5. Provide aluminum ladder with safety cage.

C. Tank Construction
1. Resin used shall have NSF-61 certification.
2. Tank shall be of high density linear polyethylene (HDLPE) construction with interior anti-oxidant resistant liner.
3. Tank shall be upright, cylindrical, flat bottom, single wall tanks molded in a one-piece seamless construction by the rotational molding process. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. All polyethylene resin material shall contain a minimum of a U.V. 15 stabilizer as compounded by the resin manufacturer.
4. The standard design specific gravity shall be 1.9. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support. The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head.

The tie-down lugs shall be designed to allow tank retention in wind and seismic loading.

5. The tank shall be properly vented and have a minimum of three inches clearance on all sides to allow for expansion and contraction
6. Minimum wall thickness shall be 1/4-inch.

2.14 BRINE TANK

A. A high density linear polyethylene (HDLPE) salt/brine storage tank shall be provided for the following operating conditions:

TANK I.D.	DIAMETER	WALL HEIGHT	SALT CAPACITY (LBS)	BRINE CAPACITY (GALLONS)
	5'-0"	3'-10"	5750	575

B. The brine tank shall be one-piece, rotationally-molded of linear high-density polyethylene. A high-quality, chemically-resistant plastic with high stress crack and impact resistance shall be used. The tanks shall be translucent and comply with USDA and FDA regulations for storage and processing of food. The plastic must contain a minimum of 0.25% to a maximum of 0.50% long term U.V. stabilizer. Plastic containing any fillers will not be acceptable.

C. The brine tank shall be designed with an open top to receive bag salt via manual loading. A removable lid shall be provided.

D. The salt/brine tank shall be provided with the following accessories utilizing threaded bulkhead fittings:
   1. Under drain.
   2. Drain valve (minimum 1" size).
   3. Level control assembly, including:
      a. Clear PVC external sight glass.
      b. Polypropylene float-type mechanical SPST level switch at 12" to activate a normally-closed, solenoid pilot-operated diaphragm valve.
      c. Polypropylene float-type mechanical SPST level switch at 12" to activate a normally-closed, solenoid pilot-operated diaphragm valve.
   4. Unless otherwise specified, all pipe and fittings shall be Sch 80 PVC and all fasteners stainless steel.

E. For tanks using granular or fine grade (less than 12 mesh) solar salt, a quartz rock filter bed shall be installed in the sump. The filter bed shall consist of a 5" layer of 0.125" x 0.125" on top of a 7" layer of 0.250" x 0.250". The filter bed shall be evenly-distributed over the entire bottom of the vessel. All quartz rock shall be AWWA-washed and NSF-certified.

F. Provide threaded 1" flexible braided hose, minimum length of 20 feet, for connection to brine tank drain for draining of brine tank contents.

2.15 HYDROGEN DETECTOR

A. A hydrogen gas monitoring system shall be provided to continuously measure and display gas concentration and provide alarms when preset limits are exceeded. A transmitter will send the signal to the control panel.

B. The gas monitoring system shall have a NEMA 4X enclosure and two-line, eight-alphanumeric character LCD display with linear 4-20 mA output signal.

C. The gas detector shall be model CN06 by Conspec Controls or Engineer approved equal.

2.16 ACID CLEANING CART

A. A pre-assembled, mobile cart including acid cleaning tank and centrifugal pump shall be provided by the OSHGS Supplier for periodic washing of the electrolytic cells.

B. The cart shall be pre-piped and pre-wired prior to shipment. All piping, fittings, and valves shall be Sch 80 PVC. The 120VAC, single-phase plug shall be included for connection to a standard electrical receptacle.

C. A discharge hose, quick-connect couplings, and appurtenance shall be included to transfer acid to and from the electrolytic cells.

2.17 TOOLS, SPARE PARTS, AND MAINTENANCE MATERIALS

A. The OSHGS Supplier shall furnish one set of the following spare parts for each onsite sodium hypochlorite generator system:
   1. One (1) electrolytic cell level sensor
   2. One (1) electrolytic cell temperature sensor
   3. One (1) brine pump spare parts kit
   4. One (1) spare parts kit for each backpressure and pressure relief valve
   5. One (1) complete electrolytic cell including cell housing (loose electrodes are not acceptable)

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the completion of the contract.

C. The OSHGS Supplier shall furnish an initial supply of all greases and lubricants required to start operations. Supply an amount of these materials necessary for one year of continuous operation.

PART 3 EXECUTION

3.01 FACTORY ASSEMBLY AND TESTING

A. The OSHGS shall be pre-assembled at the manufacturing location.

B. System shall be tested for a minimum of eight hours at the location of assembly to assure it is in full compliance with the requirements of the specific design for the project and this specification.

C. Factory testing shall include visual inspection of all equipment, complete assembly, and functional testing of equipment including leak testing, piping and instrumentation check, verification of control panel wiring and operation, and confirmation of proper operating parameters.

D. Engineer and/or Owner reserve the right to be present at the OSHGS Supplier's manufacturing facility to witness factory testing. Engineer and/or Owner shall provide intent to witness factory testing at the time of the design submittal review and approval, and OSHGS Supplier shall provide notice to Engineer and/or Owner

regarding the scheduled time of the factory testing at least five business days in advance of the proposed factory test.

E. The OSHGS Supplier shall maintain Quality Control documentation that includes system test settings and measured performance.

3.02 DELIVERY AND STORAGE

A. The OSHGS shall be packaged and shipped so as not to incur damage to any portion of the equipment through handling and installation of the system itself.

B. Deliver, store, and handle equipment in accordance with the OSHGS Supplier's recommendations.

C. Equipment and materials shall be inspected upon deliver. Any damaged equipment or material not meeting requirements of the approved Shop Drawings shall be immediately returned to the OSHGS Supplier for replacement or repair.

3.03 INSTALLATION

A. Installation of the generator, tanks, metering pumps, and appurtenances shall be in accordance with the Drawings and with the OSHGS Supplier's instructions and recommendations. The Contractor shall supply the following:
   1. Water piping and valves from source to water softener, if applicable, and from softener to brine tank and electrolytic cell skid.
   2. Brine piping and valve from brine tank to electrolytic cell skid.
   3. Sodium hypochlorite piping and valves from electrolytic cell skid to sodium hypochlorite storage tank(s), from sodium hypochlorite storage tank(s) to metering pump(s), and from metering pump(s) to point of application.
   4. All hydrogen gas vent piping, valves, and stack to be Sch 80 PVC pipe and fittings and painted to prevent UV degradation if pipe will be exposed to sunlight (i.e. outdoor vent piping).
   5. PVC joints must use a PVC primer and gray IPS Weld-on 724 CPVC cement resistant to sodium hypochlorite.
   6. All overflow and drain piping and valves.
   7. Electrical connections, wiring, and conduits to/from system control panel for power, control, and alarm interfaces with remote located instruments (tank level and pressure transmitters, etc.), plant SCADA, etc.
      a. All wiring to be TTHN stranded wiring and will conform to the most current version of the National Electric Code.
      b. All 4-20 mA instrumentation wiring will be 2- or 4-conductor shielded cable.
      c. Instrumentation and signal/control wiring will be run in conduits separated from all other AC wiring systems.
   8. Viton or Teflon seals, gaskets, and o-rings for all system piping shall be used without exception.
   9. Any necessary unistrut, hangers, supports, etc. for Contractor-supplied piping and conduits.
   10. Hydrostatic leak testing of brine and sodium hypochlorite storage tanks.
   11. Pressure testing of all interconnecting piping.
   12. Flushing of all piping with potable water prior to system start-up and commissioning to remove materials that may have entered as a result of the installation process.

B. All equipment units or assemblies shall be installed on concrete bases and secured with anchor bolts in accordance with the OSHGS Supplier's recommendations and

as shown. The contractor shall coordinate with OSHGS supplier for skid placement and anchoring.

C. Inspect all equipment before installation, if damaged; notify the Engineer and OSHGS Supplier promptly. Do not install damaged equipment until the OSHGS Supplier makes repairs in accordance with OSHGS Supplier's written instruction and approval.

D. The Contractor shall, after installation of storage tanks is complete but before piping connections are made, block all outlets and fill each tank with potable water and tested for leakage for a minimum of 24 hours prior to system start-up and commissioning. Any leaks that are observed will be repaired and the tank re-tested.

E. Contractor shall provide a drain for each piece of equipment, according to the OSHGS Supplier's instructions.

F. Power shall be provided by to the system control panels as shown on the OSHGS skid drawings.

G. Installation shall include furnishing and applying an initial supply of lubricants, as provided by the OSHGS Supplier.

H. Support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.

I. All equipment including motors, belts, and drives shall be aligned to the best industrial standards. Field check and adjust all equipment alignments in the presence of the Engineer.

J. Tie-down lugs for tanks shall be grouted or shimmed to prevent excessive loads being transferred to the tank shell.

K. Make all electrical connections in conformance with the requirements of the electrical specifications.

3.04 START-UP SERVICES AND FUNCTIONAL TESTING

A. A factory technician from the OSHGS Supplier shall be present at the jobsite for initial system start-up and commission of equipment as specified. Factory technician will insure that the systems are properly installed, start-up the systems, and train the Owner's personnel.

B. OSHGS Supplier shall make equipment adjustments required to place system in proper operating condition.

3.05 PERFORMANCE TESTING

A. Prior to commencing the performance test, the entire OSHGS shall be operated for not less eight continuous hour in order to demonstrate the mechanical and electrical integrity of the system. Any mechanical or electrical breakdowns, unusual vibrations, or control sequencing problems shall be considered sufficient cause to reject the test. Inability to successfully complete the functional testing in five tries shall be considered cause for the construction manager to reject the OSHGS.

B. The performance test shall be conducted after 300 hours operation for cell acclimation. The duration of the tests and detailed test procedure shall be submitted for approval prior to the testing period.
   1. During testing, low-low and high-high levels, control valves, transformer voltage, and all other adjustable parameters shall be held constant. Changes in

OSHGS operating conditions shall not be permitted. All fine tuning of operating conditions shall be performed prior to testing.

2. Design operating conditions shall be maintained for a minimum of eight hours. During this time, all pertinent operating parameters shall be monitored and recorded, sufficient sampling and analysis shall be conducted to demonstrate that sodium hypochlorite generation is at design conditions.
   a. Source water hardness, softened product hardness, and blower airflow rate shall be measured once at the beginning of the test and once at the end of the test.
   b. Hardness levels shall be determined by EDTA titration.
3. Air flow rate shall be measured using a hot-wire anemometer.
   a. Brine flow rate, softened water flow rate, DC amperage, cell outlet temperature, and sodium hypochlorite concentration levels shall be measured once every 30 minutes. All operating pressure shall also be recorded at this time.
   b. Sodium hypochlorite concentration shall be determined by redox titration.
4. All other data shall be direct instrument reading.
5. An analysis of the performance tests shall be submitted. The calculated consumable units shall be as specified in Section 1.03.B. Should the OSHGS performance not meet the performance requirement, that system shall have failed the performance test. The Contractor shall make any additions or modifications to that OSHGS as may be necessary, at no additional cost to the Owner, and the performance tests for that system shall be repeated in its entirety.

3.06 IDENTIFICATION AND MARKING

A. The OSHGS, along with all applicable components, shall be marked and identified for all health, flammability, and reactivity of hazardous materials as required by all applicable jurisdictional building codes, statues, standards, regulations, and laws.

END OF SECTION

SECTION 11307

SUBMERSIBLE NON-CLOG PUMP STATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide complete submersible non-clog pump(s) for the following location(s):
   1. Backwash Holding Tank Effluent Pump Station

B. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational pump system:
   1. Submersible non-clog centrifugal sewage pumps and motors with mounting plates and guide rails.
   2. Control panel.
   3. Precast concrete wet well and valve vault.
   4. Removable trash basket.
   5. Lifting hoist.
   6. One (1) spare pump and motor.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Section 02530 Sanitary Sewer System
   2. Section 13440 Telemetry Equipment

1.03 SYSTEM DESCRIPTION

A. Station Name
   1. Function: Pump from backwash holding tank to on-site sewer
   2. Number of Pumps: Two (2) in duplex operation.
   3. One (1) spare ready for storage.
   4. Performance Requirements
      a. Capacity: 50 gpm
      b. Total Dynamic Head: 10 ft
   5. Pump Characteristics
      a. Impeller Type: Nonclog, 1 or 2 vane
      b. Discharge Flange Outlet: 2 inch, 125 lb flanges
      c. Pass Sphere Size: 3/4 inch
      d. Minimum Efficiency: 40%
   6. One (1) trimming of impeller for each pump to meet field conditions after startup, as necessary as determined by Engineer.
   7. Motor Characteristics
      a. Maximum Horsepower: 0.5 hp
      b. Maximum Speed: 1200 rpm
      c. Voltage: 480 V, 3 phase, 60 Hz
      d. Motor shall be non-overloading over the entire pump curve.
   8. Controls
      a. Automatic duplex pump operation.
      b. Audible and visual alarms.

9. Wet Well and Valve Vault
    a. As indicated on the Drawings.

1.04 SUBMITTALS

A. Submit the following in accordance with Section, Submittals:
    1. Certification: Submit certified pump curves after approval of Manufacturer's Data and Shop Drawings and prior to purchase.
    2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
        a. Pumps.
        b. Precast concrete wet wells.
        c. Access hatch.
        d. Lifting hoist.
        e. Removable trash basket.
        f. Float switch.
        g. Pressure Gauges.
    3. Shop Drawings: Submit Project specific shop drawings for the following:
        a. Dimensional mounting detail for pumps and trash basket within wet well indicating position of equipment with respect to access hatches in wet well top.
        b. Electrical diagram(s) for complete operating system.
        c. Layout of control panel face.
    4. Manufacturer's Installation Procedures.
    5. Test Reports: Upon testing of the installed system, field test reports shall be submitted in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
    6. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the total system as indicated below.
    7. Parts: Provide a parts list for each piece of equipment.
    8. Spare pump and motor: Provide one spare pump and motor as provided for pump station ready for storage at the Owner's facility.
    9. Equipment and Performance Data: Pump characteristic curves showing capacity in gpm, minimum submergence, head, efficiency, and pumping horsepower from 0 to 110 percent of design capacity.

B. Submit Operation and Maintenance Instructions in accordance with Section, Submittals and the following:
    1. Pump station equipment shall be submitted in one or binders as appropriate and shall include equipment in this section and the generator and associated electrical components.
    2. Front page(s) in binder shall include the following as a minimum:
        a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service for each piece of equipment.
        b. Pump and motor plate data.
    3. After the front page provide the pump curve and field test report.

1.05 QUALITY ASSURANCE

A. Quality assurance shall be as required in Section, Quality Control and the following requirements.
    1. Product manufacturer shall have a minimum of five (5) years of experience.

2. Equipment shall be as manufactured by ABS, Inc., Fairbanks Morse Company, Flygt Corporation, or Wilo EMU.

B. Pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

C. Submit the name, address, and phone number of the firm that will provide required repair or replacement during the warranty period.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pumps and controls to the job site in as large of units as practical to require the minimum amount of field connection and assembly.

1.07 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of substantial completion of pump station.

PART 2 PRODUCTS

2.01 PUMP

A. General: Provide submersible, nonclog, centrifugal pumps specifically designed for the specified use. Openings and passages of pump shall permit passage of the specified sphere diameter and typical trash and stringy material associated with sanitary sewage. Pump with appurtenances shall be capable of continuous operation at specified submergence depth. Pump shall be designed for remote connection to a base elbow using one or two guide bars.

B. Casing: Pump casing shall be constructed of cast iron ASTM A-48, Class 30. The casing shall be of uniform quality, surface, and free from defects. The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressure. Volute shall have smooth passages, which provide unobstructed flow through the pump.
   1. Mating Surfaces: Mating surfaces where watertight seal is required shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between mating surfaces, resulting in proper compression of the O-rings without the requirement of specific torque limits.
   2. Exterior Surfaces: A factory applied sewage resistant coating shall protect exterior surfaces of the casing in contact with sewage. Exposed nuts and bolts shall be stainless steel.

C. Impeller: Impeller shall be of cast iron and shall be of the single or double shrouded nonclogging design. Impeller shall be statically, dynamically, and hydraulically balanced. Impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

D. Wearing Rings: Renewable wearing rings shall be provided on the impeller and casing and shall have wearing surfaces normal to the axis of rotation. Wear rings shall be constructed of bronze or stainless steel. Wearing rings shall be designed for ease of maintenance and shall be adequately secured to prevent rotation.

E. Shaft: Provide one piece 416 Stainless steel shaft of adequate strength to transmit full motor horsepower to the impeller.

F. Seals: A tandem mechanical shaft seal system running in an oil bath shall be provided. Seals shall be of tungsten carbide alloy with each interface held in contact by its own spring washer.

G. Bearings: Pump shall rotate on a minimum of two (2) permanently lubricated bearings with a L-10 bearing life of 40,000 hours.

2.02 MOTOR

A. Provide sealed squirrel cage induction motor for submersible operation in conformance with NEMA standards for type motor specified and shall meet the following requirements:
   1. UL listed for Class I, Division 1, Group C and D explosion proof hazardous locations.
   2. Service factor of 1.15.
   3. Horsepower, RPM, voltage and phase shall be as specified in the paragraph, System Description. Nameplate horsepower rating shall not be exceeded by the brake horsepower requirements of the specified head and capacity conditions.
   4. Continuous duty submerged and 15 minutes in air at nameplate horsepower and a minimum of 15 evenly spaced starts per hour.
   5. Exterior hardware shall be stainless steel.
   6. Class F insulation.
   7. Lifting lugs of adequate strength to lift the pump and motor assembly shall be cast into the motor housing.
   8. Two moisture detector probes to detect seal failure shall be wired internally to control cable.
   9. Two normally closed automatic reset thermostats shall be imbedded in the motor windings to open on excessive heat stopping the motor.
   10. Provide waterproof power and control cable sized to conform to NEC and ICEA standards and adequate length to connect to the control panel. Seal cables at motor entry point to prevent moisture from entering motor housing and cable wicking.
   11. Motor shall not overload throughout the pump-operating curve.

2.03 PAINTING

A. Exterior surface of pump and motor shall receive as a minimum the following paint system at the factory:
   1. SSPC-SP6, Commercial Blast Cleaning
   2. One coat of Modified Alkyd Enamel to a minimum 2 mils dry film thickness.

2.04 INSTALLATION SYSTEM

A. Provide a rail mounted installation system consisting of stainless steel guide rails, upper rail guide bracket, sliding bracket, intermediate rail guide bracket(s) (for rails over 20 ft), and a discharge connection elbow. System shall be of the size and type standard with the pump manufacturer for pump type to be supplied and shall not be used to support the weight of the pump. Stainless steel sliding guide bracket shall be an integral part of the pump unit. Discharge connection elbow and piping shall be permanently installed in the wet well. Pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection and service without entering the wet well.

B. Lifting cable: Provide a stainless steel cable capable of supporting the pump and to raise and lower the pump through one continuous motion with the hoist.

2.05 CONTROLS

A. See Division 16.

2.06 PORTABLE HOIST

A. Provide one galvanized or stainless steel portable hoist at each pump station with reach as required for the safe removal of each pump and trash basket.

B. Hoist shall have a capacity of 150 percent of equipment weight and capable of 360-degree rotation.

C. Hoist shall have winch with quick disconnect cable anchor for receiving stainless cable with swagged ball end.

D. Provide lifting cable for each pump and trash basket. Lifting cable shall be stainless steel with snap hook on pump / trash basket end and swagged ball on winch end. Cable shall have sufficient length to reach from installed equipment to lifting winch.

E. Provide number of floor mounted stainless steel sockets at each pump station as required for the removal of the equipment.

F. Portable hoist shall be as manufactured by Halliday Products, Thern Inc., or Wallace B E Products.

2.07 PRESSURE GAUGES

A. Pressure gauges shall meet the following requirements:
   1. Use: Pressure reading for sanitary sewer force main.
   2. Liquid fill: Glycern
   3. Dial: White aluminum with black markings.
   4. Dial size: 4 inch minimum.
   5. Case & Ring: Aluminum
   6. Accuracy: 1/2 % of full scale (Grade 2A).
   7. Stem connection: Back.
   8. Gauge reading: Combination reading in psi and feet of water (ft) with range as follows:
      a. Backwash Holding Tank Pump Station: 0-30 psi
   9. Equipped with a stopcock and a diaphragm isolator for use with sewage.
   10. Mounted on piping in the valve box. Provide accessories as necessary so gauge shall face up with numbers reading towards access hatch.

B. Provide a 1/4-inch tap on each effluent pipe for pressure gauge.

2.08 PRECAST CONCRETE WET WELL AND VALVE VAULT

A. Provide precast concrete wet well and valve vault to the size and depth indicated on the Drawings and in conformance with the paragraph, Manholes, Section, Sanitary Sewer System, with the deletion of the manhole steps and manhole ring and covers.

2.09 ACCESS HATCH

A. Provide access hatches in conformance to the following requirements:
   1. Size as indicated on the Drawings. The size on the Drawings is for the required minimum clear opening. Unless specifically indicated on the Drawings the doors can be single or double door as required for opening size.
   2. Frame shall be aluminum extrusion and aluminum checkered tread plate for the door(s). Frame shall be equipped with necessary anchors for setting in concrete. Hinges, nuts, bolts, and washers shall be stainless steel and tamper proof from outside.
   3. Design and construct hatches for a minimum 300 lb. live load unless an H20 load is indicated on the Drawings.
   4. Provide the following:
      a. Bituminous coating at locations, which will have contact with concrete.
      b. Waterproof hatch where indicated on the Drawings.
      c. Positive open door latch.
      d. Retractable lifting handle.
      e. Double doors shall be interlocked.
      f. Padlocking provision. Provide lock for each hatch and keyed alike for multiple hatches.
      g. Provide a stainless steel interior automatic slam lock with an interior operating handle. The lock shall be operated from the outside by a removable handle key.
      h. Provide doors requiring greater then a 50 lb lift with a stainless steel spring assist.
   5. Hatches shall be of one manufacturer.

PART 3 EXECUTION

3.01 WET WELL AND VALVE VAULT

A. Install precast concrete wet well and valve vault in accordance with paragraph, Manholes, Section, Sanitary Sewer System.

B. Wet Well Testing
   1. Test wet well for water-tightness. Perform water-tightness test in the presence of the Engineer.
   2. Water-tightness test shall be in accordance with ACI 350. IR "Testing Reinforced Concrete Structures for water-tightness." Plug influent line and fill wet well with water to 6-inches below the force main pipe. Allow water to sit for 24 hours to allow for absorption by the concrete. There shall be no loss of water over a 24 hour period. If the water level has dropped the test may be run again at the Contractor's option. If the test fails a second time, the interior of the wet well shall be coated with water proofing compound and the wet well retested.
   3. Vacuum test may be used upon approval of the Engineer. Test shall meet the requirement for manhole testing as indicated in Section, Sanitary Sewer Systems.
   4. Submit record of test signed by the Contractor.

3.02 WATER SERVICE TO PUMP STATION SITE

A. Provide water service to the pump station site as indicated on the Drawings. The service shall include, but not be limited to, the tapping of the existing water main, installation of the service piping, meter box, backflow preventer and yard hydrant.

B. Yard hydrant shall be as indicated on Drawings.

3.03 FACTORY TEST

A. Certified Performance Test shall be performed on each pump at the factory.

3.04 INSTALLATION

A. Install pumps in accordance with manufacturer's installation instructions.

B. Level base.

C. Provide electrical work in accordance with Division 16. Coordinate electrical service to site with local power company.

D. Mount pressure gauges as described above.

3.05 START UP SERVICES

A. Provide the services of manufacturer's representative to check the pump station installation, supervise initial start up, and instruct Owner's personnel in proper operation and maintenance of the pumps and appurtenances. A minimum of two separate trips to the site will be required, each consisting of a minimum of one 8 hour working day. Regardless of the time spent at the site, services will not be considered complete until the pump station operates as intended for a minimum of one (1) week of operation.

B. Operate pump station under actual field service to demonstrate that the all equipment performs to the specified criteria flow capacity and head conditions. During the field test, make adjustments as necessary for proper operation. Adjust impeller size as necessary to meet field conditions.

C. Manufacturer's recommended start up tests shall be performed according to the installation schedule. Start up tests shall include the following as a minimum:
   1. Data for each pump under operating conditions:
      a. Amperage reading.
      b. Pressure head reading.
      c. Drawdown flow test.
   2. Pull out each pump and reinstall using guide rails and hoist.
   3. Test alarm condition for high flow.
   4. Test auxiliary contacts.
   5. Test float control system.

D. Submit copy of tests and checks performed in the field, complete with recordings, where applicable, to the Engineer.

3.06 PAINTING

A. Provide touch up of exterior paint system as appropriate.

END OF SECTION

SECTION 11975

CARBON DIOXIDE STORAGE AND CARBONIC ACID FEED EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work shall include the work necessary to furnish the equipment and materials required for the carbon dioxide storage, liquid carbonic acid feed, and pH control system as specified herein and shown on the Drawings.

B. The system shall consist of the following components
1. One (1) liquid carbon dioxide storage tank system complete with refrigeration unit.
2. One (1) electric vaporizer.
3. One (1) carbon dioxide vapor heater.
4. One (1) first stage CO_2 pressure regulator.
5. One (1) Pressurized solution feed (PSF) carbonic acid feed panel.
6. One (1) carbonic acid solution diffuser (pipe mounted)
7. Instrumentation and control equipment, as specified herein

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
1. Section 13510 Reverse Osmosis Treatment Train Units
2. Section 13530 Reverse Osmosis System Process Control Logic

1.03 SYSTEM DESCRIPTION

A. Carbon Dioxide and Carbonic Acid Feed System
1. Function: Add liquid carbonic acid to Reverse Osmosis permeate water to lower the pH of the permeate to approximately 5.0 to 5.5 to dissolve calcium carbonate in the calcite contactors. Liquid carbonic acid is to be generated using carbon dioxide and potable water supply source using a pressurized solution feed panel. Liquid carbonic acid to be injected directly under pressure into the permeate water piping as shown on the drawings. Carbon dioxide feed rate to be controlled based on pH setting or selected carbon dioxide feed rate (lbs/hr)
2. Number of Feed Systems: One (1)
3. System Component Sizing
   a. Carbon dioxide feed capacity
      1) Maximum 60 lb/hr
      2) Initial 40 lb/hr
      3) Minimum 4 lbs/hr
      4) Expandable to future capacity 80 lb/hr
   b. Carbon Dioxide Storage Tank
      1) Maximum Capacity 30 ton
      2) Initial Start-Up Capacity 14 ton
   c. Carbon dioxide electric vaporizer 12 kW
   d. Carbon dioxide vapor heater 4 kW
   e. Carbon dioxide diffuser capacity, min 35 gpm
   f. Carrier Water

1)	Current required	35 gpm
2)	Future required	70 gpm
3)	Minimum Carrier Water Feed Pressure	67 psig

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
   1. Descriptive literature and drawings, including parts list, bulletins and/or catalog cuts for the equipment, including vessels, and all accessories, with the items to be furnished clearly marked in the submittal material.
   2. A list of the Manufacturer's recommended spare parts and hardware.
   3. Manufacturer's Installation Procedures.
   4. A Bill of Materials for all supplied equipment and system components. A separate Bill of Materials shall be included on the panel layout drawing which includes all panel components, interior and exterior of the panel including the enclosure. Each Bill of Materials shall include the following information for each listed item: Item number, description/location, manufacturer, complete model/part number, quantity, and other pertinent information.
   5. Control panel schematic diagrams, functional process description of the proposed control System, and the scope of the programming work to be performed by the system supplier.

B. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the equipment as supplied for the Project.
   1. Each manual shall be a bound, indexed binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Approved shop drawings.
      b. Control panel wiring diagrams.
      c. Warranty information for each component.
      d. Instructions for startup/shutdown of system and for adjustment of equipment.
      e. Inventory, functional descriptions and operating instructions for equipment.
      f. Recommended routine maintenance procedures for pumps
      g. Recommended preventative maintenance for each major component.
      h. Complete bill of material.
      i. Installation instructions for the specific equipment.
      j. Contact information for contractor capable of performing emergency repairs.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service. for each piece of equipment.
      b. Equipment plate data.
      c. After the front page provide field test report.

1.05 QUALITY ASSURANCE

A. Quality assurance shall meet the following requirements.
   1. The system, as specified herein, shall be furnished by one supplier, with at least 20 years of prior experience in supplying carbon dioxide systems of the type specified.
   2. All components of the Carbon Dioxide Storage and Carbonic Acid Feed system shall be manufactured and supplied by one (1) equipment manufacturer.

3. The Manufacturer maintains a list of at least ten (10) references who are current successful users of similar CO_2 systems designed, assembled and furnished by the Manufacturer in service for at least five (5) years.
4. The Manufacturer shall operate an ASME Pressure Vessel Shop and employ certified welders to produce the pressure vessel to ASME standards, inspection and testing as required.
5. Submit the name, address, and phone number of the firm that will provide required repair or replacement during the warranty period.
6. Any supplier submitting an alternate to the equipment defined herein shall provide the following submittals. Failure to provide a complete and thorough submittal package shall render the bid non-responsive. Approval of manufacturers will be at the sole interpretation of the Engineer. The following information is required:
   a. A complete set of drawings.
   b. A reference list of no less than then ten installations of the type and size of system proposed. The installations must have been in service for a minimum of five years. The list shall include the following information: Owner name and accurate contact information, placed in service date, and design conditions including generation capacity. Provide performance data showing that the raw materials consumption levels satisfy the project requirements.
   c. Proposed alternate shall meet all the performance, materials and operating capacity requirements of this specification.
7. Equipment shall be manufactured by TOMCO_2 Systems, Loganville, GA or approved equal.
8. Dimensions and locations shown on drawings for the CO_2 storage and feed system are based on TOMCO_2 manufactured equipment. Any change in the dimensions or location of equipment or accessories or type of accessories required to accommodate alternate CO_2 feed system manufacturers and models shall be at the Contractor's expense.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage and handling instructions for the equipment will be provided by the equipment manufacturer prior to delivery.

B. The manufacturer of the carbonic acid feed system and carbon dioxide storage equipment shall inspect the completed installation and provide written certification that the system will operate as designed and specified herein.

1.07 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of successful equipment start-up.

PART 2 PRODUCTS

2.01 LIQUID CARBON DIOXIDE STORAGE TANK

A. The storage tank shall be designed specifically for liquid carbon dioxide service. The storage tank shall consist of a welded carbon steel pressure vessel designed and constructed in accordance with Section VIII, Division 1 of the ASME "Code for Unfired Pressure Vessels" with a maximum allowable working pressure of 350 psig. A pressure vessel manufactured by a different manufacturer from the tank supplier

will not be accepted. It is the intention for the complete storage tank, pressure vessel, and vaporizer to be fabricated by the same manufacturer in the same facility.

B. The storage tank shall be horizontal C-Series with I-beam frame and capable of holding 60,000 pounds (28,000 pounds initial fill) of liquid carbon dioxide at 300 psig and 0°F. Installation including foundation, elevation, piping, wiring, and instrumentation must be performed and strictly adhered to TOMCO$_2$ recommendations and specifications.

C. The tank shall be insulated with a minimum of 4 inches of urethane foam insulation, which shall be covered with a 0.063" factory painted white aluminum shell. The ends are to be covered with aluminum performed flanged and dished heads. The thermal conductivity (overall U-factor) for the insulated tank wall shall not be greater than 0.040 Btu per hour per square foot per °F.

D. The tank shall be complete with a liquid level gauge calibrated to read in pounds, 0 to 600 psig pressure gauge and all necessary Schedule 80 pipe connections for filling and withdrawal of CO_2 from the storage tank. Truck unloading capability consisting of isolation valves with CGA forged brass fill and vapor balance fittings provided extending through the front of the tank cabinet.

E. A complete environmentally safe R-404A refrigeration system shall be provided with the storage tank that will automatically maintain the storage tank at 0°F and 300 psig. The evaporator coil of the refrigeration unit shall be located inside of the top portion of the storage tank, with the compressor and air-cooled condensing coil mounted on the frame at the end of the tank. The refrigeration unit shall be equipped with a condensing unit driven by a 4 HP, 480 volt, 60 cycle, 3-phase compressor and provided with a circuit breaker disconnect with operating handle, motor starter, and a 120-volt control voltage transformer in a NEMA 4X type 304 stainless steel electrical enclosure. The condensing unit will include a sight glass, refrigerant line, solenoid valve, expansion valve and a refrigeration coil mounted internally in the storage tank. Automatic controls shall be provided to start and stop the compressor, thereby controlling the temperature of the CO_2 in order to maintain the proper operating pressures.

F. The storage tank shall be protected from being subjected to pressures greater than the maximum allowable working pressure by means of two ASME approved, spring actuated safety relief valves and two bleeder type relief valves, complete with three way switching valves.

G. The tank shall be provided with a pressure switch to sound an alarm automatically in the event of excessive high or low pressure in the tank. The alarm horn and indicating lights shall be mounted on the refrigeration control panel located in the storage tank cabinet. The panel shall be complete with an alarm silence circuit to shut off the audible alarm. Contacts shall be provided for remote indication of high and low tank pressure alarm.

H. All nozzles on the vessel shall be schedule 80 stainless steel. All piping and fittings provided internal to the storage tank system shall be Schedule 80 carbon steel. All piping and fittings provided external to the vessel and supplied as part of the storage system shall be Schedule 80 type 304 stainless steel, with 2,000 psi rated threaded fittings. Type 316 stainless steel ball valves shall be provided where the connections for the liquid fill, vapor return, vaporizer and vapor process lines connect to the tank. 1-1/2" liquid CO_2 and 1" vapor balance fill couplings shall be standard CGA brass threaded connections for CO_2 service.

I. The storage tank shall be provided with an enclosure at one end, which shall provide weather protection for the refrigeration unit, vaporizer, vapor heater, electrical panels and fill valves. The enclosure shall consist of a structural frame, which shall be covered with aluminum sheet, minimum thickness 0.04 inches (1 mm). The storage tank, enclosure, frame, and other exposed metal surfaces shall be painted according to Manufacturers' Standards. All stainless steel surfaces shall be left unpainted.

J. Adequate vent area shall be provided to allow cooling air circulation for the refrigeration system. Three lockable, hinged doors to provide access to the enclosure shall be provided.

K. The overall tank dimensions are 36'-0" long x 7'-6" wide x 8'-10" high. The shipping weight is approximately 30,000 lbs.

L. The storage tank shall be TOMCO$_2$ Systems Model No. 3075CA or equal.

2.02 CARBON DIOXIDE ELECTRIC VAPORIZER

A. The carbon dioxide storage tank shall be provided with one complete electric vaporizer unit, capable of vaporizing 325 lbs of liquid carbon dioxide per hour at 300 psig. Automatic controls shall be provided to control the vaporizer to maintain the tank pressure above 245 psig. An adjustable differential pressure switch shall activate the vaporizer at 245 psig and shall deactivate the unit at 255 psig. Liquid carbon dioxide shall be drawn off of the bottom tank, with the resulting vapor returning to the top of the tank. A purging valve for easy removal of accumulated impurities, safety controls consisting of a safety relief valve, a thermostat for overheat protection and a fused control circuit for coil protection shall be provided.

B. Electrical requirements shall be 12 kW, 480-volt, 3-phase, 60-Hz, and shall be provided with a circuit breaker disconnect with operating handle in a NEMA 4X type 304 stainless steel electrical enclosure.

C. The vaporizer shall be supplied as an integral part of the storage tank; pre-piped, pre-wired and pre-insulated and located in the equipment enclosure.

D. The vaporizer shall be TOMCO$_2$ Systems Model No. M-259CI or equal.

2.03 CARBON DIOXIDE VAPOR HEATER

A. One 4 kW carbon dioxide vapor heater shall be provided to heat the 0°F CO_2 gas to near room temperature. The vapor heater shall be rated for operation at 480 volts single-phase, 60 Hz. The vapor heater shall be supplied complete with electronic temperature control. Operating control range shall be adjustable from 30° to 110°F. Solid high conductivity aluminum pressure castings containing the electrical resistance heaters and aluminum castings containing the stainless steel tubing for the CO_2 vapor shall be provided. An overheat device shall be supplied to shut off the heating element should the temperature reach 200°F. A manual reset button shall be supplied for restarting the heater after the overheat temperature controller has tripped out.

B. The vapor heater shall be pre-piped and pre-wired with a thru-the-door disconnect switch and NEMA 12 type 304 stainless steel cover inside the storage tank aluminum control house with a separate cabinet door for access.

C. Vapor heater shall be TOMCO$_2$ Systems Model No. CVH-4SS or equal.

2.04 FIRST STAGE PRESSURE REGULATOR

A. One (1) carbon dioxide pressure reducing regulator will be supplied, pre-installed in the CO_2 pipeline after the carbon dioxide vapor heater. The regulator shall be used to reduce the pressure from approximately 300 psig to 120 psig. The regulator shall have a malleable iron body, aluminum spring case and lower case, nitrile and aluminum valve disc and holder, nylon fabric coated with nitrile diaphragm, stainless steel valve stem and valve stem guide. The outlet pressure of the regulator shall be easily adjusted through the use of an adjustment screw.

B. One (1) pressure gauge, 2-1/2" dial, 0 to 600 psig range, complete with isolation valve, shall be provided for indication of the CO_2 pressure downstream of the regulator.

C. One (1) pressure relief valve shall be provided installed in the pipeline prior to the pressure regulator. Relief valve shall be set for 450 psig.

2.05 PRESSURIZED SOLUTION FEED CARBONIC ACID FEED SYSTEM

A. One (1) carbonic acid solution feed panel will be provided with the capability to be expanded to 80 lb/hr in the future. The panel will be capable of mixing carbon dioxide gas from the storage tank with potable finished water to produce a carbonic acid solution to be injected into the permeate water line.

B. All CO_2 piping and fittings will be ½ inch Type 304 stainless steel, threaded. All water piping and fittings will be 2" Schedule 10 stainless steel, welded. The enclosed panel will be free-standing and constructed of type 304 stainless steel. The carbon dioxide at 75 psig, minimum, will be diffused into the carrier water. The carrier water supply shall be capable of providing 35 gpm at a minimum constant pressure of 67 psig (~55 psi above the permeate water pressure) and approximately 5° C to 25° C to the panel. Electrical supply to the panel shall be 120 volts, 60 Hertz. The panel shall be approximately 48 inches wide x 60 inches tall.

C. The carbonic acid feed panel will contain the following:
   1. One (1) stainless steel "Y" strainer provided on the inlet side of the CO_2 feed panel to remove any debris that might pass through the CO_2 vapor line from the storage tank and piping system.
   2. One (1) second stage pressure reducing valve. The regulator will reduce the CO_2 pressure from the first stage regulator to the desired operating pressure. The regulator will have a malleable iron body, aluminum spring case and lower case, nitrile and aluminum valve disc and holder, nylon fabric coated with nitrile diaphragm, stainless steel valve stem and valve stem guide. The outlet pressure of the regulator will be easily adjusted through the use of an adjustment screw.
   3. Two (2) Pressure gauges, 2-1/2" dial, 0-200 psi range, complete with isolation valves, for indication of the CO_2 pressure upstream and downstream of the second stage pressure regulator.
   4. One (1) indicating electronic Coriolis CO_2 flow meter/transmitter. The body and wetted parts will be Type-316 stainless steel. The meter will be designed for mass flow and will transmit an analog signal to the plant control system. Accuracy of the meter will be one percent of full scale. The flow meter shall be sized to correspond with the design rate of carbon dioxide per hour. A local LCD display shall provide readout of local flow rate or total flow. The sensor housing shall be type 316L stainless steel. The meter housing shall be rated NEMA 4X. Flow meter to be Micro-Motion Elite-Series.

5. One (1) Gas actuated (ATO) CO_2 flow control valve assembly. The pneumatically operated, spring opposed diaphragm actuator is controlled via an electronic signal from an electro-pneumatic I/P transducer. The transducer converts a DC current input signal to a directly proportional pneumatic output. The transducer is designed to accept a proportional 4-20 mA D.C. signal from the Plant SCADA System. The transducer will also accept a proportional 4-20 mA D.C. signal transmitted from a potentiometer and signal conditioner for local control of the valve. The valve will be supplied complete with a CO_2 gas regulator and pressure gauge for utilizing the CO_2 gas at the panel as the pneumatic source. The valve body shall be 316 stainless steel. valve and actuator shall be Badger.
6. One (1) manually operated by-pass CO_2 flow control valve. The valve will be stainless steel construction and designed for positive control of CO_2 flow.
7. Seven (7) CO_2 isolation ball valves: one for the panel, two for the control valve by-pass, three for the flow meter and by-pass, and one for the solenoid valve by-pass. The valve bodies will be of Type-316 stainless steel construction with stainless steel trim. The valves will be designed specifically for CO_2 service.
8. Two (2) Pressure gauges, 2-1/2" dial, 0 - 160 psig range, complete with isolation valves, for indication of the water pressure upstream and downstream of the mixers.
9. Two (2) in-line mixers designed to continuously mix carbon dioxide with the water. The CO_2 vapor will be injected upstream of the mixer though a stainless steel diffuser. The mixers shall be constructed of PVC.
10. One (1) Hand/Auto/Off switch and power light on the control panel door. The switch will provide 120 Volt AC power to the electronics in the panel.
11. One (1) stainless steel ball check valve in the CO_2 injection line.
12. One (1) carrier water drain valve. The valve body will be of stainless steel construction with stainless steel trim.
13. One (1) Solenoid valve for initiating or stopping CO_2 flow to the PSF panel. The valve shall have a brass body and 120 volt AC coil. The valve shall be normally closed (energize to open - fail closed). In case of loss of power, the CO_2 solenoid will stop CO_2 flow to the panel. A manual by-pass isolation valve shall be provided to by-pass flow around the solenoid valve for manual operation.
14. One (1) Carrier water low pressure switch. A low water pressure signal (dry contact) shall be provided to the plant control system.
15. Three (3) pressure relief valves for protection of the PSF Panel components. The valves shall have a brass body and stainless steel spring. Safety relief valves shall be set to relieve at 150 psig, 100 psig and 50 psig.
16. One (1) alarm light on the control panel door. The lights will indicate a low carrier water pressure. Light module shall be NEMA 4X rated.
17. One (1) electric panel heater for minimizing moisture condensation on the PSF panel components. Heater shall be Hoffman Series, 400 Watts, 115 volts.

D. All necessary panel valves, safeties, gauges, pipe, pipe fittings, etc. will be included as part of the PSF Carbonic Acid feed system panel.

E. Panel shall be TOMCO_2 Systems PSF panel or equal.

2.06 CARBON DIOXIDE GAS DETECTOR

A. One (1) infrared, photo-acoustic, absorption type CO_2 gas monitor will be supplied to monitor carbon dioxide gas in the room where the PSF is housed. The monitor shall be capable of detecting the presence of CO_2 in air over the range of 0 to 2 percent. The monitor will include a high-level alarm contact. The high level alarm

contact shall be provided to energize an alarm beacon on a remote alarm panel when the CO_2 concentration in the room reaches 5000 ppm. Monitor to be Ultima-X Series by MSA 120 volt AC.

B. One (1) stainless steel NEMA 4X, 120 volt AC, remote alarm panel, with alarm horn and visual alarm beacon, will be provided for installation by the Water Treatment Plant Contractor as shown on the Drawings. The panel will come complete with mounting brackets suitable for wall mounting.

2.07 CONTROLS

A. Storage Tank Pressure Control
   1. Storage tank pressure shall be controlled/maintained through use of the refrigeration subsystem and the vaporizer system
   2. The refrigeration subsystem shall maintain the liquid carbon dioxide in the tank at 0 F and a tank vapor space pressure between 295 to 305 psig. The system shall maintain this pressure by cooling and condensing the CO_2 vapor in the vapor space during periods of low or no CO_2 vapor withdrawal. A solenoid valve control the refrigerant flow in the vapor space refrigerant coils. The solenoid valve shall be opened by a pressure switch at 305 psig and closed at a pressure of 295 psig
   3. At tank pressures between 295 psig and 255 psig neither the refrigerant or vapor system shall be operating
   4. The vaporizer system shall operate during periods of high CO_2 vapor withdrawal and shall maintain a minimum tank pressure of 245 psig. The vaporizer system shall vaporize liquid CO_2 to increase the storage tank pressure. The vaporizer shall operate when the tank pressure is in the range 245 psig to 255 psig.

B. Vapor Heater and Pressure Regulator
   1. The vapor heater shall be used to increase the temperature of the CO_2 vapor withdrawn from the storage tank from 0 F to room temperature for solution mixing.
   2. The pressure regulator shall reduce the vapor pressure from 300 psig to 150 psig for feed to the PSF Panel.

C. Pressurized Solution Feed (PSF) Panel
   1. The PSF panel shall mix carbon dioxide gas from the storage tank with potable finished water to produce a carbonic acid solution to be injected into the permeate water line via a solution diffuser. The solution diffuser shall have fixed orifices to create a constant solution flow at any set operating pressure in the permeate pipe. The solution water pressure is maintained at 55 psig above the pipe pressure. The strength of the carbonic acid solution is varied by varying the flow of CO_2 gas being introduced into the carrier water.
   2. Under normal conditions, the gas flow will be controlled by the Plant SCADA system via a 4-20 mA signal form a pH probe/sensor on the main permeate header. The pH signal will be transmitted to the Plant SCADA System. A control valve positon signal (4-20 mA) will be transmitted to the PSF control panel from the Plant SCADA System. At 4 mA, the control valve will be closed and at 20 mA the valve will be 100 % open. The desired pH range (~ 5. To 5.5 set point) is input into the Plant SCADA System. The pH analyzer will measure the pH and transmit the pH signal (4-20 mA) to the Plant SCADA System. The control valve percent opening will be increased or decreased by a signal from the Plant SCADA system based on the pH instrument readings.

3. The control valve can also be controlled via a 4-20 mA signal from the Plant SCADA System from the permeate flow rate in the main pipe and a setpoint carbon dioxide dose (mg/L).

D. The following signals shall be exchanged between the storage tank, PSF local control panel and Plant SCADA system:
   1. From the CO_2 storage tank to the SCADA system:
      a. CO_2 tank low pressure alarm
      b. CO_2 tank high pressure alarm
      c. CO_2 tank low level alarm
      d. Vapor Heater low temperature alarm
   2. From the SCADA system to the PSF control panel:
      a. PSF panel selected (on/off)
      b. CO_2 control valve position (4-20 mA)
   3. From the PSF control panel to the SCADA control system:
      a. Carrier water low pressure alarm.
      b. CO_2 flow rate (4-20 mA)
      c. Panel On/Off indication
   4. From the CO_2 alarm panel to the SCADA Control System
      a. High CO_2 concentration

E. Alarms
   1. High Storage Tank Pressure
   2. Low Storage Tank Pressure
   3. Low Storage Tank Level
   4. Vapor Heater Low Temperature
   5. Low Carrier Water Pressure
   6. High CO_2 concentration
   7. The alarms above will be transmitted back to the Plant SCADA System.

2.08 SPARE PARTS

A. Provide the following spare parts for the system:
   1. Vaporizer heating element
   2. Vaporizer pressure switch
   3. Three (3) fuses of each type used.

B. Pack spare parts in wooden boxes; label with manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained therein.

PART 3 EXECUTION

3.01 DELIVERY AND STORAGE

A. The storage tank and PSF feed panel shall be shipped as complete assemblies and delivered to the job-site in one shipment. The equipment shall not be delivered until the storage tank can be placed on the completed storage tank foundation. The PSF feed panel shall be left in it's shipping container to protect it from the elements until it is ready to be placed and installed. The main storage tank safety relief valve assembly shall be shipped loose inside the storage tank cabinet for installation by the contractor. The solution diffuser, CO_2 detector and alarm panel shall be shipped with the PSF feed panel to be installed by the contractor as indicated on the drawings.

3.02 INSTALLATION

A. Provide continuous protection of the installed equipment from the elements, dust, debris, paint spatter, or other conditions which will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing.

B. The manufacturer of the carbonic acid feed system and carbon dioxide storage equipment shall provide written installation instructions for all equipment and be on-site to inspect the tank and PSF panel prior to start-up and commissionsing.

C. The manufacturer of the carbonic acid feed system and carbon dioxide storage equipment shall inspect the completed installation and provide written certification that the system will operate as designed and specified herein.

3.03 PAINTING AND COATING

A. Do not coat stainless steel components.

B. The storage tank, enclosure, frame, and other exposed metal surfaces shall be painted according to Manufacturers' Standards.

3.04 FIELD TESTING

A. Field verify that the refrigeration and vaporizing subsystem are fully functional.

B. Assure that in the automatic mode the system responds to the appropriate control signal. Assure that the PSF panel operates at a steady rate (±5% of set point) at any given carbon dioxide feed rate up to 100% of the maximum capacity specified.

3.05 START-UP SERVICES

A. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of one trip to the site will be required consisting of a minimum of one 8-hour working day.

B. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) month of plant operation.

C. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

END OF SECTION

SECTION 12350

LABORATORY CASEWORK AND RELATED PRODUCTS
(CONVENTIONAL RADIUS LIP – STYLE 1)

PART 1 DESCRIPTION OF WORK

1.1 SUMMARY AND SCOPE

A. Section Includes:
1. Wood casework. Furnishing all cabinets and casework, including tops, ledges, supporting structures, and miscellaneous items of equipment as listed in these specifications, or equipment schedules including delivery to the building, setting in place, leveling, scribing to walls and floors as required. Furnishing and installing all filler panels, knee space panels and scribes as shown on drawings.
2. Furnishing and delivering all utility service outlet accessory fittings, electrical receptacles and switches, as listed in these specifications, equipment schedules or as shown on drawings as mounted on the laboratory furniture. The above-defined items shall be furnished with supply tank nipples and lock nuts, loose in boxes and properly marked. All plumbing and electrical fittings will be packaged separately and properly marked for delivery to the appropriate contractor.
3. Furnishing and delivering, packed in boxes for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment or listed in the specifications, equipment schedules or shown on the drawings. Integral tailpieces when required shall be in accordance with the manufacturer's standards. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.
4. Furnishing service strip supports and setting in place service tunnels, service turrets, supporting structures and reagent racks of the type shown on the details.
5. Removal of all debris, dirt and rubbish accumulated as a result of the installation of the laboratory furniture to an onsite container provided by others, leaving the premises clean and orderly.

B. Related Divisions:
1. Divisions 5 & 6: Behind the Wall Blocking and Studs
2. Division 9: Base Molding
3. Division 15: Plumbing
4. Division 16: Electrical Fittings and Connections

C. Related Publications:
1. SEFA 3 – Scientific Equipment and Furniture Association
2. SEFA 8 – Scientific Equipment and Furniture Association
3. NFPA 30 – National Fire Protection Association
4. NFPA-45 - National Fire Protection Association
5. UL - Underwriters Laboratory
6. ASTM D552 - Bending Test
7. ANSI/HPVA HP-1 1994 – Hardwood Plywood
8. ANSI A208.1-1999 – Particleboard Plywood
9. ANSI A208.2-1994 – MDF Plywood

1.2 BASIS OF WORK

A. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval from the owner/architect. This approval must be obtained seven (7) days before the quotation deadline. Procedures for obtaining approval for an alternate manufacturer are defined in section 2.00.C in this specification.

B. General Contractors should secure a list of approved wood laboratory furniture manufacturers from the architect as a protection against non-conformance to these specifications.

C. Participants in the quotation process have the option of clarifying deviations to the specified design, construction, or materials. Without such clarifications, sealed quotations to the owner or owner representative will be construed as being in total conformance to the requirements of the specification.

D. The owner / owner representative reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

1.3 QUALITY ASSURANCE

A. The wood laboratory furniture contractor shall also provide work tops and fume hoods all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.

B. General Performance: Provide certification that furniture shall meet the performance requirements described in SEFA 8.

C. Finish Performance: Provide independent test lab certification that the furniture finish shall meet the performance requirements described in section 2.03 of these specifications.

1.4 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's data and installation instructions for each type of casework. Provide data indicating compliance with SEFA 8 Standard.

B. Shop Drawings: Submit shop drawings for furniture assemblies showing plans, elevations, ends, cross sections, service run spaces, location and type of service fittings.
   1. Coordinate shop drawings with other work involved.
   2. Provide roughing-in drawings for mechanical and electrical services when required.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The basis of this specification is wood casework manufactured according to the standards used by Kewaunee Scientific Corporation, 2700 Front Street, Statesville, North Carolina. The specified design is Signature Series – Conventional Radius Lip – Style 1.

B. Mott Manufacturing.

C. Larsen Furniture Co.

D. Leonard Peterson Co.

E. Substitutions: Under provisions of Division 01.

F. The selected manufacturer must warrant for a period of one-year, starting on the date of acceptance or occupancy, whichever comes first, that all products sold under the contract referenced above shall be free from defects in material and workmanship. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

G. Samples: Samples from non-specified manufacturers will be required and reviewed per specification. Samples shall be delivered, at no cost to the architect or owner to a destination set forth by the architect or owner. This must be done seven (7) days before quotation deadline as a condition of approval of each bidder. Samples shall be full size, production type samples. Miniature, or "Show Room" type samples are not acceptable. Furnish the following:
   1. One combination drawer and cupboard base unit showing complete construction details, including one shelf.
   2. One acid storage base cabinet typical of specified elevations.
   3. One sample of all top materials shown or called for, of sufficient size to perform finish requirement tests.
   4. Sample of all mechanical service fittings, locks, door pulls, hinges, and interior hardware.

H. The above samples of the successful manufacturer will be impounded by the architect or owner to insure that material delivered to the jobsite conforms in every respect to the samples submitted.

2.2 MATERIALS

A. General: Material shall be selected so that the finished installation shall provide an attractive and harmonious appearance. All exterior casework surfaces exposed to view after installation, and cabinet interior surfaces, shall be **Red Oak**. Solid woods and veneers exposed to view after completion of installation shall be of color and graining in conformance with the normally accepted standards required of the scientific laboratory equipment industry.

B. Solid Woods: All solid woods shall be carefully and thoroughly air-dried, then kiln dried in humidity controlled kilns to a moisture content of 4-1/2%. All kiln dried lumber shall then be tempered to a moisture content of 6% before use. This moisture content shall be maintained throughout production.

C. Plywoods: All plywood shall be hardwood plywood. Softwoods such as Fir or Pine are not permitted.
   1. Veneer Core Plywood
      Veneer core plywood shall be either 7-ply (3/4") or 9-ply (1") and shall be

compliant with ANSI/HPVA HP-1 2004.

2. Composition Core Plywood
   Composition core plywood shall be 3-ply and shall be compliant with ANSI A208.1-1999, and/or ANSI A208.2-1994.
3. Face Veneers
   Plywood face veneers shall be Grade A, plain sliced, slip matched, Red Oak on face, and Grade 1, Red Oak on back.

D. Banding: Plywood panels shall be edge banded as specified with 3mm hardwood edge-banding to match the plywood veneer.

E. Hardboard: Hardboard shall be a wood fiber/resinous combination formed with heat and pressure into sheets providing a hard, smooth surface.

F. Glass: Glass used for framed sliding and swinging doors shall be 1/8" float glass. Glass used for unframed sliding doors shall be 14" float glass.

G. Hardware and Trim:
   1. Drawer and Door Pulls: Drawer and door pulls shall be mounted on 4" centers, offering a comfortable hand grip, and be securely fastened to doors and drawers. They shall be anodized aluminum in a shallow rounded shape. Use of plastic pulls (molded or extruded) or a design not compatible for usage by the handicapped shall be unacceptable.
   2. Flush Pulls: Flush pulls for sliding doors shall be satin finish chrome, providing a recessed finger grip. Finger holes or slots machined into doors shall be unacceptable.
   3. Hinges: Hinges shall be the five (5) knuckle, satin finish stainless steel, institutional, offset type for all swinging doors. Hinges shall be 2-3/4" long, and secured to cabinet and doors with flathead screws, so applied to withstand a weight load of 150 lbs. minimum.
   4. Locks:
      Pin Tumbler: Locks when shown or called for shall be a pin tumbler with heavy duty interchangeable cylinder. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers. Locks shall have capacity of at least 1000 primary key changes, and the capacity to be Masterkeyed, Grand-masterkeyed, Sub-masterkeyed, and Mason Keyed.
   5. Roller Catches: Roller Catches shall have a spring-loaded polyethylene roller and a steel strike plate.
   6. Elbow Catches: Elbow catches and strike plates shall be cast aluminum with bronze finish.
   7. Drawer Slides: Drawer slides shall be zinc plated, cold rolled steel, full extension, linear ball bearing slides rated at 100 pounds minimum. The drawer shall be removable without the use of tools.
   8. Leg Shoes: Leg shoes shall be provided on all table legs. Shoes shall be 2-1/2" high and a pliable, black vinyl material. Use of a leg shoe which does not conceal leveling or anchoring device will not be acceptable.
   9. Floor Glides: Floor glides, where specified for movable open-leg tables, shall be a non-marring material at least 1" dia. to prevent indenting composition flooring and shall have at least a 5/8" height adjustment. Use of metal buttons will not be acceptable.
   10. Dowels: Dowels used to join frames and panels shall be fluted hardwood not less than 8mm in diameter.
   11. Shelf Support Clips: Shelf support clips shall be twin pin type for mounting on interior of cabinet end panels. Clips shall be corrosion resistant and shall retain shelves from accidental removal. Shelves shall be adjustable on 32mm centers. Surface

mounted metal support strips and clips subject to corrosion are not acceptable.

12. Base Molding: Base molding shall be provided by others.
13. Support Rods, Upright Rod Assemblies and Rod Sockets: Upright rods, cross rods and ring support rods, where specified, shall be anodized Duraluminum (1/2" or 3/4" dia., as required). Rod sockets shall be chrome plated brass, secured through table tops with lock nut and spring washer. Rod clamps shall be heavy duty, designed to securely hold rod assembly in any position.
14. Label Holders: Label holders, where shown or called for, shall be self adhesive type aluminum with satin finish and designed for 2-1/2" x 1-1/8" cards, unless otherwise specified.
15. Number Plates: Number plates, where shown or called for, shall be aluminum brad-attached type with satin finish and indented black lettering.
16. Sink Supports: Sink Supports, where required, shall be of a cradle type consisting of two 1-1/4" x 1-3/4" horizontal cleats and adjustable leveling bolts or glides. The horizontal cleats shall be supported by two 3/4" x 2-1/2" hardwood plywood cleats attached to the cabinet end panels, or by four 1/4" steel rods attached to the cabinet top frame.
17. Support Struts: Support struts shall consist of two 16 gauge channel uprights fastened top and bottom by two adjustable "U" shaped spreaders, each 12 gauge, 1-1/2" x length required. Struts shall be furnished to support drain troughs, and to support work top at plumbing space under fume hood superstructures or other heavy loads. They shall be fabricated so as to accept industry standard, pipe and conduit hangers.

2.3 CONSTRUCTION

A. General Requirements: It is the intent of this specification to provide a high quality wood cabinet specifically designed for the laboratory environment. The cabinet shall be radius lip, semi-overlay. The door and drawer fronts shall occupy a plane extending 5/16" past the plane of the front of the cabinet body. Edges of door and drawer fronts shall be radiused. All cabinet end panels shall be finished for the purpose of future relocation unless cabinet is selected with the "unfinished end" option. The exposed grain for doors shall run vertical; exposed grain for drawer fronts shall run horizontal.

B. Base Cabinets:
   1. End Panels, Bottoms, and Shelves: All cabinet end panels shall be 3/4" thick Red Oak veneer core plywood edge banded on exposed edges. End panels shall be multiple doweled, glued, and screwed to top frame members, intermediate rails, and bottoms. Cupboard bottoms shall be 3/4" thick Red Oak veneer core plywood edge banded on exposed edge. All cupboard base cabinet shelves shall be full-width adjustable, 3/4" thick Red Oak veneer core plywood edge banded on exposed edge. Integrally joined parts shall result in a totally enclosed cabinet.
   2. Backs: Cabinet backs shall be 1/4" thick hardboard, dadoed into end panels and securely fastened to cabinet bottom and top back rail. Backs that are attached to end panels with cleats shall be unacceptable.
   3. Top Frame: (select one of the following types)
      a. Two-piece Top Frame: The cabinet top frame shall consist of a front rail and a back rail. The front rail shall be 3-1/8" x 1" hardwood with 3mm Red Oak facing. The back rail shall be 2-1/2" x 3/4" hardwood plywood.
      b. Full Top Frame: The cabinet top frame shall consist of a front rail, a back rail and two side rails. The front rail shall be 3-1/8" x 1" hardwood with 3mm Red Oak facing. The back rail shall be 2-1/2" x 3/4" hardwood plywood. The side rails shall be 1-3/4" x 3/4" hardwood and shall be screwed to end panels and

front and back rails.

4. Intermediate Rails: Intermediate rails shall be 3-1/4" x 3/4" hardwood plywood edge banded on exposed edge. Rails shall be multiple doweled and screwed to end panels. Intermediate rails shall be mounted at the front between the drawers and between all drawers and doors.
5. Drawers: (select one of the following types)
   a. Drawers with Hardboard Bottom: Drawer sides, back, and sub-front shall be 1/2" thick, 9-ply Birch plywood. Drawer heads shall be 3/4" thick, solid Red Oak. A dovetail joint shall be used to attach the drawer sub-front and drawer back to the drawer sides. Drawer bottoms shall be 1/4" thick hardboard, set and hot- melt glued into 1/4" grooves, four sides. Each drawer shall have one pull mounted horizontally, drawers over 24" long shall have two pulls. Drawer sub-fronts attached to drawer sides with a lock-tenon joint shall be unacceptable.
   b. Drawers with White Hardboard Bottoms: Drawer sides, back, and sub-front shall be 1/2" thick, 9-ply Birch plywood. Drawer heads shall be 3/4" thick, solid Red Oak. A dovetail joint shall be used to attach the drawer sub-front and drawer back to the drawer sides. Drawer bottoms shall be 1/4" thick hardboard with a white melamine finish, set and hot-melt glued into 1/4" grooves, four sides. Each drawer shall have one pull mounted horizontally, drawers over 24" long shall have two pulls. Drawer sub-fronts attached to drawer sides with a lock-tenon joint shall be unacceptable.
6. Doors:
   a. Swinging doors shall be 3/4", Red Oak, core banded composite core plywood, mounted on cabinet with 1 pair of offset hinges and shall be latched with a roller catch. Double doors shall have a roller catch on each door and a Red Oak astragal mounted to the left- hand door. Each door shall have one pull mounted vertically. Locks, when required on double doors, shall be mounted on the right-hand door.
   b. Sliding doors shall be 3/4" thick, Red Oak, composite core plywood, edge banded on the vertical edges. Doors shall be suspended from adjustable hangers and glide on nylon rollers riding on a double extruded aluminum track attached to the top of the cabinet. Each door shall have one recessed pull.

C. Counter Mounted and Wall Mounted Cabinets:
   1. Cabinet: All cabinet end panels shall be 3/4" thick Red Oak veneer core plywood edge banded on front and bottom edge. Tops and bottoms shall be 1" thick Red Oak veneer core plywood edge banded on exposed edge, multiple doweled into end panels, and secured with glue and countersunk screws. Shelves shall be 1" thick Red Oak veneer core plywood edge banded on exposed edge. Shelves shall be adjustable on 32mm centers utilizing shelf support clips. The backs in open and glazed door cases shall be 1/4" Red Oak composite or veneer core plywood while the back not exposed to view shall be 1/4" hardboard. Case interior shall be flush.
   2. Doors:
      a. Swinging Doors:
         1) Door Construction: Panel doors shall be 3/4", Red Oak, core banded, composite core plywood. Glazed doors shall have 3/4" x 3-3/16" Red Oak framing mortised, tenoned, and glued. Glass shall be set into door frame and secured with a plastic retainer. Each door shall have one pull mounted vertically.
         2) Door Mounting: Swinging doors shall be hung on 1 pair of offset hinges, under 48" in height, and 1-1/2 pair on cabinets 48" high.
         3) Door Latching: Doors shall latch with a roller catch. Double doors without

locks shall have a roller catch on each door and a Red Oak astragal mounted to the left-hand door. Double doors with locks shall have an elbow catch and Red Oak astragal mounted to the left- hand door and the lock and a roller catch mounted on the right-hand door.

2.4 FINISH AND PERFORMANCE REQUIREMENTS

A. All cabinet end panels, whether exposed to view in the final installation or not, shall be stained and finished to match cabinet face to allow the cabinet to be relocated at a later date unless cabinet is selected with the "unfinished end" option.

B. Environmental Standards: The finish must be low VOC and reclaimable with enclosed spray and/or roll coat application; thus providing an environmentally responsible product.

C. Wood Surface Preparation: Prior to application of wood finish, all cabinet component surfaces shall be sanded smooth to remove loose fibers, scratch marks, and abrasions, with all dust thoroughly removed.

D. Wood Finish Application: Cabinet components shall be finished using a state of the art flat-line system. The finish shall be applied under controlled conditions prior to casework assembly and attachment of hardware. This will provide maximum coverage and protection to the assembled product. The finish shall be fully UV cured to ensure proper performance.

E. Interior Wood Casework Finish: Interior surfaces shall receive two applications of chemical-resistant, UV cured, epoxy top coat. The first application will be cured, sanded, and cleaned. The final top coat will then be applied and fully cured.

F. Exterior Wood Casework Finish: Exposed exterior surfaces, and interiors of glazed cabinets and open cabinets shall be stained and additionally sealed with two applications of chemical-resistant epoxy top coat. The fully reclaimable low VOC water-borne stain shall be uniformly applied by a series of automated spray applicators. The stained components shall then travel through a series of heated chambers to incrementally achieve a temperature of 140 degrees F to dry the stain material. The first of two low VOC epoxy top coats shall be applied, cured, sanded, and cleaned. The final top coat will then be applied and UV cured, providing a semi-gloss sheen. The completed product shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS paragraph F and SEFA.

G. Performance Test Results (Chemical Spot Tests):
   1. Testing Procedure: Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.
   2. Test Evaluation: Evaluation shall be based on the following rating system.

a. Level 0 – No detectable change
b. Level 1 – Slight change in color or gloss
c. Level 2 – Slight surface etching or severe staining
d. Level 3 – Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration
e. After testing, panel shall show no more than three (3) Level 3 conditions.

3. Test Reagents

Test No.	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Acid Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle
7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle
12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Acid	Cotton ball & bottle
16.	Dimethylformanide	Cotton ball & bottle
17.	Dioaxane	Cotton ball & bottle
18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Acid, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrochloric Acid, 37%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Cloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Acid, 20%	Watch glass
32.	Nitric Acid, 30%	Watch glass
33.	Nitric Acid, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Acid, 85%	Watch glass
36.	Silver Nitrate, Saturated	Watch glass
37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Acid, 33%	Watch glass
43.	Sulfuric Acid, 77%	Watch Glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Acid 77% and Nitric Acid, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle

47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Cotton ball & bottle

* Where concentrations are indicated, percentages are by weight.

H. Performance Test Results (Heat Resistance): Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

I. Performance Test Results (Moisture Resistance): A cellulose sponge (2" x 3" x 1") shall be soaked with water and placed on the finished surface for a period of 100 hours. The sponge shall be maintained in a wet condition throughout the entire test period. At the end of the test period, the surface shall be dried and no visible effect shall be shown on the finish.

J. Performance Test Results (Impact Resistance): A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of a 3/4" thick plywood panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.

2.5 WORKSURFACES

A. Materials: Kemresin Epoxy Resin Tops: Epoxy Resin tops shall consist of modified epoxy resin that has been especially compounded and cured to provide the optimum physical and chemical resistance properties required of a heavy-duty laboratory table top. Tops and curbs shall be a uniform mixture throughout their full thickness, and shall not depend upon a surface coating that is readily removed by chemical and/or physical abuse. Tops and curbs shall be non-glaring. Tops shall be 1" thick, exposed edges beveled top and bottom, and drip grooves provided on the underside at all exposed edges. 4" high curbs at the backs and ends of tops shall be 1" thick and bonded to the deck to form a square watertight joint. Sink cutouts shall be smooth and uniform without saw marks with the top edge beveled. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness. Corners of sink cutouts shall be radiused not less than 3/4".

PART 3 EXECUTION - LABORATORY CASEWORK AND RELATED PRODUCTS

3.1 SITE EXAMINATION

A. The owner and/or his representative shall assure all building conditions conducive to the installation of a finished goods product; all critical dimensions and conditions previously checked have been adhered to by other contractors (general, mechanical, electrical, etc.) to assure a quality installation.

3.2 INSTALLATION

A. Preparation: Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.

B. Coordination: Coordinate the work of the Section with the schedule and other requirements of other work being performed in the area at the same time both with

regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

C. Performance:
   1. Casework:
      a. Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.
      b. Screw continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.
      c. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
      d. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8" between top units.
   2. Worksurfaces:
      a. Where required due to field conditions, scribe to abutting surfaces.
      b. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
      c. Secure worksurfaces to casework and equipment components with materials and procedures recommended by the manufacturer.

D. Adjust and Clean:
   1. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.
   2. Adjust doors, drawers and other moving or operating parts to function smoothly.
   3. Clean shop finished casework; touch up as required.
   4. Clean worksurfaces and leave them free of all grease and streaks.
   5. Casework to be left broom clean and orderly.

E. Protection:
   1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
   2. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

END OF SECTION

SECTION 12495

HORIZONTAL LOUVER BLINDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Horizontal slat louver blinds.
   2. Operating hardware.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Describe blind construction and finishes.
   2. Samples: 3 inch long slat samples showing available colors.

1.3 PROJECT CONDITIONS

A. Do not install blinds until painting and finishing work is complete.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Hunter Douglas, Inc. (www.hunterdouglas.com)
   2. Levolor Contract. (www.levolor.com)
   3. Springs Window Fashions Division, Inc. (www.springs.com)

B. Substitutions: Under provisions of Division 01.

2.2 COMPONENTS

A. Louver Slats: 1 inch wide, 8 gauge, prefinished spring tempered aluminum, horizontal slats with radiused corners, and hidden cord holes.

B. Slat Support: Woven polypropylene ladders.

C. Head Rail: Prefinished, formed aluminum or steel box, internally fitted for hardware, pulleys, and bearings for blind operation.

D. Cord: Braided nylon or polypropylene.

E. Control Wand: Hollow extruded plastic, height of window opening less 12 inches.

F. Support Brackets: Suitable for wall or soffit mounting, formed metal to match head rail, allowing removal of head rail for maintenance without removing bracket.

G. Operation: Full range lift locking.

2.3 FABRICATION

A. Fabricate blinds to fit openings with uniform edge clearance of 1/4 inch.

B. At openings requiring multiple blind units, provide separate blind assemblies with space of 1/4 inch between assemblies, occurring at window mullion centers.

2.4 FINISHES

A. Slats: Static-reducing Baked enamel, color to be selected from manufacturer's full color range.

B. Head Rails and Brackets: Static-reducing Baked enamel, color to match slats..

C. Ladders and cords: Dyed to closely match slats.

D. Control Wands: Clear.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install blinds in accordance with manufacturer's instructions.

B. Secure with concealed fasteners.

C. Place intermediate head supports at maximum 48 inches on center.

D. Installation Tolerances:
   1. Maximum gap at window opening perimeter: 1/4 inch.
   2. Maximum offset from level: 1/8 inch.

3.2 ADJUSTING

A. Adjust blinds for proper operation.

END OF SECTION

SECTION 12900

LABORATORY EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

A. Provide all labor, materials, and equipment for the installation of the laboratory equipment as indicated on the Drawings and specified herein.

1.2 DESCRIPTION

A. Equipment: Provide the following equipment:
   1. Refrigerator
   2. Undercounter washer / dryer

1.3 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 12350 Laboratory Casework

1.4 QUALITY ASSURANCE

A. Laboratory equipment shall be manufactured by a company which has been in the established practice of manufacture of similar equipment for a period of not less than 5 years immediately prior to furnishing the equipment under this contract. In lieu of the experience, the equipment supplier or manufacturer may provide a cash deposit or bond to guarantee replacement of the equipment in the event of failure.

1.5 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Refrigerator
      b. Undercounter washer/dryer
   2. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for each piece of equipment.
   3. Manufacturer's Installation Procedures.
      a. Refrigerator
      b. Undercounter washer/dryer
   4. Warranties.

PART 2 PRODUCTS

2.1 LABORATORY EQUIPMENT

A. General

1. Equipment shall be suitable for operation on 120 V, 60 cycle, single phase current unless specified otherwise.
2. Provide mounting, plumbing and electrical accessories as required for a complete and operational installation.

B. Drying Rack: Provide Fisher Scientific No. 91-163 or equal.

C. Refrigerator: The Contractor shall provide one (1) automatic defrost model refrigerator having about 23.3 cu. ft. refrigerated space and suitable for plug-in operation on 120 volts, 60 Hz. The unit shall be designed for adjustable temperature control in the range of + 1° C to + 8° C, factory preset at + 4° C, and digital temperature display (resolution to within 1.0° C). The unit shall be designed and constructed to meet UL and CSA criteria for safety and performance. The unit shall be Fisher Scientific No. 13-991-52, VWR No. 55701-044, REVCO Model REL-2304A, or equal.

D. Undercounter Washer/Dryer: The Contractor shall provide the undercounter washer/dryer. The washer dryer shall be a Labconco Steam Scrubber model 4400300, 115V, 60 Hz. or equal. Provide stainless steel racks with glassware baskets, as necessary, to hold beakers, BOD bottles, and other general purpose glassware.

PART 3 EXECUTION

3.1 INSTALLATION

A. Laboratory Equipment:
1. Mount laboratory equipment where indicated on the Drawings and as recommended by the manufacturer.

3.2 PROTECTION

A. Protect finished work until acceptance. Damaged or marred surfaces shall be repaired or replaced at no cost to the Owner.

END OF SECTION

SECTION 13121

PRE-ENGINEERED BUILDINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pre-engineered, shop fabricated structural steel building frame.

B. Insulated framed wall and sloped metal roof system including gutters and downspouts, roof mounted equipment curbs, 8' high metal liner panel, gable and eave trim.

1.02 RELATED SECTIONS

A. Section 03300 - Cast-In-Place-Concrete: Concrete footings grade beams and floor slab.

B. Section 04300 - Unit Masonry System: Masonry Walls.

C. Section 07212 - Board Insulation: Subgrade insulation at foundation perimeter.

D. Section 07213 - Batt Insulation: Vinyl Faced Wall and Roof Insulation.

E. Section 07900 - Joint Sealers.

F. Section 08111 - Standard Steel Doors: Metal doors.

G. Section 08112 - Standard Steel Frames: Metal Frames.

H. Section 08360 - Sectional Overhead Doors: Overhead.

I. Section 08710 - Finish Hardware.

J. Section 09900 - Painting

K. Section 15005 - Basic Plumbing Requirements: Plumbing utilities.

L. Section 15500 - Basic HVAC Requirements: Mechanical rough-in utilities.

M. Section 16001 - General Provisions Related to Electrical Work: Electrical rough-in utilities.

1.03 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 03300 - Cast-In-Place-Concrete: Placement of anchor bolts and base plates.

1.04 REFERENCES

A. AISC - Specification for Structural Steel for Buildings - Allowable Stress Design and Plastic Design.

B. AISC - Quality Certification Program, Category MB.

C. ASTM A36/A36M - Structural Steel.

D. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

F. ASTM A307 - Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength.

G. ASTM A325/A325M - High Strength Bolts for Structural Steel Joints.

H. ASTM A446/A446M - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.

I. ASTM A490/A490M - Heat Treated Steel Structural Bolts, Classes 150 ksi (1035 MPa) Tensile Strength.

J. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

K. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

L. ASTM A525/A525M - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

M. ASTM A529/A529M - Structural Steel with 42 ksi (290 MPa) Minimum Yield Point (1/2 in (12.7 mm) Maximum Thickness).

N. ASTM A572/A572M - High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality.

O. ASTM A792/A792M - Steel Sheet, Aluminum-Zinc Alloy Coated by the Hot-Dip Process.

P. ASTM C1107 - Packaged, Dry, Hydraulic-Cement Grout (Non-shrink).

Q. AWS A2.0 - Standard Welding Symbols.

R. AWS D1.1 - Structural Welding Code - Steel.

S. MBMA (Metal Building Manufacturers Association) - Metal Building Systems Manual.

T. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

1.05 SYSTEM DESCRIPTION – OPERATIONS BUILDING

A. Single span rigid frame. Span 58'-8"

B. Bay Spacing: 26'-8" AND 32'-0".

C. Eave Height: 18 feet.

D. Primary Framing: Rigid frame of rafter beams and columns, end wall columns, and wind bracing.

E. Secondary Framing: Purlins, girts, eave struts, clips, and other items detailed.

F. Wall Systems: pre-formed metal panels of vertical rib profile with sub-girt framing/anchorage assembly, and accessory components. Eight foot high metal wall liner on the interior side of all exterior Truck Bay walls.

G. Roof System: Preformed factory rolled metal panels with concealed clip system and factory applied sealant with sub-girt framing/anchorage assembly, insulation, and accessory components. Roof system to have a UL 90 uplift rating when tested in accordance with UL 580.

H. Roof Slope: 3:12.

1.06 SYSTEM DESCRIPTION – SHED (Calcite Vessels)

A. Single span rigid frame. Span 70'-0" maximum.

B. Bay Spacing: 27'-6" maximum.

C. Eave Height: 36'-0" maximum.

D. Primary Framing: Rigid frame of rafter beams and columns, end wall columns, and wind bracing.

E. Secondary Framing: Purlins, girts, eave struts, clips, and other items detailed.

F. Wall Systems: pre-formed metal panels of vertical rib profile with sub-girt framing/anchorage assembly, and accessory components.

G. Roof System: Preformed factory rolled metal panels with concealed clip system and factory applied sealant with sub-girt framing/anchorage assembly, insulation, and accessory components. Roof system to have a UL 90 uplift rating when tested in accordance with UL 580. Panel tested in accordance with air infiltration ASTM E1680 and water penetration, ASTM E1646.

H. Roof Slope: 3:12.

1.07 SYSTEM DESCRIPTION – SHED (CO_2 Feed System)

A. Rigid, Clear Span, Single Slope. Span 30'-0" maximum.

B. Bay Spacing: 30'-0" maximum.

C. Low Eave Height: 15''-0" maximum.

D. Primary Framing: Rigid frame of rafter beams and columns, end wall columns and wind bracing.

E. Secondary Framing: Purlins, eave struts, clips and other items detailed.

F. Wall Systems: None.

G. Roof System: Preformed factory rolled metal panels with concealed clip system and factory applied sealant with sub-girt framing/anchorage assembly, insulation, and accessory components. Roof system to have a UL 90 uplift rating when tested in accordance with UL 580. Panel tested in accordance with air infiltration ASTM E1680 and water penetration, ASTM E1646.

H. Roof Slope: 1:12

1.08 DESIGN REQUIREMENTS

A. Design members to withstand dead load, applicable snow load, and design loads due to pressure and suction of wind calculated at 130 MPH in accordance with North Carolina State Building Code, 2012 edition, and ASCE 7-98 exposure, "C".

B. Design members to withstand UL 580 - Uplift Resistance, Uplift Class 90.

C. Exterior wall and roof system shall withstand imposed loads with maximum allowable deflection of span: As required by the North Carolina State Building Code.

D. Provide drainage to exterior for water entering or condensation occurring within wall or roof system.

E. Permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to temperature range of -5 to 120 degrees F.

F. Size and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance.

1.09 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Product Data: Provide data on profiles, component dimensions, and fasteners.

C. Shop Drawings: Indicate assembly dimensions, locations of structural members, connections, attachments, openings, cambers, loads; wall and roof system dimensions, panel layout, general construction details, anchorages and method of

anchorage, method or installation; framing anchor bolt settings, sizes, and locations from datum, and foundation loads; indicate welded connections with AWS A2.0 welding symbols; indicate net weld lengths; provide professional seal and signature of a North Carolina licensed engineer.

D. Samples: Submit two samples of precoated metal wall and roof panels for each color selected, 6 x 6 inch in size illustrating color and texture of finish.

E. Product Data: Provide data on profiler component dimensions fasteners, sealants and wall and roof panels.

1.10 1.9 SUBMITTALS FOR INFORMATION

A. Section 01300 - Submittals: Procedures for submittals.

B. Manufacturer's Instructions: Indicate preparation requirements, anchor bolt placement.

C. Erection Drawings: Indicate members by label, assembly sequence, and temporary erection bracing.

1.11 SUBMITTALS FOR CLOSEOUT

A. Section 01700 - Contract Closeout: Procedures for submittals.

B. Project Record Documents: Record actual locations of concealed components and utilities.

1.12 QUALITY ASSURANCE

A. Perform Work in accordance with AISC - Quality Certification Program Category MB. MBMA - Metal Building Systems Manual.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

C. Erector Qualifications: Company specializing in performing the work of this section with minimum five years documented experience approved by manufacturer.

D. Design structural components, develop shop drawings, and perform shop and site work under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located in the State of North Carolina.

1.13 REGULATORY REQUIREMENTS

A. Conform to North Carolina State Building Code for submission of design calculations, reviewed shop and erection drawings, and as required for acquiring permits.

B. Cooperate with regulatory agency or authority and provide data as requested.

1.14 PRE-INSTALLATION MEETING

A. Section 01039 - Coordination and Meetings: Pre-installation meeting.

B. Convene one week before starting work of this section.

1.15 WARRANTY

A. Section 01700 - Contract Closeout.

B. Panel Material: Durability of the roof panels due to rupture, structural failure or perforation shall be warranted for a period of 20 years by the manufacturer.

C. Painted Panels: The exterior color finish for painted roof, wall and liner panel shall be warranted by the manufacturer for twenty (20) years against blistering, peeling, cracking, flaking, checking, and chipping. Excessive color change and chalking shall be warranted for twenty (20) years. Color changes shall not exceed 9 N.B.S. units for white or 5 N.B.S. units for any other color (per ASTM D2244.64T and caulking shall not be less than a rating of 6 for white or 8 for any other color (per ASTM D-659).

D. Weathertightness:

1. The entire roof system, flashing, etc., shall be warranted against leaks for a period of twenty (20) years.
2. The warranty shall be issue to the Owner by the manufacturer.
3. The Manufacturer's warranty liability is limited to the total contract amount of the installed system less the cost of items incorporated in the work provided by another manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS - BUILDING SYSTEM

A. Manufacturers:
1. American Building Company
2. Butler
3. CECO
4. Inland Steel Buildings
5. MCBI
6. Varco-Pruden
7. Kirby Building Systems
8. Metallic Building Company
9. Substitutions: Refer to Section 01600.

2.02 MATERIALS - FRAMING

A. Structural Steel Members: ASTM A572, Grade 50 or ASTM A36 modified to 50,000 psi.

B. Purlins and Girts: Hot rolled steel strip minimum yield 55,000 psi, ASTM A570.

C. Structural Tubing: ASTM A500, Grade.

D. Plate or Bar Stock: ASTM A529/A529M.

E. Anchor Bolts: ASTM A307, galvanized to ASTM A386, Class B or ASTM 325.

F. Bolts, Nuts, and Washers: ASTM A325, galvanized to ASTM A153.

G. Welding Materials: AWS D1.1; type required for materials being welded.

H. Primer: SSPC 20, Red Oxide.

I. Grout: ASTM C1107, Non-shrink type, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 5000 psi in two days and 9000 psi in 28 days.

J. Cable: ASTM A475, Class A.

2.03 MATERIALS – LINER, WALL AND ROOF SYSTEM

A. Manufacturers:

1. Roof Panels: Substrate shall be 50,000 psi minimum yield steel meeting ASTM A792 with an aluminum-zinc ally coating meeting A250 having a minimum thickness of 0.50 oz per sq. ft. when tested by the triple spot method. Panels shall receive a "Galvalume" Coating. The panel shall be similar to roof panels 24 inches wide with 3 inch locking vertical rib, field seamed and a minimum of 24 gauge. The interlocking vertical rib shall contain a factory applied sealant. Panels shall be attached to the structure by concealed fasteners clips and thermal spacer over conditioned spaces. Factory finish, with fluorocarbon Kynar 500/Hylar 500 polyvinyl fluoride (PVC) coating. Exposed Exterior Surfaces: Design Basis: Architectural Metal Systems – Standing Seam II.
2. Liner Panels: Substrate shall be 50,000 psi minimum yield steel meeting ASTM A792 with an aluminum-zinc alloy coating meeting A250 having a minimum thickness of 0.50 oz per sq. ft. when tested by the triple spot method. Panels shall receive a "Galvalume" Coating. The panels shall be 36 inches wide with a decorative shadow line and semi-concealed fasteners. Rib height is 1 ¼" on 12" centers and be a minimum 24 gauge steel. Design Basis: Architectural Metal Systems – Architectural III Panels. Factory finish, with fluorocarbon Kynar 500/Hylar 500 polyvinyl fluoride (PVC) coating.
3. Wall Panels: Substrate shall be 50,000 psi minimum yield steel meeting ASTM A792 with an aluminum-zinc alloy coating meeting A250 having a minimum thickness of 0.50 oz per sq. ft. when tested by the triple spot method. Panels shall receive a "Galvalume" Coating. The panels shall be 24 inches wide with a decorative shadow line and semi-concealed fasteners. Rib height is 1 ¼" on 12" centers and be a minimum 24 gauge

steel. Design Basis: Architectural Metal Systems – Architectural III Panels. Factory finish, with fluorocarbon Kynar 500/Hylar 500 polyvinyl fluoride (PVC) coating.

4. Other acceptable manufacturers offering equivalent products.
   a. Varco-Prudem.
   b. Butler.
   c. CECO.
   d. Building Technologies.
   e. American Building Company.
5. Substitutions: Refer to Section 01600.

B. Insulation: Roll glass fiber type, faced with reinforced white vinyl, UL flame spread classification of 25 or less where exposed in accordance with Section 07213 Batt Insulation.

C. Joint Seal Gaskets: Manufacturer's standard.

D. Fasteners: Manufacturer's standard type, galvanized to ASTM A153 2.0 oz/sq ft, finish to match adjacent surfaces when exterior exposed.

E. Bituminous Paint: Asphaltic type.

F. Sealant: Manufacturer's standard type, non-staining, elastomeric, skinning.

G. Roof Curbs: Insulated metal same as roofing, 2 inch, designed for imposed equipment loads, anchor fasteners to equipment, counterflashed to metal roof system.

H. Trim, Closure Pieces, Caps, Flashings, Fascias and Infills, and same material, thickness and finish as exterior sheets; brake formed to required profiles.

2.04 METAL DOOR AND FRAME

A. Doors: Specified in Section 08111.

B. Frames: Specified in Section 08112.

2.05 OVERHEAD DOOR

A. Overhead Doors: Specified in Section 08360.

B. Overhead Door Frames: Manufacturer's standard.

2.06 FABRICATION - FRAMING

A. Fabricate members in accordance with AISC Specification for plate, bar, tube, or rolled structural shapes.

B. Anchor Bolts: Formed with bent shank, assembled with template for casting into concrete.

C. Provide framing for ventilator, and louver openings.

2.07 FABRICATION ROOF SYSTEMS

A. Roofing: Minimum 24 gage metal thickness, profile, lapped male/female edges fitted with continuous gaskets.

B. Girts/Purlins: Rolled formed structural shape to receive siding, roofing sheet.

C. Internal and External Corners: Same material thickness and finish as adjacent material, profile brake formed shop cut and factory mitered to required angles.

D. Expansion Joints: Same material and finish as adjacent material thick, manufacturer's standard brake formed infill type, of profile to suit system.

E. Flashings, Closure Pieces, Fascia, Infills, Caps: Same material and finish as adjacent material, profile to suit system.

F. Fasteners: To maintain load requirements and weather tight installation, same finish as cladding, non-corrosive type.

G. Wall Louvers: See Section 10211.

2.08 FABRICATION - GUTTERS AND DOWNSPOUTS

A. Fabricate of same material and finish as roofing metal.

B. Form gutters and downspouts of profile and size to collect and remove water. Fabricate with connection pieces.

C. Form sections in maximum possible lengths. Hem exposed edges.

D. Fabricate support straps of same material and finish as roofing metal, color as selected.

2.09 FINISHES

A. Primary Framing Members: Hot-dip zinc coating, ASTM F2329, Class C.

B. Secondary Framing Members: Hot-dip zinc coating, ASTM F2329, Class C.

C. Exterior Surfaces of Roof Liner Panel, Components and Accessories: Precoated on steel of Silicone Polyester finish, color as selected from manufacturer's standard range.

D. Interior Surfaces of Roof Panel, Components and Accessories: Galvanized steel, unfinished.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01039 - Coordination and Meetings: Verification of existing conditions before starting work.

B. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position

3.02 ERECTION - FRAMING

A. Erect framing in accordance with AISC Specification.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing.

C. Set column base plates with non-shrink grout to achieve full plate bearing.

D. Do not field cut or alter structural members without approval.

E. After erection, field touch-up abrasions to primary and secondary framing members with galvanized coating.

3.03 ERECTION - ROOFING SYSTEMS

A. Install in accordance with manufacturer's instructions.

B. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface.

C. Fasten cladding system to structural supports, aligned level and plumb.

D. Locate end laps over supports. End laps minimum 2 inches. Place side laps over bearing.

E. Provide expansion joints where indicated.

F. Use concealed fasteners.

G. Install insulation and vapor retarder utilizing purlins for attachment.

H. Install sealant and gaskets to prevent weather penetration.

3.04 ERECTION - GUTTER AND DOWNSPOUT

A. Rigidly support and secure components. Joint lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.

B. Apply bituminous paint on surfaces in contact with cementitious materials.

C. Slope gutters minimum 1/8 inch/ft.

D. Install splash pads under each downspout.

3.05 INSTALLATION - ACCESSORIES

A. Install door frame, door, overhead door, window and glass, in accordance with manufacturer's instructions.

B. Seal wall and roof accessories watertight and weather tight with sealant.

3.06 TOLERANCES

A. Framing Members: 1/4 from level; 1/8 inch from plumb.

B. Siding and Roofing: 1/8 inch from true position.

END OF SECTION

SECTION 13203

HORIZONTAL CALCITE CONTACTOR VESSEL (PRESSURE) SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. This specification describes a complete operational system to be furnished by a single responsible equipment manufacturer. It is the intent of this specification that the horizontal calcite vessel system manufacturer (equipment manufacturer) assumes system and process responsibility for the horizontal calcite contactor equipment in this section and supply all appurtenances described in this Section.

B. The system shall consist of the following components:
   1. Two (2) horizontal upflow calcite contactor vessels, each with three sealed compartment cells, individual cell calcite level sensor rods, effluent flow collector, influent flow distributor, gravel and sand media, calcite, air release valves, and other appurtenances as specified.
   2. Two (2) facepiping assemblies for each contactor vessel complete with piping, automated valves, and manual valves.
   3. Automated knife gates and stainless steel hoppers for overhead calcite loading from bags.
   4. Instrumentation and control equipment, as specified herein.
   5. Supply and loading of each vessel compartment cell with the initial load of calcite to the full bed depth.

C. This specification has been prepared on the basis of the specific requirements for this application. These specifications may require modification of manufacturer's standard equipment design. It will be mandatory that all equipment manufacturers meet all requirements of this specification. Any claims to the contrary, whether specific or implied, indicating that the equipment may not meet the specifications, will be considered grounds for rejection of shop drawing submittals.

1.02 RELATED WORK

A.	Section 11100	Electric Actuators
B.	Section 13445	SCADA system
C.	Section 13510	Reverse Osmosis Treatment Trains

1.03 SYSTEM DESCRIPTION

A. Upflow Calcite Contactor System
   1. Function: The purpose of the calcite contactor system will be to dissolve solid calcite with low pH (5 to 5.5) permeate water from the RO Treatment Trains. Permeate will flow under low pressure upward in the contactor vessels when the RO trains are operating. Calcium and carbonate will be dissolved from the calcite in order to add hardness and alkalinity to the permeate water. The reaction process will require sufficient empty bed contact time (EBCT) to achieve the equilibrium reaction. Treated water will flow out of the vessel cells via effluent collector cell at the top of each compartment (cell).
   2. System Design

a.	System design flow rate (w/one cell out of service)	2,778 gpm (4 mgd)
b.	Surface loading rate (5 cells in service)	4 gpm/sq ft

c.	Surface loading rate (6 cells in service)	3.5 gpm/sq ft
d.	Minimum empty bed contact time (EBCT) per cell	8 minutes
e.	Calcite bed depth at minimum EBCT	54 inches
f.	Calcite bed depth drop between loadings	~ 6 inches
g.	Rinse/backwash rate	up to 15 gpm/sq ft
h.	Rinse/backwash time	5 to 20 minutes
i.	Maximum cell pressure drop from inlet flange to outlet flange (bottom distributors, gravel, sand and top laterals)	2.5 psi
j.	Calcite media head loss, normal/maximium	1 psi/7 psi

3. Horizontal Contactor Vessels

a.	Number of Horizontal Vessels:	2
b.	Vessel diameter	12 ft
c.	Vessel length	36 ft
d.	No of Cells per vessel	3
e.	Total No. of Cells	6
f.	Cell hydraulic loading capacity	556 gpm/cell
g.	Cell bed surface area	~137 sq. ft/cell
h.	Total bed surface area per vessel	~ 411 sq. ft/vessel
i.	Vessel Pressure Rating	100 psi
j.	Vessel Test Pressure	130 psi

4. Calcite

a.	Calcite Bed Depth	60 inches
b.	Calcite Weight per Cell	31 tons
c.	Calcite Properties	
	1) $CaCO_3$ (% by wt)	>95
	2) $MgCO_3$ (% by wt)	<3
	3) Acid Insolubles (% by wt)	<2
	4) Moisture (%)	<0.2
	5) Specific gravity	~2.7
	6) Effective Size	1.5 to 3.0 mm
	7) Uniformity Coefficient	<1.5
	8) Loose density	~ 90 lb/cu ft
	9) NSF 61 approved	
	10) Puri-Cal RO, Imerys OZ white, or Engineer approved equal.	

5. Support Gravel and Sand Layer

a.	Overall depth	15 inches
b.	Gravel Layers	
	1) Bottom layer, 3/4" x 1/2"	4 inches
	2) Second layer, 1/2" x 1/4"	4 inches
	3) Third layer, 1/4" x 1/8"	4 inches
c.	Torpedo sand top layer, 0.8 to 1.2 mm	3 inches

6. Facepiping, Valves, and Knife Gates
   a. As shown on Drawings
7. System Performance

a.	Alkalinity addition per cell (inlet to outlet)	50 mg/L as $CaCO_3$
b.	Outlet water turbidity, NTU	<0.3 NTU units

1.04 QUALITY ASSURANCE

A. Reference Standards. AWWA, ANSI, ASME, FDA, and NSF.

B. Qualification of Manufacturers.

1. All bidding contractors shall base their bids on systems and equipment manufactured as specified in this section.
2. Calcite Contactor Manufacturers shall have the following qualifications:
   a. Installed a minimum of two reference systems with horizontal pressure vessels with calcite media. Provide installation, operation and maintenance manuals from the above referenced installations.
   b. Detailed equipment drawings, to scale, and complete detailed information covering equipment, processes and methods specified.
   c. Proof that the manufacturer has been active in horizontal pressure contactor systems for at least ten (10) years.
   d. A proposal indicating the total scope of the work being proposed and containing an itemized list of all equipment, materials and appurtenances, including structural configuration drawings and details.
   e. Evidence of manufacturer's engineering staff experience necessary to complete this project. Included shall be the resume of the supervisory P.E. who will affix his stamp on the submittal drawings. Such engineer shall be a direct employee of the manufacturer.
   f. Warranties and Bonds. Proof of ability to furnish warranties and bonds as described elsewhere in this specification.
3. Calcite Contactor Manufacturer shall be Tonka Water, Wigen Water Technologies, or Miami Tank.
4. Evidence of the manufacturer's ISO 9001:2008 quality system certification, including certificate. Manufacturer must submit their quality manual upon request.
5. Evidence of local representation in the State of North Carolina. Manufacturer must submit the company name, personnel names and phone numbers, and North Carolina address.
6. Proof of meeting the qualifications listed above shall be submitted by all bidding Contractors with their bids. **Failure to submit this information shall render the Contractor's bid as non-responsive.**

1.05 SUBMITTALS

A. The calcite contactor manufacturer shall submit information as specified in Sections 01330. Submittals shall include at least the following:
   1. Certified shop and erection drawings showing all details of construction, dimensions, support requirements, and anchor bolt pattern.
   2. Calculations for the pressure drop (in psi) for the nozzles in the lower flow distribution system or a contactor cell in Section 2.02.B.2. These shall be sealed by a P.E.
   3. Descriptive literature and drawings, including parts list, bulletins and/or catalog cuts for the equipment, including vessels, and all accessories, with the items to be furnished clearly marked in the submittal material.
   4. A list of the Manufacturer's recommended spare parts, including gaskets and hardware.
   5. A Bill of Materials for all supplied equipment and system components. A separate Bill of Materials shall be included on the panel layout drawing which includes all panel components, interior and exterior of the panel including the enclosure. Each Bill of Materials shall include the following information for each listed item: Item number, description/location, manufacturer, complete model/part number, quantity, and other pertinent information.

6. Control panel schematic diagrams, functional process description of the proposed control System, and the scope of the programming work to be performed by the system supplier.

B. The supplier of the Calcite Contactor system shall coordinate with the Control System Integrator (CSI) to ensure compatibility and commonality of the supplied system to other control systems furnished under this contract. The Calcite Contactor system shall be in accordance with Division 17, Instrumentation and Controls.

C. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the equipment as supplied for the Project.
   1. Each manual shall be a bound, indexed binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Approved shop drawings.
      b. Control panel wiring diagrams.
      c. Warranty information for each component.
      d. Instructions for startup/shutdown of system and for adjustment of equipment.
      e. Inventory, functional descriptions and operating instructions for equipment.
      f. Recommended routine maintenance procedures for pumps
      g. Recommended preventative maintenance for each major component.
      h. Complete bill of material.
      i. Installation instructions for the specific equipment.
      j. Contact information for contractor capable of performing emergency repairs.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service. for each piece of equipment.
      b. Equipment plate data.
   3. After the front page provide field test report
   4. Finals, "As Commissioned" non-password protected and fully documented Program application files shall be submitted electronically on a CD-ROM.
   5. Provide 3 printed and 1 digital media copy of the O&M Manual.
      a. Digital copy shall be in Adobe Acrobat format with an electronic Table of Contents. Scanned drawings shall have a minimum resolution of 400 DPI.

D. Factory Test Reports and certified performance information.

PART 2 PRODUCTS

2.01 GENERAL

A. All components of the system herein described shall be fabricated and manufactured from new, unused materials, free from defects, of the highest quality possible.

B. The materials and equipment shall be of the configuration, quality and design features as specified herein.

2.02 DETAILS OF CONSTRUCTION

A. Vessel

1. All pressure vessels shall conform to the Equipment Schedule and be constructed in accordance with Section VIII of the ASME code requirements for cold fired pressure vessels, and shall bear the ASME stamp. Minimum thicknesses shall be furnished in accordance with ASME code requirements. Verification of ASME code design to include calculated head, shell, and cell isolation wall thicknesses. They shall be submitted with the first submittal drawing and be approved by the engineer prior to authorization of fabrication. Vessels shall be fabricated in a facility holding a current ASME U-stamp. Facilities holding an ASME R ("repair") or other certification shall not be considered acceptable for vessel fabrication.
2. All flanges, plates, angles, channels, beams, etc., including sideshell to head connections, shall be joined by penetration welds, each side, continuous welding. Flanges shall be factory welded on split centers prior to shipment.

B. Vessel Interior Construction

1. Effluent Collection System
   a. Each contractor cell shall include a header/lateral collection system, factory installed prior to shipment. The header lateral flow distributor shall be constructed of Schedule 80 PVC with all joints solvent welded. All mounting hardware shall be 316L stainless steel.
   b. The header lateral system shall be designed to accept a flow up to 12 gpm/square foot of contactor area.
   c. Pipe Collectors with submerged or semi-submerged orifice collection points shall not be acceptable.
2. Low Flow Distributer System
   a. A header-lateral inlet lower flow distributer system shall be installed in the bottom area of each contactor cell. It shall be designed to insure uniformity of flow through the filter cells in both the backwash and treatment modes of operation. The flow distributer systems shall be of Schedule 80 PVC.
   b. Pressure drop across distributor nozzle shall be design for 1.0 psi or less during design service upflow operation (4 gpm/sq ft).
   c. The lower head area of the filter shall be sandblasted and finish painted the same as the interior of the vessel above the underdrain.
   d. After installation of the header/lateral underdrain, concrete fill shall be installed by the contractor under the calcite contractor system manufacturer's direct supervision. The concrete fill shall be installed up to the bottom of the low flow distributor laterals during the installation process. The laterals shall be protected until the installation process has been complete.
   e. The distributor diffuser nozzles shall be non-metallic, self cleaning nozzles and shall be chemically resistant to acidified permeate water (pH of 4 to 6). They shall be mounted in the distributor lateral risers arranged on approximate 12" centers. Nozzles shall be provided with peripheral slot openings as required to collect and distribute flow laterally. Slot openings shall be designed to prevent lodging of support gravel in the slot opening. Toggle-bolted designs are not permitted due to their inherent loosening potential. Diffuser nozzles using parallel metal or plastic plates, spacers and coupling bolts shall not be acceptable.

C. Vessel Miscellaneous Components

1. Each contractor cell shall be equipped with one 14"x18" manway, rated for the working pressure of the vessel. Manways shall be placed in each cell near the top of the vessel for access into the contractor for gravel and calcite loading and cell access.
2. Each horizontal pressure vessel shall be completely subdivided into three equal isolated contactor cells. The isolated cell design shall be designed to permit the operator to place any cell out of service at atmospheric pressure, while the remaining cells continue to operate at full working pressure. Each cell wall shall be subjected to test pressure as listed in Part 1.03 during shop testing.
3. Structural steel saddles shall be provided for support of vessels. Anchor bolts shall be furnished by the installing contractor.
4. Contactor tank connections shall consist of Sch. 40 steel pipe with interior and exterior coating per Part 2.14 , projecting and terminating in a flange 6" from the outside face of the sideshell. Flanges shall be standard ANSI pattern, welded on split centers ad shall be true and plum. Nozzle size and quantity for each vessel shall be as follows:
   a. Cell influent, 10-inch flanged 3
   b. Cell effluent, 10-inch flanged 3
   c. Air Release, 2" NPT 3
   d. Cell top loading, 18-inch flanged 3
5. Sampling Taps
   a. Provide five (5) ½-inch size sample taps with ball valves for each cell: influent, effluent, 3" above the gravel layer, 20" above the gravel layer, 40" above the gravel layer.
   b. 1/2" diameter full couplings shall be provided for sample taps.

2.03 SUPPORT GRAVELS AND FILTRATION MEDIA

A. The support gravel shall consist of hard rounded stones with an average specific gravity of not less than 2.5. It shall not contain more than 2% weight of pieces in which the length is three times the width. The gravel shall be free of shale, mica, clay, sand, dirt and organic impurities.

B. Support gravels and sand layers size and thickness shall be as specified in Section 1.03.

C. The bottom layer of the screened support gravel shall be placed by hand to avoid damage to the diffuser assemblies. Each layer shall be placed and leveled before the addition of the next layer is started. A gravel-less flow distributor system shall not be acceptable.

D. The support gravels shall be procured from a manufacturer that complies with AWWA-B 100-01 standards. Installation of support gravels shall be under the direct supervision of an employee of the equipment manufacturer experienced in this procedure. If media skimming is required, it shall be the responsibility of the installing contractor.

2.04 CALCITE

A. Calcite shall meet the requirements listed in Part 1.03. Calcite chosen shall also meet the performance requirements in Part 1.03. Equipment manufacturer is at liberty to perform suitable column tests or other in-house laboratory tests to check performance prior to selection of calcite to be used.

B. The equipment manufacturer shall provide the initial fill of calcite for all cells. The calcite shall be placed on top of the support gravel. The vessel/cell shall first be filled with water up to the design calcite bed depth (60 inches) to avoid dust and for uniform calcite distribution.

C. The equipment manufacturer shall supply sufficient calcite to top off cells as required to maintain a calcite bed depth of 60" after operational testing.

D. Installation of calcite shall be under the direct supervision of an employee of the equipment manufacturer experienced in this procedure.

2.05 FACEPIPING

A. All piping and fittings shall be Sch 80 PVC in accordance with Section 02510 Water Distribution System.

B. Facepiping shall be provided by the equipment manufacturer to the limits shown on the Drawings.

2.06 FACEPIPE VALVES

A. Contractor function valves shall be electrically actuated and shall be provided by the equipment manufacturer. Valve number and size shall be as shown on the Drawings.

B. All facepiping valves shall be fully lugged style butterfly valves, and shall be one-piece disc through shaft constructed with Nylon coated cast iron bodies. Disks and stems shall be 316 stainless steel. Disk-stem will be through-stem direct drive double "D" design requiring no disk screws or pins to connect stem to disc with no possible leak path. Stem shall be mechanically retained in body neck and no part of stem or body exposed to line media.

C. Valve seats shall be EPDM-Food Grade with tongue and groove design with primary hub seal and molded O-ring. Seat shall totally encapsulate the body with no flange gaskets required.

D. Discs shall be spherically machined, hand polished disc edge and hub for minimum torque and maximum sealing capabilities. Valves shall have non-corrosive bushings and self-adjusting stem seals. Valves shall be bi-directional and tested to one hundred ten percent (110%) of full rating. No field adjustment shall be necessary to maintain performance.

E. Butterfly valves supplied shall be Bray Series 30/31, Dezurik BOS; or approved equal.

F. Where shown on the Drawings, an electric motor operator shall be supplied on butterfly valves. Electric actuators shall meet the requirements in Section 11100 Electric Actuators.

G. Where shown on the Drawings, manual valve operators shall be hand-wheel type gear with cast iron housing and hand-wheel, position indicator, and have adjustable open and closed position stops.

H. Combination air/vacuum release valves shall be supplied for each compartment cells (total of six) and shall be Val-Matic Model #202C or equal. Each combination air vacuum release valves shall be supplied with a 2" isolating gate valve. The exhaust piping shall be by the installing contractor to daylight on the contractor concrete pad. Each combination valve exhaust piping shall be piped separately.

2.07 KNIFE GATES

A. Automatic knife gates shall be provided for calcite loading at the top of each cell (total of 6). Knife gates shall be 18-inch size, flanged and connected to a flanged pipe connection at the top of each vessel cell. Valves shall be supplied with electronic actuators with remote and local manual push button for open/close control.

B. Knife gate valve shall seat from the fluid and pressure from inside the vessel cell. When the valve is opened during loading, knife design shall be such that calcite is prevented from entrapment in the gate valve seat during calcite loading.

C. Knife gate valve body, gate, gate stem and guide, packing gland, bolts and all other hardware shall be 316 stainless steel.

D. Knife gate shall be 316 stainless steel. Gate edge shall be machined, finished, and rounded and have a 45 degree beveled knife edge for drip tight seal against the resilient seat. The gate faces shall be finish ground.

E. Valve packing shall fit a rounded cast packing chamber. The packing system shall consist of multiple layers of TFE packing with copper scraper ring. Scraper ring tolerances shall exclude calcite material from the packing material during calcite loading operation. The packing gland shall match the valve body material. The fasteners shall be stainless steel.

F. Valve body shall be a one piece lug casting of type 316 stainless steel. Valve body shall incorporate cast guides and jams and can handle full reverse pressure without damage. Valve seat retainer shall be cast as part of the valve body. The back side of the valve seat retainer shall be beveled to direct calcite away from the seat material when the vessel is being filled with calcite (i.e. on the hopper side of the valve). Valve inside port diameter shall be equal to ANSI B36.10 STD pipe inside diameter for both metal and resilient seated valves. Raised faces shall be full width per ASME B16.20 standards for spiral-wound gaskets.

G. Valve shall have resilient seats. Resilient seated valves shall have the resilient seat material molded on three sides of the stainless steel seat ring for drip-tight shutoff. Resilient seat material shall be abrasion resistant, chlororene (CR) suitable for use with solid calcite material and treated RO permeate.

H. Face to face dimensions shall meet MSS SP-81. Flange drilling shall be in accordance with ANSI B16.5 class 150, 2" - 24"/50mm - 600mm.

I. Valve pressure rating shall be 150 psi.

J. Knife gate valves shall be DeZurik Model KGC-HD, or Engineer approved equal.

K. Knife Gate Electronic Actuator
   1. An electric actuator shall be supplied on each knife gate valve to open and close the gate on the valve. Actuator shall be as specified in Section 11100 Electric Actuators.
   2. Limit switches shall be provided to indicate valve open or closed positon to the control panel.

2.08 CALCITE LOADING HOPPER

A. A 316 stainless steel calcite top-loading hopper shall be provided for each vessel cell (total of six). Each hopper shall have a 18-inch round bottom flange for

connection to the knife gate. Flange bolt pattern shall be compatible with the knife gate valve for direct mounting of hopper on the knife gate.

B. Hopper shall be 24 inches high from bottom flange to top edge. Hopper shall have 24-inch by 24-inch square opening for the top 1 foot and then transition to 18-inch round flanged bottom connection.

C. Provide 316 stainless steel pipe spool from each vessel cell top exit flange to the bottom of the knife gate assembly (total of six). Pipe to conform to Section 02511 Stainless Steel Water Pipe.

2.09 BACKWASH FLOWMETER

A. Backwash flow meters shall be supplied by the equipment manufacturer on the backwash supply line as shown on the Drawings and specified herein. Flow meters shall be magnetic meter type.

B. Meter Design

1. The magnetic flowmeter shall be an obstruction-less pipeline-mounted instrument to magnetically measure the flow of the process media. The output signal shall not be affected by changes in fluid viscosity or density and shall have zero point stability and auto zeroing functions. Provide the magnetic flowmeter with the following features:
   a. Drip and splash proof, capable of withstanding temporary submersion of up to 30 feet of water for 48 hours.
   b. Integral terminal box with watertight cable seals.
   c. Stainless-steel grounding rings and grounding straps.
   d. Interconnecting cables.

C. Meter Performance

1. Accuracy: 0.5% of flow rate with minimum fluid velocity of 1 fps.
2. Repeatability: +0.1% of flow rate.
3. The accuracy of each meter shall be verified by calibration in a flow laboratory traceable to the U.S. National Institute of Standards and Technology.
4. Adjustable full-scale range.
5. Outputs: Bidirectional, isolated 4- to 20-ma d-c.
6. Minimum Conductivity: 5 micromho/centimeter.
7. Power Consumption: 20 watts maximum.
8. Temperature Limits, Ambient: -20°F to +140°F.
9. Temperature Limits, Process: Elastomers +160°F, Teflons +300°F, ceramic 350°F.
10. The flowmeter shall have a positive zero return (PZR) input controlled by an external dry contact.
11. Environmental Rating: NEMA 4X, Class I, Division 1, Groups B, C, and D for both sensor, and electronics.
12. The meter shall have empty pipe detection.
13. A common alarm discrete output (a dry contact or a transistor switch) shall be provided for remote indication of fault conditions.

D. Materials of Construction

1. The flow tube shall be Type 316 stainless steel.
2. Liner shall be Teflon
3. Electrodes shall be 316L stainless steel.

E. Indicator/Totalizer

1. The indicator/totalizer shall accept the process flow signal from the magnetic flowmeter and convert its electrical output signals directly proportional to the instantaneous metered flow rate. The housing shall be suitable for field mounting.

F. Transmitter
1. The transmitter shall be microprocessor based with flow rate indicator in engineering units, forward, reversed, and net flow totalizer, all in user-selectable engineering units.
2. The transmitter shall be remotely mounted on the train instrument panel.
3. The preamplifier input impedance shall be a minimum of 10E+11 ohms.
4. Power Requirements: 115-volt a-c, 60 Hz.
5. Totalized flow and programmed configuration shall be maintained in memory for up to 10 years.

G. Interconnecting Cable
1. The interconnecting cable between the sensor and the transmitter shall be furnished by the magnetic flowmeter manufacturer.

H. Manufacturers
1. The backwash magnetic flow meters shall be manufactured by Rosemount, Yokogawa, Endress & Hauser, or approved equal.

2.10 WASTE TO DRAIN VALVE

A. Provide one waste to drain valve on the backwash/rinse waste line. Valve shall be butterfly type and meet requirements of Section 2.06.

2.11 INSTRUMENTATION

A. Loss of Head Gauge Panel:
1. For each vessel, the equipment manufacturer shall furnish an aluminum loss of head gauge panel completely factory fabricated from 3/16" brushed aluminum plate having a textured finish, with minimum dimensions of 18" x 22". Panel shall measure loss of head for all three cells in a vessel.
2. The gauge panel shall have the following 4-1/2" flush mounted gauges for <u>each</u> calcite vessel:
   a. Inlet header (0-30 psi)
   b. Effluent header (0-30 psi)
   c. Loss of head between influent and effluent headers (0-10 psi setable differential pressure gauge with switch). Pressure differential switch to be field set at time of panel installation.
   d. Pressure switch shall send signal to Calcite Contactor Control Panel if high differential pressure is sensed at a vessel.
3. Each panel shall be equipped with the following component:
   a. Phenolic nameplates identifying gauges and sample taps for each cell.
   b. Two flush mounted sample taps for influent and effluent locations for each vessel.
   c. Manufacturer nameplate, aluminum construction.
4. Manufacturer shall furnish mounting hardware (brackets, U-bolts, nuts, washers, etc.) for affixing panel to facepiping. Installation of panel shall be by the Contractor.

B. Calcite Bed Level Sensors

1. Calcite bed level shall be sensed by an ultrasonic level instrument. The sensor shall sense the interface level of the top of calcite bed and the overlying water and display the level on instrument controller and at the Calcite System Control Panel. When the level drops to an operator settable setpoint, an advisory alarm shall be annunciated at the Calcite System Control Panel. This will indicate the need to fill the cell with more calcite.
2. Sensor shall be top-mounted into each calcite cell above the calcite bed and submerged in water. The sensor shall be no closer than 24-inches to the design calcite bed height.
    a. Sensor Mounting: Provide ¾ inch NPT. 4" stainless steel blind flange drilled to accept a water tight cable gland rated for 45 psi for passing sensor cable from within the tank to the outside of tank. Sensor to be fastened to the blind flange within the calcite vessel.
    b. The weight of the sensor shall not be support directly by the sensor cable.
    c. The sensor shall be mounted in a rigid fashion such that the sensor will not move when temporarily exposed to air (during calcite loading) or during calcite cell rinse or backwash operations.
3. The system shall consist of six (6) microprocessor-based sensor(s), two (2) Controller(s), six (6) Power Supply Unit(s), interconnecting cable, and hardware. One controller and three sensors will be provided for each Calcite Vessel.
    a. Sensor
        1) The primary element shall be a microprocessor based ultrasonic Smart Sensor operating in the range of 550kHz to 750kHz. Sensors shall be implemented in a multiple sensor Field Network. Sensors shall receive power from a Power Supply Unit that they are connected to and shall receive programming instructions from the Controller.
        2) Performance
            i) Measurement Range: 1.0 ft. to 32.0
            ii) Resolution: 0.12 in. at 10.0 ft.
            iii) Accuracy: 0.1 ft. at 10.0 ft.
            iv) Sensor Operating Temperature: 34°F to +125°F.
        3) Materials
            i) ABS and epoxy, IP68 Dimensions: Standard Sensor, 2.44 x 2.95 in.
    b. Controller
        1) The Controller shall consist of a multi-function graphical user interface with integral membrane switch for instrument programming, measurement indication, and other instrument functions. It shall supply power to a sensor, and provide connections necessary to effect instrument communication.
        2) The Controller shall be capable of being fitted with a cell modem to facilitate remote factory start-up and technical support. The cell modem feature shall enable remote programming and control of the Smart Sensor(s).
        3) Operating Temperature: -40°F to +140°F.
        4) NEMA 4X, IP65, Polycarbonate Enclosure.
        5) Dimensions: 9.25 x 9.0 x 4.5 in.
    c. Power Supply Unit

1) The Power Supply Unit shall consist of a power supply and communications hub. It shall supply power to a sensor, and provide connections necessary to effect instrument communication.
2) The Power Supply Unit shall be capable of being fitted with a cell modem to facilitate remote factory start-up and technical support when such service is specified as an option. The cell modem feature shall enable remote programming and control of the sensor(s).
3) Operating Temperature: -40°F to +140°F.
4) NEMA 4X, IP65, Polycarbonate Enclosure.
5) Dimensions: 7.125 x 7.125 x 2.375 in.

4. Networked Instrument Configuration and Communication
   a. Smart Sensors shall be interlinked into a wired Field Network by twisted pair cable in daisy-chain fashion beginning at the Controller. The network shall be comprised of Smart Sensors, one Controller, and Power Supply Units in quantity that together with the Controller equal the number of sensors in the network.
   b. Console Programming: There shall be a Windows®-based software program that enables communication with the Smart Sensor(s) for programming, monitoring, data download and instrument diagnostics when connected to a PC or laptop computer via RS-485, Modbus RTU protocol.
   c. Sensor signal output
      1) RS-485 Modbus RTU protocol
      2) 4-20mA Current Loop into Max. 600 ohms
   d. Controller
      1) Display - 320 x 240 Backlit Graphical Monochrome (2.6 x 3.45 in. viewing area)
      2) RS-485 Modbus RTU protocol, RS-232 Modbus protocol
      3) Programmable Relays, four (4)
   e. Power Supply Unit
      1) RS-485 Modbus RTU protocol
5. Power Requirements
   a. Sensor: 15VDC, 20W (Provide By the Power Supply Unit).
   b. Controller: 100-240 VAC, 50/60 Hz (1A).
   c. Power Supply Unit: 100-240 VAC, 50/60 Hz (1A).
6. Sensor system shall be Entech Design, Inc., EchoSmart Interface Level Analyzer.

2.12 CONTROLS

A. General: The contactor manufacturer shall furnish a PLC-based Calcite System control panel with OIT, necessary hardware, components, timers, operator interface terminal, enclosure, relays, switches, alarms, I/O, and other items necessary for a complete operational system.

B. Hardware:
1. Programmable Logic Controller (PLC): The control panel shall be PLC-based using an AllenBradley CompactLogix PLC, as specified under Part 2.15 and as specified herein. The system PLC shall include a minimum of 10% spare I/O capacity including digital and analog I/O. Power integrity shall be furnished via Uninterruptable Power Supply (UPS) as specified under Part 2.15.
2. SCADA Communications: The Plant SCADA System communications network connection shall be Ethernet I/P per Part 2.15. Calcite contactor system

supplier shall coordinate with the control system integrator (CSI) for the amount of allotted space required inside the calcite contactor system control panel for the communications equipment (fiber optic patch panel, network switch, and media converters), furnished by the CSI, along with the fiber optic cable.

3. Panel Components and Enclosure: The system control panel enclosure shall be 316 stainless steel, NEMA 4X, and shall include temperature controls, transient surge protection, etc, as required for an outdoor installation for the Calcite control system. The panel mounted components (HOA switches, lights, indicators, horn, etc.) shall be NEMA 4X rated and in conformance with Part 2.15
4. Operator Interface Terminal (OIT) shall be Series 1000 Panel-View Plus OIT color touch screen by AllenBradley. Refer to Part 2.15 for OIT specifications and additional requirements.

C. The OIT shall be panel mounted and shall indicate the following, via a series of custom designed screens:
   1. Service, Backwash and Rinse operation status for each cell.
   2. Calcite bed level indication for each cell.
   3. Valve open/closed position for all electrically actuated valves.
   4. Backwash supply line flow rate and timer clock display with countdown
   5. Rinse timer clock display with countdown.
   6. Drain timer clock display with countdown.
   7. Alarms/alarm acknowledges
   8. Status of external signals from Plant SCADA system
      a. Backwashing holding tank level
      b. Finished water tank level
      c. RO Treatment Train run status
   9. Other functions, indication and information as required for a complete operating system.

D. Timers: Countdown timers' setting inputs and displays shall be available on the OIT for the following:
   1. Backwash period
   2. Rinse period

E. Transient Voltage Surge Suppression
   1. Refer to Part 2.15 for transient voltage surge suppression.

F. Functional Control Description
   1. General: The Calcite System Control Panel shall have manual and automatic operating modes.
      a. Automatic Mode. Automatic mode shall be the normal operating mode. In automatic mode, valve operation, with the exception of the knife gate valves, will be opened and closed by the control logic based on operator selected cells to be in operation. Backwash cycle shall also be automated once the operator starts a backwash cycle from the OIT. The control panel shall open and close appropriate valves and send start/stop signals to the backwash pump. The panel backwash timer shall control the backwash period.
      b. Manual Mode. This mode will only be used with the operator present. In this mode, the operator will manually open/close all cell valves in the correct sequence and modulate the backwash valve opening setting from the OIT. The OIT screen shall include HAND-OFF-AUTO selection on the

screen for all valves and each valve shall have an OPEN-CLOSE selector switch.

1) It is the intent that the only operation that will routinely use Manual Mode is the calcite loading operation.

c. Opening/closing of the knife gate for calcite loading will only be allowed manually from the OIT. A Local-Off-Remote (LOR) switch will also be provided at each knife gate valve location at the top of each cell by the equipment manufacturer. In the Local position, the gate will be in open/close position by a local switch, in the OFF position, the gate shall be closed, and in the Remote position the gate open/close shall be controlled by the Calcite System Panel PLC.

d. The Calcite System Panel PLC shall control the contactor functions and shall indicate and communicate contactor status to the OIT and to the Plant SCADA system.

e. Contactor cell differential pressure (i.e. headloss) will be sensed for each cell at the loss of head panel. At a pre-selected differential pressure, as sensed by the differential sensing device, the OIT screen will indicate a backwash is required for that cell.

f. The configuration of the face piping shall allow individual cell backwashing/rinsing.

g. Operator selectable functions:
   1) Automatic or Manual Mode
   2) Service, Backwash, or Rinse Operation
   3) Cells Operating (Cell 1 through Cell 6)
   4) Pressure differential alarm setpoint for each cell
   5) Backwash cycle timer setpoint, 0-20 minute
   6) Backwash flow rate (8 to 15 gpm/sq ft)
   7) Rinse cycle timer setpoint, 0-20 minutes
   8) Rinse flow rate (4 to 8 gpm/sq ft).
   9) Drain cycle timer septpoint, 0 to 20 minutes
   10) Cell Bed low level alarm setpoint, 6 to 12 inches below full calcite bed level.

2. Service Operation (Automatic Mode)

a. In service operation, permeate will flow upward in the contactor bed, be treated, and flow via a low pressure pipe to the finished water ground storage tank. Once set, valves for each cell will remain in the service position until either the operator either starts a backwash/rinse cycle or the operator chooses to stop flow to the cell by manually shutting the cell OFF at the OIT.

b. In Service Operation mode the operator shall make the following selections:
   1) Select cells (Cells 1 through 6) to be in service via cell ON/OFF button.

c. Once the ON button is selected by the operator the valves associated with that cell will automatically be opened/closed per the following sequence:
   1) Confirm that knife gate valve is closed.
   2) Close all backwash valves. Confirm that backwash valves are closed.
   3) Open influent valve to the cell.
   4) Open effluent valve to the cell.

d. Once the cell OFF button is selected by the operator the valves associated with that cells will be automatically opened/closed per the following sequence:

1) Check that knife gate valve is closed.
2) Close effluent valve.
3) Close influent valve

3. Backwash Operation (Automatic Mode)
   a. Only one cell will be allowed to backwash at a time.
   b. Backwash operation will be started manually by the operator. Typically this will be prompted by a cell high differential pressure setpoint alarm at the OIT. This will indicate a high head loss situation. The backwash rate and time will be based on the setpoint values. Backwash will be in an upflow direction and finished treated water will be used.
   c. In Backwash Operation mode the operator shall make the following selections:
      1) Select an alternative cell to be placed in service (if cell available).
      2) Select a single cell (Cells 1 through 6) to backwash via START BACKWASH button.
      3) Controls will only allow one cell to be backwashed at a time.
   d. Once the BACKWASH START button is selected by the operator the valves associated with that cell will automatically be opened/closed per the following sequence:
      1) Confirm that knife gate valve is closed.
      2) Close effluent valve.
      3) Close permeate supply valve
      4) Open backwash supply valve.
      5) Open backwash to waste valve.
      6) Backwash supply valve modulates to backwash flow set point for the setpoint time period.
      7) When backwash times out, backwash supply valve is closed and all cell valves will set to closed position.
      8) Operator will then need to initial a service START to bring cell back into service operation.
4. Calcite Loading Operation (Manual Mode Only)
   a. Calcite loading operation will be a manual operation by the operator.
   b. The operator will select OFF in the Service Mode for the cell to be loaded and all valves to that cell will be closed.
   c. The operator will manually OPEN the cell rinse/backwash drain valve to lower the water level approximately 1 foot in the cell. The operator will then manually CLOSE the valve when all the water has drained from the upper part of the cell and no more water is draining. Once the rinse/drain valve is closed, then the operator can then select the KNIFE GATE OPEN button on the OIT or use the push button at the knife gate location.
   d. Once the KNIFE GATE OPEN button is selected by the operator the following sequence will follow:
      1) PLC check that Service, Backwash, and Rinse modes are in OFF position and all electric actuated valves are closed
      2) Open knife gate valve.
      3) Gate will remain open until the operator selects "KNIFE GATE CLOSE" button on the OIT
5. Rinse Operation (Automatic Mode)
   a. Rinse operation will be manual start by the operator after a calcite loading cycle has been completed. The rinse flow and time will be based on the setpoint values. Rinse will be in an upflow direction in the vessel and

finished water (from the backwash supply line) will be used for the rinse operation at normal service flow rates.

b. The cell will already have been turned OFF in the Service Mode and all valves will be closed (except the knife gate) during calcite loading operations.

c. In Rinse Operation mode the operator shall make the following selections:
   1) Select a single cell (Cells 1 through 6) to rinse via START RINSE button.
   2) Controls will allow one cell to be rinsed at a time.

d. Once the RINSE START button is selected by the operator the valves associated with that cell will automatically be opened/closed per the following sequence:
   1) Check that knife gate valve is closed.
   2) Close effluent valve.
   3) Open backwash supply valve.
   4) Open backwash to waste valve.
   5) Backwash supply valve modulates to rinse flow set point for the rinse setpoint time period.
   6) After timer times out, all cell valves will set to the closed position for that cell.
   7) Operator will then need to initial a service START to bring the cell back into service operation.

6. Manual Mode. Operator shall manually open and close all valves and start and stop backwash pump in the order listed above. Backwash and rinse timers will not be used in this mode and the operator will need to select a manual stop button for these operations.

G. Power Failure: If power to the PLC is lost, the uninterruptible power supply shall engage and shall continue automatic operation of the Calcite Contactor Control Panel (all function and indication) for a minimum of 15 minutes. If after 15 minutes power has not been restored to the panel, then all valves shall fail to "service" condition, meaning that all cells shall be placed into normal service mode. If a cell is in backwash or rinse mode, then the process will be placed in hold until the return of power at which time it will resume and complete the process.

H. Alarms: The following events will trigger alarms and send signals back to the Plant SCADA system. Alarms will be initiated by the Calcite System Control Panel and be communicated back to the Plant SCADA. System alarms and shutdowns will be initiated by the Plant SCADA System. All alarms listed below shall be indicated on the alarm OIT screen and the Plant SCADA System. Alarms times prior to any shutdowns will be field set.

1. Contactor System Panel Alarms
   a. Cell backwash required (high differential pressure) advisory
   b. Backwash to waste valve fail shutdown backwash/rinse
   c. Backwash valve fail shutdown backwash/rinse
   d. Cell Knife Gate Valve Open (during cell operation) cell shutdown
   e. Cell bed level low alarm advisory
2. Plant SCADA System
   a. High finished water tank level advisory
   b. High flush water waste holding shutdown backwash/rinse

I. Shop Testing. Prior to shipment the Calcite System Control Panel shall be fully tested with all alarms, indication and I/O fully simulated at the factory prior to shipment. All screens shall be tested along with all alarm functions and other control parameters, verified by factory certification as to inspector and date inspected. Testing shall be subject to verified witnessing by the engineer if required.

2.13 PAINTING

A. The interior of the vessel and all tank connections and flanges shall be sandblasted and protected from corrosion by proper application of approved coatings for potable water by the equipment manufacturer. The exterior of the vessel shall be sandblasted and prime painted at the factory by the equipment manufacturer and finished onsite by the contractor. Interior paint/coatings shall all be NSF 60/61 approved material.

B. Surface preparation:
   1. Interior
      a. Sandblasted to near white blast cleaning (SSPC-SP10 Commercial Blast Cleaning with a minimum sharp angular anchor profile of 1.5 mils).
   2. Exterior
      a. Sandblasted to commercial blast cleaning (SSPC-SP6/NACE 3 Commercial Blast Cleaning with a minimum sharp angular anchor profile of 1.5 mils).

C. Surface preparation shall include:
   a. Correct steel and fabrication defects revealed by surface preparation.
   b. Remove weld spatter and slag.
   c. All welds shall be ground to a smooth contour as per NACE Standard RP0178, Designation D for Lap, Butt and Fillet Welds.
   d. Smooth weld undercuts and recesses
   e. Grind down porous welds to pinhole-free metal.
   f. Remove weld flux from surface.

D. Coatings:
   1. Interior
      a. Stripe coating: hand-applied one coat Tnemec Series N140 or N140F Pota-Pox Plus in color 15BL Tank White to all welds and hard to reach areas using high quality natural or synthetic bristle brush, to a dry film thickness of 3-5 mils.
      b. Prime coating: Tnemec Series N140 or N140F Pota-Pox Plus in color 1255 Beige primer to a dry mil thickness of 3-5 mils before any rust can form.
      c. Finish coating: Tnemec Series N140 or N140F Pota-Pox Plus in color 15BL Tank White to a dry mil thickness of 4-6 mils for a total dry film thickness of 7-11 mils.
   2. Exterior
      a. Stripe coating: hand-applied one coat Tnemec Series N140 or N140F Pota-Pox Plus in color 15BL Tank White to all welds and hard to reach areas using high quality natural or synthetic bristle brush, to a dry film thickness of 3-5 mils.
      b. Prime coating: Tnemec Series N140 or N140F Pota-Pox Plus in color 1255 Beige to a dry mil thickness of 3-5 mils before any rust can form.

c. Finish coating: Tnemec Series N140 or N140F Pota-Pox Plus in color 15BL Tank White to a dry mil thickness of 4-6 mils for a total dry film thickness of 7-11 mils.

E. The total paint system shall be the product of and be applied in accordance with the recommendations of one manufacturer. Alternate paint systems must be pre-approved by Engineer. Contractor shall purchase an adequate amount of touch-up paint, if required. Uniformly apply coatings at spreading rate required to achieve specified DFT. Thickness of coatings and paint shall be checked with a non-destructive, magnetic-type thickness gauge, as per SSPC-PA 2 "Measurement of Dry Film Thickness with Magnetic Gages".

2.14 CONTROL PANEL COMPONENTS AND ACCESSORIES

A. Pilot Relays
1. Pilot relays shall be supplied with the following:
a. 24 VDC coils.
b. At a minimum, DPDT contacts rated at 5 A, 120 VAC or 28 VDC.
c. Socket of different configuration from 120 VAC relays.
d. Clips for attachment to sockets.
e. Indicator lights that glow when the relay coil is powered.
2. Pilot relays shall be as manufactured by Square D, Allen Bradley, Potter & Brumfield, or equal.

B. Programmable Logic Controllers
1. General
a. The UV System Manufacturer shall furnish programmable controllers (PLC's) as specified herein and as shown on the Drawings. PLC's shall be provided complete with rack, power supply, I/O cards, special function cards, instructions, memory, input/output capacity, and appurtenances to provide all features and functions as described herein. No substitutions will be permitted.
b. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.
c. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.
d. Where applicable, the minimum PLC rack size for rack-based PLCs shall be 7 slots power supply slots. All input/output modules shall be hot-swappable.
e. System configuration shall be as shown on the Control System Block Diagram. PLC types shall be designated on the Control System Block Diagram and correspond to the specifications herein. Only a single type of

processor shall be supplied for all PLC's of a designated type. Memory and processor shall be adequate for all control functions specified. PLC's shall be ControlLogix-series as manufactured by Allen-Bradley.

2. Processors
   a. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Nonvolatile memory in the form of a manufacturer supplied industrial CompactFlash card or equivalent technology shall be required to maintain the entire current program and firmware of the controller in the event of power loss. The program shall be updated onto the flash memory each time a program change such as an online edit or tag value is changed. When nonvolatile memory (flash memory) is not available for certain controller models as offered by the PLC manufacturer, long-life lithium batteries shall be used to maintain process RAM memory for at least one year in the event of power loss. The lithium battery unit shall be an externally mounted battery assembly with the highest available capacity. The PLC shall send an alarm to the plant control system if battery level is low and the low battery warning LED shall be indicated on the processor module.
   b. The instructions set for the PLC shall conform to the requirements of IEC 61131-3. Each PLC shall have the capability to run all five of the standard IEC 61131-3 languages simultaneously. These five languages shall be:
      1) Ladder Diagram
      2) Stuctured Text
      3) Instruction List
      4) Function Block Diagram
      5) Sequential Function Chart
   c. PLC processors shall be provided with substantial user program, data and logic memory to allow for future expansion of the overall system. The total memory used on each processor shall be less than 60% of available memory at project completion.
3. Communications
   a. In addition to a communications port for the data highway network, communication ports shall be provided for any other devices required (i.e., operator interface unit) plus an additional communication port for connection to a notebook computer.
   b. Additional communication modules or protocol gateways may be required to support specific communication protocols required under this Contract, and shall be supplied at no extra cost to the Buyer.
4. Input/Output Subsystems
   a. Input/output hardware shall be plug-in modules in associated I/O rack or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.
   b. Discrete inputs shall be 24 VDC (integral to the PLC) from dry field contacts. Discrete outputs shall be 24 VDC outputs sourced from the PLC,

or dry relay contacts (2A minimum) as required. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 32 per input module and 16 per output module.

c. Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be miniature type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall be Type KU as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

d. Analog input circuits shall be isolated, minimum 12-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTD's. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Maximum density for analog I/O modules shall be 8 per module.

e. Transient Voltage Surge Suppression Devices
   1) All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.
   2) Manufacturer's Requirements: All surge protection devices shall be manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Edco, Phoenix Contact, Transtector, or equal.
   3) Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.
   4) Surge protection devices shall be installed as close to the equipment to be protected as practically possible.
   5) Device Locations: As a minimum, provide surge protection devices at the following locations: At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters; At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building; At both ends of all copper-based communications cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.

f. AC Power Protection - Surge protection device assemblies for connections to AC power supply circuits shall:
   1) Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.

2) Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.
3) Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.
4) Comply with all requirements of UL 1449, second edition.
5) Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
6) Have the following characteristics: Maximum Continuous Operating Voltage: 150VAC; Maximum Operating Current: 20 amps; Ambient Temperature Range: -20 degrees C to +65 degrees C; Response Time: 5 nanoseconds.

g. Analog Signal Circuit Protection - Surge protection device assemblies for analog signal circuits shall:
1) Have four lead devices with DIN Rail mounting.
2) Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
3) Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.
4) Comply with all requirements of UL 497B.
5) Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
6) Limit line-to-line voltage to 40 volts on 24VDC circuits.
7) Have the following characteristics: Maximum Continuous Operating Voltage: 28VDC; Ambient Temperature Range: -20 degrees C to +65 degrees C; Response Time (Line-to-Line): 5 ns

h. Communication Circuit Protection - Surge protection devices for copper-based data communication circuits shall:
1) Be designed for the specific data communication media and protocol to be protected (i.e. telephone, serial, parallel, network, data highway, coax, twinaxial, twisted pair, RF, etc.).
2) Provide protection of equipment to within the equipment's surge withstand levels for applicable standard test wave forms of the following standards: IEC 60-1 / DIN VDE 0432 part 2; CCITT K17 / DIN VDE 0845 part 2; IEEE C62.31.
3) Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
4) Provide automatic recovery.

i. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals

for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting mode, or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

j. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

5. Remote I/O Subsystems
   a. Remote I/O shall be provided as designated on the Control System Architecture Drawing. Remote I/O shall be either PLC rack type I/O or field modules as manufactured by the PLC manufacturer. Field modules shall meet the requirements of Subsection 2.04, Input/Output Subsystems. Remote I/O processor or communication modules shall be modular and individually replaceable.
   b. Remote I/O shall communicate with the PLC using the PLC manufacturer's standard protocol or an open standard network such as DeviceNet, Ethernet IP, Profibus, Foundation Fieldbus, Modbus, or equal.
6. Programming Software
   a. The PLC programming and configuration software shall be the manufacturer's latest version, Windows-based. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. Programming shall be accomplished through the use of ladder logic and other IEC 1131.3 languages. PLC programming software shall include CD-ROM documentation.
   b. Third-party programming software shall be acceptable if recommended by the manufacturer and if that software exceeds the capabilities of the PLC manufacturer's standard software package.

C. Operator Interface Unit
1. An Operator Interface Unit (OIT) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface. The OIT shall provide the following features as a minimum.
   a. Minimum of 10.4 inch diagonal display
   b. 18-bit color TFT LCD display of 640 x 480 pixels
   c. Resistive film touch screen interface
   d. Minimum of 512 MB internal storage
   e. Minimum of 512 MB RAM application memory
   f. 1.0 GHz CPU
   g. Windows CE Operating System
   h. Battery Backed real-time clock
   i. SD, 2 USB-A, 1 Mini-USB, and PCI interface
   j. RJ-45 Ethernet communication interface, 10/100 Mb auto selecting

k. RS-232 serial port
l. Sound and buzzer output
m. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
n. Enclosure Rating: shall match the enclosure's rating that it is mounted in.
o. Environment: 0-50°C, 20-85% relative humidity, non-condensing

2. The operator interface unit shall be Allen Bradley PanelView Plus 6 1000, or equal.

D. Ethernet Network Switches

1. Except where specifically allowed on the Control System Architecture Drawing, industrial Ethernet network switches shall be provided for each device connected to the process control system network. The switches shall create switched Ethernet networks that conform to the IEEE 802.3 and 802.3u standards using copper wires or optical fibers in a bus, tree or ring network topology as shown on the Drawings. Ethernet network switches shall be modular, rack mounted, or standard DIN-rail mounted within the PLC cabinet or in an adjacent communication cabinet, as shown on the Drawings.
2. Ethernet network switches shall support ring, bus, tree, or point-to-point network topologies. The Ethernet network switches shall support the non-proprietary Rapid Spanning Tree Protocol (RSTP) in addition to the switch manufacturer's standard redundant ring network protocol, both of which shall provide self-healing communication recovery.
3. Ethernet network switches shall meet the following minimum performance requirements:
   a. Functions: Modular managed switch with store and forward switching mode, 10 Mbps Ethernet or 100 Mbps Fast-Ethernet support, muLti-address capability, auto-crossing, auto-negotiation, auto-polarity. Each network switch shall manage up to eight (8) ports possible via integrated media modules specified below.
   b. Management: Simple Network Management Protocol (SNMP) (v1/v2/v3) and Common Industrial Protocol (CIP) support; IGMP filtering and snooping.
   c. Power Requirements: Redundant 24 VDC power supply
   d. Operating Temperature: 0° - 60°C
   e. Relative Humidity: 10 – 95%
   f. Network Size: Up to 50 nodes in ring structure
   g. Port Type & Quantity (at each PLC location)
      1) Minimum of four (4) 10/100Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment
      2) Two (2) 100Base-FX, multimode fiber optic cables (62.5/125 µm), ST or SC sockets, 0-5000 meters LAN segment
   h. Link Budget: 8 dB @ 1300 nm; 10 dB @ 850 nm
   i. Wavelength: 850 or 1300 nm
4. Acceptable Ethernet network switches shall be as manufactured by Hirschmann, or equal.

E. Uninteruruptible Power Systems

1. Each UPS shall consist of a tower or rack-mounted UPS module and battery modules as required to meet backup run time requirements.
2. UPS systems shall be true on-line, double-conversion type. Each UPS shall be sized to match the maximum power requirements of the associated digital

equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.

3. UPS units using line interactive or ferro-resonant transformer technology shall not be acceptable.
4. An automatic bypass switch shall be provided on each UPS. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.
5. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.
6. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.
7. Each UPS shall meet the following requirements:
   a. Input voltage shall be 117 VAC, single phase, 60 Hz.
   b. Voltage regulation shall be +/-5 percent for line and load changes.
   c. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.
   d. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for servers, client workstations, and PLC-based control panels, and 45 minutes for remote telemetry units.
   e. A status monitoring and control panel shall be provided and shall include the following:
      1) Status indicating lights for both normal and abnormal conditions.
      2) Common alarm contacts that shall be wired to the closest discrete input subsystem. An RS-232 and USB port shall provided for communication of UPS status to a server, client, or other suitable hardware. All required interface software and hardware shall be provided.
      3) Circuit breaker for the AC input.
      4) Sound absorbing enclosure.
      5) EMI/RF noise filtering.
      6) Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
   f. UPS systems shall be Eaton Powerware 9130, Emerson Network Power (Liebert) Model GXT3, equivalent by MGE UPS Systems, GE Digital Energy, or equal.

F. Terminal Blocks

1. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be

of the screw down pressure plate type as manufactured by Phoenix Contact, Wieland, Square D, or equal.

2. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30 amps.
3. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

G. Cabinets and Panels

1. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.
2. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.
3. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in chlorine storage/feed areas shall be of non-metallic, FRP construction, rated NEMA 4X.
4. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.
5. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel, fast operating clamp assemblies that do not require bolts or screws to secure. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.
6. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
7. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC or DCU) shall be provided with a folding laptop programmer shelf on the inside of the door.
8. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Rittal. The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

H. Electronic Indicators

1. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup.

Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor services as required and shall have the same NEMA rating as the enclosure it is installed on. Indicators shall be Red Lion Model IMP or APLCL, or equal.

I. Signal Converters

1. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.
2. General Requirements – Converters shall be of the miniature type, utilizing all solid state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.
3. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.
4. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4-20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.
5. Frequency to Current Transducers – Frequency to current transducers shall convert pulse-rate and pulse-duration signals to 4-20 mA, 24 VDC analog signals. Converters shall include field-adjustable input frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Timeverter as manufactured by AGM, Moore Industries equivalent, Rochester Instrument Systems (RIS) equivalent, or equal.
6. Current to Frequency Transducers – Current to frequency transducers shall convert 4-20 mA, 24 VDC analog signals to pulse-rate and pulse-duration signals. Converters shall include field-adjustable output frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Quantimer as manufactured by AGM, Moore Industries equivalent, Rochester Instrument Systems (RIS) equivalent, or equal.
7. Integrators – Integrators shall be provided as interchangeable plug-in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be

+ 0.1% of input span. Integrators shall convert linear analog signals to pulse rate and provide a solid-state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), or equal.

8. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4-20 mADC, and the set point shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be +0.1% per degree F. The repeatability shall be +0.1% of span. The units shall be furnished with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.
9. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4-20 mADC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Contractor shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer's standard enclosure for installation in an existing indoor electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.
10. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be miniature type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall be Type KU as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.
11. Timing Relays – Timing Relays (TR) shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.
12. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA-classified hazardous areas. Intrinsically safe relays and barriers shall be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

J. Accessories

1. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.
2. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated,

maintained contact type. Pilot lights shall be of the proper control voltage, LED type with light lens colors shall be as specified below.

Color	Function
Red	Running (Open)
Green	Stopped or Off (Closed)
Amber	Fault
White	Other

3. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.
4. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Delivery and Storage
   1. Upon delivery of the equipment to the jobsite, the contractor shall take inventory of the shipment and immediately report to the equipment manufacturer any discrepancies between the equipment manufacturer's packing lists and shipping documents.
   2. The contractor shall be responsible for off-loading and protection of all equipment against damage and during the on-site storage and installation. All media must be stored on pallets in a manner that protects it from UV, radiation and weather. Damaged equipment and materials will be replaced by the contractor at the contractor's expense.

B. Manufacturer's Instructions: Installation shall be as shown on the plans and in accordance with the manufacturer' recommendations, installation instructions and assembly drawings shall be submitted and approved by the engineer prior to shipment of equipment. Installation of the filtration system shall be in strict accordance with the details shown on the drawings and in complete conformance to manufacturer's instructions and procedures.

3.02 FACTORY SERVICES AND START-UP

A. Installation Supervision. The Contractor shall coordinate with the equipment manufacturer to provide factory supervision or direction during critical phases of installation. Critical phases will include setting of equipment, installation of internals, installation of controls, wiring instrumentation and other components critical to the successful operation of the system. The representative shall be on-site for a minimum of 3 days, however, the representative is required to be on-site as necessary for a complete installation.

B. Calcite and Gravel Installation. Installation of support gravels and calcite shall be under the direct supervision of an employee of the calcite contactor manufacturer experienced in this procedure.

C. System Start-Up and Training

1. The contractor will verify in writing that the project is ready for manufacturer's field services. Copies of written verification shall be given to the manufacturer, engineer and owner prior to scheduling field services.
2. The contractor shall provide the services of a factory trained representative during start-up of the calcite contactor vessels. The representative shall be on-site for train a minimum of 3 days. At a minimum, the equipment manufacturer's technician shall perform the following start-up functions:
   a. Inspect the final installation to assure proper installation, connection and wiring of all equipment of the manufacturer's supply.
   b. Start-up of the equipment in the presence of the Contractor and Owner's operating personnel.
   c. Training of Owner's operating personnel in proper operation and maintenance procedures, start-up/shutdown procedures, response to emergency conditions and troubleshooting. The responsibility of the Contractor and the factory service representative with regard to start-up shall be fulfilled when the start-up is complete, the equipment is functioning properly, operating personnel have been trained and the equipment has been accepted by the Owner.
3. In addition to the above requirements, the Contractor shall provide pre- startup software coordination services for incorporating monitoring and control functionality of the calcite contactor system into the plant SCADA system. The Contractor shall also include a minimum of 4 hours during startup assistance with the SCADA System Programmer (SSP) which includes coordination, programing, startup, and testing services as necessary to ensure the supplied system is in accordance with the contract specification and drawings and successfully integrated into the Plant SCADA system.

3.03 PERFORMANCE TESTING

A. Performance testing shall be conducted for each of the six calcite contactor cells.

B. During start-up, the equipment manufacturer's representative shall perform individual cell inlet water and outlet water field tests to confirm performance of the equipment. Analytical methods employed for field testing shall be performed by a drop down titration field test kit. Filed test kit shall be Hach Alkalinity Test Kit, Model AL-AP (Part No. 2444301), low range, alkalinity in 5 mg/L increments or equivalent. Equipment manufacturer may use another method with Engineer approval.

C. Once the equipment manufacturer is satisfied with the field testing results and that the effluent turbidity is as desired, one set of inlet and outlet sample from each cell shall be taken and sent to the laboratory for alkalinity analysis.

D. The amount of alkalinity added will be equal to the outlet alkalinity minus the inlet alkalinity measurements.

3.04 WARRANTY AND BONDS

A. Effluent Performance Warranty

1. Sampling for conformance shall be taken during following one hour of operation after calcite flushing and placement into operation. All adjustments necessary to comply with this guarantee shall be made at the Contractor's expense.

B. The equipment shall be warranted for a period of one year from the date of placing it on-line.

END OF SECTION

SECTION 13206

PRESTRESSED CONCRETE WATER TANK

PART 1 GENERAL

1.01 SCOPE

A. Provide labor, including the engineering design, materials, and equipment for the construction of wire-wound circular prestressed-concrete water tank indicated as finished water ground storage tank on the Drawings, and specified herein.

B. The Project shall consist of the following tank:

	Tank Name	Size (mg)	Top	Disinfection
1.	Ground Storage	1.0	Covered	Yes

C. Work shall include, but not be limited to, the following major items:
1. Clearing, grading, excavating, and backfilling required for the tank construction.
2. Construction of the above listed tanks with appurtenances indicated on the Drawings and specified herein.
3. Piping to five (5) feet outside of the tank.
4. Interior baffles as indicated on the Drawings.
5. Disinfection of tank(s) as listed above.
6. Painting of the exposed exterior surfaces.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
1. Section 00320 Geotechnical Data
2. Section 02512 Disinfection of Potable Water Systems

1.03 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
1. American Concrete Institute (ACI)
   a. 344R Design and Construction of Circular Prestressed Concrete Structures
   b. 350R Concrete Sanitary Engineering Structures
   c. 506 Recommended Practice for Shotcreting
2. American Society for Testing and Materials (ASTM)
   a. A366 Specification for Steel Sheet, Carbon, Cold-Rolled, Commercial Quality.
3. American Water Works Association (AWWA) Standards
   a. D110 Wire-Wound Circular Prestressed-Concrete Water Tanks

1.04 DEFINITIONS

A. Tank Contractor: The words "Tank Contractor" when used in these specifications shall be defined as indicated in the Definitions of Document 00800, Supplementary Conditions.

B. Structural Engineer: The words "Structural Engineer" when used in this Section shall be defined as a professional engineer registered in the State of North Carolina working for the Tank Contractor and specializing in the design and construction

supervision of prestressed concrete water tanks and the associated foundation. The Structural Engineer shall have a minimum of five years of experience in the design and construction supervision of the type tank provided for this Project.

1.05 SYSTEM DESCRIPTION

A. Tank(s) designed and constructed under this specification shall conform to AWWA D110 and the following requirements:
   1. Minimum volume as indicated above.
   2. Core walls shall be Type II, shotcrete with a steel diaphragm.
   3. Floors shall be a concrete membrane floor.
   4. Covered tanks shall have a roof designed as a spherical thin shell free span dome with ring girder.
   5. The following shall be as indicated on the Drawings:
      a. Inside diameter and wall height.
      b. Finished floor and overflow elevations.
      c. Location and size of the inlet, outlet, drain, and overflow pipes.
      d. Location and size of access hatch(es), exterior and interior ladders, and vents.
   6. Finish: Unless indicated otherwise, interior surface shall receive a light broom finish and the exterior surface to receive a steel fresno trowel finish.
   7. Exterior finish as specified.

1.06 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures.
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Tank accessories and components including, but not limited to, ladders, hatches, ventilators, and supporting devices.
      b. Exterior coating system.
      c. Interior baffle curtains
   2. Shop Drawings: Submit project specific shop drawings for the following:
      a. Submit design plans signed and sealed by a professional structural engineer registered in the State of North Carolina, specializing in wire-wound circular prestressed-concrete water tanks. Design plans shall indicate the following:
         1) Description of structural design loading conditions including seismic requirements used for tank design including foundation.
         2) Plans shall include a note that the design was based on the soils report included in this Project Manual.
         3) Detail drawings indicating types, sizes, locations, installation details of all components, and other construction details.
         4) Design for piping entrance at floor.
   3. Manufacturer's Instructions:
      a. Exterior coating instructions.
   4. Test Reports:
      a. Wire Stress Tests
   5. Certificates of Compliance:
      a. Baffle curtain system composed of NSF 61 compliant geo-membrane components.
      b. Design certification: After completion of construction, submit structural engineer's certification that the tank(s) were constructed in conformance with the design plans in paragraph 1.6.A.2 above and these specifications.

6. Warranty:
    a. Geo-membrane baffle system.

1.07 QUALITY ASSURANCE

A. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.

B. Design the prestressed tanks for the loads as required in AWWA D110, the soil conditions as indicated in the soils report included in this Project Manual, and the wall height and roof spans as indicated on the Drawings.

C. The baffle curtain fabricator shall have furnished and had in satisifactory service for a period not less than 5 years, at least 5 baffle systems with dimensions and quanitities similar to the one specified for this project.

D. Tank shall be constructed by the Crom Corporation, Natgun Corporation, Precon Corporation, Preload Company, or approved equal.

E. Substitutions shall be as specified in Section 01600, Product Requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Product shall be handled in accordance with Section 01600, Material and Equipment.

1.09 GUARANTEE

A. Tank Contractor shall guarantee workmanship and materials on the complete tank for five years from the date of acceptance of the work. In case of defects appearing within the five year period, the Tank Contractor shall promptly repair the tank at its own expense upon written notification by the Owner that such defects have been found. Leakage shall be defined as measurable flow appearing on the exterior of the tank, the source of which is from the inside of the tank.

B. The geo-membrane baffle manufacturer shall confirm in writing that the material to be furnished will be free of defects in materials and workmanship at the time of sale, and against deterioration due to effects of ozone, ultraviolet or other normal weathering on a pro-rated basis for 10 years from the date of completed installation.

PART 2 PRODUCTS

2.01 CONSTRUCTION MATERIALS

A. Materials used in the construction of the tank(s), including but not limited to the following, shall comply with AWWA D110:
    1. Concrete
    2. Shotcrete
    3. Water
    4. Admixtures
    5. Reinforcement
    6. Steel sheet diaphragm
    7. Sealants

B. Piping shall be ductile iron in accordance with Section 02510, Water Distribution System.

2.02 TANK ACCESSORIES

A. Wall Manhole: Stainless steel with stainless steel fasteners. Cover shall be gasketed and easily resealable. The manhole shall have a waterstop ring that is to be sealed watertight to the diaphragm.

B. Dome Access Opening: Provide a roof opening with a minimum clear dimension of 36 inches and framed a minimum of 4 inches above the roof surface. The opening shall have a lockable hinged fiberglass or aluminum watertight cover, which overlaps and extends down from the frame a minimum of 2 inches and is capable of supporting a minimum concentrated live load of 150 lbs. The cover shall have a compressible seal.

C. Ventilator: Provide a fiberglass ventilator with stainless steel fasteners. Ventilator shall be double screened with 20 x 20 mesh vinyl screening. Ventilator shall be caulked to the dome.

D. Ladders: Exterior ladder shall be aluminum with stainless steel fasteners and interior ladder shall be stainless steel with stainless steel fasteners.

E. Pipe Railing
   1. Pipe railing shall be designed and installed in accordance with OSHA and the N. C. State Building Code, Factory - Industrial occupancy, Group F, and the following requirements.
   2. Rail requirements:
      a. Height: 42 inches to centerline of top rail. (1121) Not more than 34 inches nor less than 30 inches from leading edge of tread for stairs. (1112.5.1)
      b. Number of rails: Two (One top, one intermediate)
      c. Rail Spacing: Maximum clear distance between rails shall be 21 inches. (1121.5)
      d. Pipe cross section: 1-1/2 inch minimum diameter (1112.5.3)
      e. Pipe material: Schedule 40 (min.) aluminum alloy 6063-T6 or 6105-T5, ASTM B-429 or ASTM B-221.
      f. Toe plate: 4 inch high, mounted 1/4 inch above walking surface. (11121)
      g. Max. post spacing: 6 feet center to center.
      h. Finish: Anodized. Pipe shall be plastic wrapped and shall not be removed until after installation.
      i. The top surface of the rail shall be smooth and not be interrupted by projections.
      j. Provide self-closing gate at all rail openings.
      k. Manufacturer shall provide expansion joint for rail and toe plate as necessary.
      l. Aluminum surfaces in contact with concrete or grout shall have a coating of bituminous paint. When in contact with dissimilar metals pipe shall be protected by a mylar isolators or other approved material.
   3. Rail system shall be of welded construction or made of component fittings. Railings shall be shop assembled in the largest practical sections for shipping and installing.
   4. Component fittings must be mechanically fastened with stainless steel hardware. Holes must be located on the underside of the railings and on posts away from the walking surface. Pop-riveted or glued joint will not be acceptable.
   5. Welds shall be ground smooth.

6. Rail system shall be mounted on the top or side of structure surface as indicated on the Drawings. Mounting shall be as designed by manufacture using stainless steel type 303 wedge expansion bolts.
7. Shop drawings for rail system shall be signed and sealed by a professional engineer registered in the State of North Carolina who is regularly engaged in the design of pipe rail system. Shop drawings shall include a note that the rail system was designed in accordance with the N. C. State Building Code.
8. Rail system shall be as manufactured by Alumaguard, Hollaender Manufacturer, Thompson Fabricating Co., or equal.

F. Overflow: Equip overflow discharge with a stainless steel insect screen and flap valve. Flap valve shall be as specified in Section 02082, Specialty Valves.

2.03 BAFFLE CURTAIN

A. Design Requirements
1. The baffles shall conform to the specified dimensions and shall be designed for installation in potable water. All parts shall be made from corrosion resistant and chemical resistant materials suitable for service in raw or treated water storage facilities and comply with current AWWA and ANSI/NSF-61 standards. The suspended baffles and accessory materials shall be capable of withstanding exposure to chlorine and ammonia, extreme temperatures, rips, and hydraulic shock. The baffle system shall be suitable for expected water levels with daily fluctuations and shall have adequate strength to resist 0.5 inch of water depth difference across the baffle.
2. The baffles shall be erected and anchored to the floor, walls, and roof as shown in the plans to provide a flow path for maximum contact time for potable water in the tank.

B. Fabric
1. The fabric shall be listed by NSF61 as being acceptable for use in potable water. The fabric shall have a knitted polymer coated polyester fabric with a 6.5 oz. /sq. yd. minimum weight.
2. The fabric shall be of good appearance and free of all defects such as holes, tears, blisters and any other defects that may affect its serviceability.
3. The coated fabric shall not be less than 30 mils thickness with a +10 percent allowable variation. There shall be not less than 7 mils thickness of polymer coating over the base fabric.
4. The polyester fabric shall be non-wicking.
5. The coated fabric shall be UV stable (either black or black/white) in order to possess maximum UV resistance when exposed to the atmosphere for extended periods of time.
6. The fabric shall meet or exceed the following minimum physical properties:

Fabric	**Standard**	**Metric**
Base Fabric Type	Polyester	
Base Fabric Weight (nominal)	6.5 oz/yd^2	220 g/m^2
Thickness ASTM D 751	30.0 mils min	0.75 mm min
Weight – ASTM D 751	30.0 ± 2 oz/yd^2	1020 ± 70 g/m^2
Tear Strength – ASTM D751, Trapezoid Tear	35/35 lb min	155/155 N min
Breaking Yield Strength – ASTM D751, Grab Tensile Procedure A	550/550 lb min	2450/2450 N min
Low Temperature – ATSM D 2136, 4 hr (1/8" mandrel)	Pass @ -30°F	Pass @ -35°F
Dimensional Stability – ASTM D 1204, 212°F (1 hour)	1.5% max each direction	1.5% max each direction
Adhesion Heat Sealed Seam – ASTM D 751, Dielectric Weld	35 lb/2 in min	150 N/5 cm min

Dead Load Seam Shear Strength – ASTM D 751, 4 hr test	2 in seam, 1 in strip 210 lb @ 70°F 105 lb @ 160°F	5 cm seam, 2.5 cm strip 935 N @ 21°C 465 N @ 70°C
Bursting Strength – ASTM D 751, Ball Tip	650 lb min 800 lb typical	2890 N min 3560 N typical
Hydrostatic Resistance – ASTM D 751, Method A	800 psi min	540 N/sq cm min
Blocking Resistance – ASTM D 751, 180°F/82°C	#2 rating max	
Adhesion – Ply – ASTM D 413, Type A	15 lb/min or Film Tearing Bond	65 N/2.5 cm min or Film Tearing Bond
Bonded Seam Strength ASTM D 751, Grab Test Method, Procedure A	550 lb min	2450 N min
Abrasion Resistance – ASTM D 3389, H-18 Wheel 1000g load	2000 cycles (min) before fabric exposure 50 mg/100 cycles max weight loss	
Weathering Resistance – ASTM G 153 (Carbon-Arc)	8000 hrs (min) – No appreciable changes or stiffening or cracking of coating	
Water Adsorption – ASTM D 741, Section 12, 7 days	0.025 kg/m^2 max @ 70°F/21°C 0.14 kg/m^2 max @ 212°F/100°C	
Wicking – ASTM D 751	1/8 in max	0.3 cm max
Puncture Resistance – ASTM D 4833	250 lb min	1110 N min
Coefficient of Thermal Expansion/Contraction – ASTM D 696	8 x 10^{-6} in/in/°F max	1.4 x 10^{-5} cm/cm/°C max

C. Fasteners and Hardware
   1. All bolts, washers, nuts, and expansion anchors shall be type 316 stainless steel, minimum 3/8-inch diameter.
   2. Curtain connections shall be fiberglass angle, minimum ¼-inch thickness by 2 inches wide by 2 inches wide.
   3. Suspension and Tension for the top and open ends of the curtain(s) shall be type 316 stainless steel 3/16" diameter cable with type 316 stainless steel 3/16" cable clamps and thimbles.

PART 3 EXECUTION

3.01 SOILS DATA

A. The subsurface investigation is attached to the end of Section 00220, Geotechnical Data.

B. The tank Structural Design Engineer shall be responsible for obtaining additional soils data as he determines necessary for the required design of the water tank.

3.02 TANK FLOOR

A. Provide a minimum thickness of 8 inches of concrete over all pipe encasements under the floor membrane. The minimum percentage (0.6%) of reinforcing steel applies to these thickened sections and shall extend a minimum of 2 feet into the adjacent 4 inch thick floor.

B. Floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.

C. Floor shall be continuously water cured until tank construction is completed.

D. Provide thickened areas beneath the membrane slab as required for securing the base of the baffle curtain.

3.03 TANK STEEL-SHELL DIAPHRAGM

A. Seal vertical joints in the diaphragm watertight by epoxy sealants suitable for bonding to concrete, shotcrete, and steel.

B. Steel shell design and its sealant procedure shall have been used in a minimum of ten tanks previously constructed by the tank construction company. No nail or other holes shall be made in the steel shell for erection or other purposes except for inserting pipe sleeves, reinforcing steel, bolts, or other special appurtenances. Seal penetrations with an approved epoxy sealant. Tanks designed to use a waterstop at the floor / wall joint, the steel shell diaphragm shall be epoxy bonded to this waterstop.

3.04 SHOTCRETE

A. Apply shotcrete under direct supervision of experienced nozzlemen certified per ACI CP-60. Broom each shotcrete layer prior to final set to effect satisfactory bonding of the following layer. No shotcrete shall be applied to reinforcing steel or diaphragm which is encrusted with overspray.

3.05 HORIZONTAL PRESTRESSING

A. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire, placed under high tension. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.

B. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive stress equivalent to that required in the design calculations. Splicing of the wire shall be permitted only when completing the application of a full coil of wire, or when removing a defective section of wire.

C. Areas to be prestressed will contain not less than 10 wires per foot of wall. A maximum of 24 wires per layer per foot will be allowed. Shotcrete shall be used to completely encase each individual wire, and protect it from corrosion by having a clean space between adjacent wires at no less than one wire diameter.

D. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire as it is positioned on the tank wall.

3.06 EXTERIOR OVERCOAT

A. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This shotcrete encasement shall completely encapsulate each wire, and shall permanently bond the wire to the tank wall. The shotcrete cover shall have a thickness of no less than one inch over the wire. When multiple layers of wire are required, shotcrete cover between layers shall be not less than 1/8 inch thick.

3.07 DOME ROOF

A. Design dome as a free span, spherical thin shell, with a minimum rise-to-span ratio of 1:10. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have a cross section suitable to accept the applied prestressing forces.

B. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.

3.08 TESTS AND REPAIRS

A. Wire Stress: The tank contractor shall supply the necessary equipment to measure tension in the wire after it is positioned on the tank wall. This stress measuring

equipment shall include electronic direct reading stressometer accurate to within 1% and calibrated dianometers. The initial tension in each wire shall be recorded with a copy of field measurements provided to the Engineer.

B. Leakage Tests: The tank shall be filled with potable water to the maximum level and allowed to stand for at least 24 hours. The drop in liquid level shall be measured over the next 72 hours to determine the liquid volume loss. The net liquid loss for a period of period of 24 hours shall not exceed 0.01 of 1 percent of the tank capacity. Damp spots on the exterior wall surface or measurable leakage of water at the wall base shall not be permitted. The leakage test as outlined above shall be in conformance with Section 4.13, AWWA D110.

C. Repairs: Repairs may be made as allowed under Section 4.14, AWWA D110.

3.09 BAFFLE CURTAIN

A. Preparation and Fabrication
   1. Prior to factory seaming, all roll goods shall be inspected. All factory seams shall be made by thermal fusion methods. All factory seams shall have a minimum scrim-to-scrim overlap of one and one-half inches (1½") when fabricated. Fabricated seams found to have less than the specified minimum overlap shall be repaired by adding an overlap or cap strip that provides the minimum specified overlap or it will be rejected. All seams shall be made so that thermal fusion bond extends fully along the width of the sheet so that no loose edges are present.
   2. Prior to installation, all unnecessary material and equipment shall be removed from the tank and the floor slab installation areas shall be swept clean.

B. Inspection
   1. All sheets and seams shall be 100% visually inspected during fabrication. No defective seams or exposed scrim will be allowed. All exposed scrim edges shall be sealed with an additional strip of 8130 XR-3PW. All indicated repairs shall be made by the geomembrane fabricator before the panels are packaged for shipment.
   2. In addition to visual inspection, a 48-inch (1.2m) weld sample shall be made with each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Sample shall be taken from a seam specifically made for quality testing and not taken from the fabricated panel itself. Test specimens shall be cut at quarter points from each 48-inch seam sample (a total of three places) and tested for seam strength and peel adhesion. The shear seam strength shall be tested in accordance with ASTM D751 as modified in Annex A of ANSI/NSF 54. The peel adhesion shall be tested in accordance with ASTM D 4437 as modified in Annex A of ANSI/NSF 54.
      a. A log shall be maintained showing the date, time, panel number and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the material and/or seams as appropriate. The Fabricator shall provide the test results to the Owner or Engineer upon request.
   3. Upon completion of baffle wall installation, contractor shall visually inspect the baffle walls for damage from ground level. Any repairs shall be made with newly manufactured material cut with rounded corners extending 4-inches in each direction from the damaged area. The entire repair shall be completely welded to the baffle wall.

C. Installation

1. Contractor shall field verify dimensions and provide the field dimensions to the baffle curtain fabricator prior to fabrication of the baffle curtains.
2. All work shall be fabricated and erected in accordance with the approved submittal drawings. No field seaming shall be allowed.
3. Baffle shall be secured to the floor and wall with fiberglass angles with type 316 stainless steel expansion anchors or cast in place threaded inserts. All baffle penetrations shall be punched.
4. Provide a 3/8-inch polypropylene rope in the perimeter of the baffle curtain(s). Rope shall be secured with a 4½-inch wide double hem at the floor and wall connections and a 3-inch wide double hem at the top and open end connections. The floor and wall hems shall be reinforced with an additional 2½-inch wide chafing strip on both sides of the hem, front and back. Install curtain(s) so that chaffing strip is mounted behind the angles in direct contact with the concrete.
5. Provide fiberglass NSF approved or stainless steel angle sandwiching the baffle curtain on the top edge and open end of the baffle wall with 3/8-inch bolts for attaching the baffle to the top and the open end wall of the tank as shown on the drawings.
6. Provide type 316 stainless steel 3/16" diameter cable from the tank roof/wall to the top edge or open end of the baffle curtain to tension or suspend the baffle curtain. The type 316 stainless steel 3/16" diameter cable shall be secured using type 316 stainless steel 3/16" cable clamps.
7. Hardware and fasteners shall be made of type 316 stainless steel.

3.10 DISINFECTION

A. Provide chlorination and testing as specified in Section 02512, Disinfection of Potable Water Systems.

3.11 PAINTING

A. Paint exposed exterior surfaces as follows:
   1. Prime coat: Thoroseal or equal at a minimum application rate of 2 pounds per square yard to provide a smooth even surface for finish coats.
   2. Finish coat: Two coats of Tnemec Series 156 or equal shall be applied at a rate to achieve 200 sg ft per gallon. Color selected by Owner.

B. Apply coating in accordance with manufacturer's recommendation.

END OF SECTION

SECTION 13229

HORIZONTAL CARTRIDGE FILTERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide horizontal cartridge filter vessels in the locations as indicated on the Drawings and specified herein. This section includes the furnishing, installation, and testing of cartridge filter housings, filter cartridges, and appurtenances.

B. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational system:
   1. Complete Pretreatment Cartridge Filters prior to RO Feed Pump(s)

1.02 RELATED SECTIONS

A. The following sections have equipment that are directly related to this Section. The does not relieve the Equipment Supplier of responsibility of proper coordination of all the equipment to be supplied
   1. Section 02510 Water Distribution System

1.03 SYSTEM DESCRIPTION

A. Pretreatment Filters

1. Service	Brackish groundwater (6,700 total dissolved solids)
2. Number of horizontal cartridge filter vessels	2
3. Number of cartridge sets	3 (start-up and testing)
4. Number of cartridge sets per filter vessel	118
5. Type	Horizontal
6. Design Flow per Filter	1,750 gpm
7. Maximum Flow per 10" cartridge equivalents	3.7 gpm
8. Cartridge Length	40 inches
9. 90% efficiency particle size filtration	5 micron
10. Nominal Housing Internal Diameter	36 inches
11. Inlet and outlet Flanges	12 inches, raised face
12. Pressure Loss, Clean Cartridges	< 3 psi
13. Tag #	CF-1, CF-2

1.04 SUBMITTALS

A. Submit the following:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
      a. Horizontal Cartridge Filter Vessels.
      b. Cartridge Filters
   2. Shop Drawings: Submit Project specific dimensioned shop drawings for the following:
      a. Horizontal Cartridge Filter Vessels.
   3. Manufacturer's instruction manual including cartridge changing and housing maintenance.
   4. Test Reports: Submit for the following:

a. Factory test.
b. Field start up report.

B. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the equipment as supplied for the Project.
   1. Each manual shall be a bound, indexed 3-ring binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Approved shop drawings.
      b. Control panel wiring diagrams.
      c. ASME certifications
      d. Warranty information for each component.
      e. Instructions for startup/shutdown of system and for adjustment of equipment.
      f. Inventory, functional descriptions and operating instructions for equipment.
      g. Recommended routine maintenance procedures
      h. Recommended preventative maintenance for each major component.
      i. Complete bill of material.
      j. Installation instructions for the specific equipment.
      k. Contact information for contractor capable of performing emergency repairs.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service for each piece of equipment.

1.05 QUALITY ASSURANCE

A. Horizontal Cartridge Filter manufacturer shall have been engaged in producing filters for a minimum of ten years. This experience shall consist of installations where equipment of same size and design has been in operation successfully in a similar process for a minimum of three years.

B. Housing manufacturer shall be
   1. Parker Process Filtration, Model #6LMP118H-4-12FK1 for pretreatment or engineer approved equal

C. Cartridge manufacturer shall be Parker Process Filtration, Model HFT5M40A-TX-N, or engineer approved equal.

D. Show materials of construction by ASTM reference and grade.

E. Submit certification of compliance with ASME code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver vessels as complete units as to require the minimum amount of field connection and assembly.

1.07 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of substantial completion of the project.

PART 2 PRODUCTS

2.01 HOUSINGS

A. Fabricate the filter cartridge housing, support legs and eyebolts for cover closure of Type 316L stainless steel.

B. Housing shall be divided into two chambers. The inlet chamber shall house the filter cartridges and have a removable cover. Cover closure shall use swing bolts with nuts. The outlet chamber shall be sized to transport water from the cartridge filters to the outlet.

C. The O-ring cover gaskets shall be Buna-N.

D. Inlet and outlet flanges shall be sized for piping diameters as specified in the "Service Condition". Flanges shall be Class 150, raised face.

E. Housing shall be of sufficient dimension to contain the cartridges as specified in the "Service Conditions."

F. Housing shall have the following connection: one 1/2-inch threaded vent connection on the cover, one 1/2-inch threaded pressure gauge/sample connection for each chamber, one 2-inch treaded connection for draining the inlet chamber, and one 2-inch threaded connection for draining the outlet chamber. Connections shall be 3,000-pound NPT female couplings. Provide plugs for all threaded connections. Provide flange gaskets in accordance with the detailed pipe specifications.

G. Design housing for 150-psi working pressure. Housing materials, design, fabrication, and inspection shall conform to Section VIII of the ASME Boiler and Pressure Vessel Code. Design temperature shall be 250°F. Provide the ASME code stamp.

H. The filter housings shall be factory-equipped with a manual davit lifting device for removing the access cover from the filter housing.

I. Design housing to meet the hydraulic conditions listed in the section on "Service Conditions."

J. Inlet and outlet nozzles shall be oriented as shown in the drawings.

K. Baffle the inlet nozzle so that the in-coming flow stream does not impact directly on the cartridges.

L. Provide a support assembly to be installed midway along the cartridges to prevent cartridge "sagging".

2.02 CARTRIDGES

A. All cartridges shall be single open end. Single open end cartridges have dual 222 O-rings on the sealing end, and a polypropylene capo on the closed end.

B. All cartridge materials shall be FDA grade polypropylene, NSF Standard 61 approved for use with potable water.

C. Cartridges shall be provide with a one (1) inch diameter polypropylene core.

D. The media shall be FDA grade polypropylene continuously wound to a tension that provides 90% efficiency at the micron rating.

E. Core covers are unacceptable.

2.03 SPARE PARTS

A. Provide the following spare parts:

1. Provide one three (3) sets of cartridge filters for pretreatment filters, three (3) sets for cleaning filter. Spares are in addition to those used in startup.
2. Provide 1 O-ring cover gasket for each type of vessel.
3. Pack spares in boxes; label with manufacturer's name and representative's name, address, and telephone number; and attach list of material contained within.

PART 3 EXECUTION

3.01 INSTALLATION

A. Set each cartridge filter in place on preset anchor bolts, plumb, level with leveling nuts, and securely anchor. Grout under feet as shown on the drawings. Extend drains and vent as shown in the drawings. Provide fittings as necessary.

B. Do not install cartridge elements until each element housing has been thoroughly cleaned and connecting pipelines have been thoroughly flushed.

3.02 FIELD TESTING

A. Factory pressure test the housings in accordance with ASME requirements, and provide test certificate.

3.03 START-UP SERVICE

A. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of one trip to the site will be required consisting of a minimum of one 8-hour working day.

B. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) month of plant operation.

C. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

END OF SECTION

SECTION 13420

INSTRUMENTATION

PART 1 GENERAL

1.01 SCOPE

A. Provide materials, equipment, labor, and services required to achieve a fully integrated and operational instrumentation system. Design and coordinate the instrument and control system for proper operation with related equipment and materials furnished under other sections of these Specifications and with related existing equipment.

B. Work shall include, but not be limited to, the provision of instruments, mounting hardware, appurtenant equipment, piping and accessories, specifically or reasonably implied as indicated on the Drawings and specified herein for a complete and operating instrumentation and monitoring system.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 13445 Supervisory Control and Data Acquisition (SCADA) System

1.03 DEFINITION

A. Systems Equipment Manufacturer: The individual or corporation furnishing the equipment and services specified herein.

1.04 SYSTEM DESCRIPTION

A. Principal items of work are as follows:
   1. Instrument controllers.
   2. Chlorine analyzers.
   3. pH analyzers.
   4. Conductivity sensors.
   5. Turbidimeter.
   6. Submersible level detectors.
   7. Ultra-sonic level detectors.
   8. Magnetic flowmeters.
   9. Pressure Transmitter
   10. Differential Pressure Transmitter
   11. Pressure Switch
   12. Piping and valves as required for complete system.

1.05 INSTRUMENTATION LOCATION AND FUNCTION

A. Instrumentation Controllers
   1. Locations:
      a. Raw Water Sample Panel
         1) Dual channel unit for pH and conductivity. Provide additional output card to monitor temperature.
         2) Single channel unit for turbidity.
      b. Combined Permeate Panel
         1) Dual channel unit for pH and conductivity.

c. Combined Concentrate Panel
    1) Dual channel unit for pH and conductivity.
d. Cleaning Solution/Spent Cleaning Solution Panel
    1) Single channel unit for cleaning solution pH. Provide additional output card to monitor temperature.
e. pH and Chlorine Residual Panels (3 total)
    1) Dual channel unit for pH and chlorine residual.

2. Function: Indicate locally and transmit respective instrument reading as indicated for the above water samples to the plant SCADA system.

B. Chlorine analyzers
1. Locations: See Instrumentation Schedule
2. Function: Indicate locally and transmit free chlorine residual reading to the plant SCADA system.

C. pH analyzers
1. Location: See Instrumentation Schedule
2. Function: Indicate locally and transmit pH reading to the plant SCADA system.

D. Conductivity Sensor
1. Location: See Instrumentation Schedule
2. Function: Indicate locally and transmit conductivity reading to the plant SCADA system.

E. Turbidity Analyzer
1. Location: Raw Water Sample Panel
2. Function: Indicate locally and transmit turbidity reading to the plant SCADA system.

F. Ultrasonic level detectors
1. Location: See Instrumentation Schedule
2. Function: Indicate locally and transmit level reading to the plant SCADA system.

G. Submersible Level Transducers
1. Location: See Instrumentation Schedule
2. Function: Measure groundwater level at wells, indicate locally, and transmit level ready to the plant SCADA System.

H. Magnetic Flowmeters
1. Location: See Instrumentation Schedule
2. Function: Measure water flow rate and transmit reading to SCADA System.

I. Pressure Transmitters
1. Location: See instrumentation schedule.
2. Function: Measure pressure reading and transmit signal to the plant SCADA System.

J. Pressure Differential Transmitters
1. Location: See instrumentation panel.
2. Function: Measure pressure differential reading and transmit signal to the plant SCADA System.

1.06 SUBMITTALS

A. Submit the following in accordance with Section 01300 Submittals:
   1. Certificates of Compliance: Certificates shall attest that supplied products conform to the referenced standard and this specification and that all tests set forth in each applicable referenced publication have been performed and that all test requirements have been met.
   2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Chlorine analyzers
      b. pH analyzers
      c. Conductivity analyzers
      d. Turbidimeter
      e. Ultrasonic level detector
      f. Submersible level transducers
      g. Magnetic flowmeters
      h. Pressure transmitters
      i. Differential pressure transmitters
      j. Pressure switch
   3. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Complete instrumentation panel layouts showing all equipment, piping, valves, electrical connections, and labeling with the detailed interconnection and installation data.
      b. Individual instrument layout showing equipment, piping, valves, electrical connections, and labeling with the detailed interconnection and installation data.
   4. Operation and Maintenance Manuals: Submit complete operation and maintenance manual for all instrumentation, which shall include, but not be limited, to the following:
      a. Chlorine analyzers
      b. pH analyzers
      c. Conductivity analyzers
      d. Turbidimeter
      e. Ultrasonic level detector
      f. Submersible level transducers
      g. Magnetic flowmeters
      h. Pressure transmitters
      i. Differential pressure transmitters
      j. Pressure switch
   5. Spare Parts: Submit a list of manufacturer's recommended spare parts and parts requiring normal replacement within a year's period.
      a. Provide a minimum of month supply of all regents required for instrumentation at start up.

1.07 QUALITY ASSURANCE

A. Instrumentations are an integrated system, and as such shall be closely coordinated by the Contractor and suppliers to ensure satisfactory operation of the entire system.

B. Instrument manufacturer selected by the Contractor shall have the following qualifications and responsibilities to the Contractor:
   1. Be regularly engaged in type of work called for under these specifications for a minimum of 5 years.

2. Employ competent personnel with qualifications necessary for design, manufacture, and testing of instruments to be furnished under these specifications.
3. Assign an individual with a minimum of two years experience in the instrument design and installation as project manager.
4. Designated project manager shall coordinate system design with equipment suppliers found in other sections of these specifications, which require interfacing with the system to be furnished under this section of the specifications.
5. Be responsible for detailed design and proper functioning of the total system to be furnished under these specifications. As such; manufacturer shall, as required under these specifications, provide submittal data, operations and maintenance manuals, conduct all tests for calibration and operational demonstrations, technical supervision to the Contractor for installation and connection of equipment, and training of Owner's personnel in operation of the equipment. Send submittals to the Engineer through the Contractor for his review and approval.
6. Shall have an in-house quality assurance organization with the capabilities of ensuring compliance with the standards set forth in these specifications.
7. Have a permanent field service organization capable of providing service and maintenance of the system as called out in these specifications.
8. Provide equipment under this section through one supplier whenever possible. Supplier shall be responsible for the details and coordination of the plant instrumentation to insure satisfactory operation.

C. For standardization, flow primaries, flow transmitters, square root extractors, level transmitters, loss of head transmitter, receivers, indicators, recorders, totalizers, and control station shall be by the same manufacturer wherever possible.

PART 2 PRODUCTS

2.01 GENERAL DESIGN CRITERIA

A. Completed instrumentation system shall provide the functions specified. Specifications and Drawings indicate major instrumentation equipment and functions required for the Project, but do not purport to cover all details necessary for a complete and operational instrumentation system. Provide appurtenances as necessary to provide a complete, and operational instrumentation system as required by instrumentation supplier. Equipment shall be the manufacturer's latest and proven design. Supplied instrumentation shall be compatible with associated equipment required in other specifications sections.

B. Finish: Components shall be finished to the manufacturer's standard for the service intended unless otherwise indicated in the specifications or Drawings. Components located in clusters shall be finished alike.

C. Provide an engraved laminated plastic nameplate to be mounted on or above the associated instrument. Tag instrument and components mounted on control panels on the backside with embossed plastic tape labels.

D. Mount control panels on floor or wall as indicated on the Drawings.
1. Electrical components of the system shall operate on 120 volt, single phase, 60 cycle current, unless otherwise noted in the specifications.

2. Energy Sources: Drawings and specifications indicate the energy sources that will be provided. Other devices necessary to obtain proper operation of the instrument system from these energy sources shall be furnished with the instrumentation.
3. Surge and Transient Protection: Equipment shall be fully protected against voltage surges or transient voltages.
4. Controls for remote electrical operation of motor driven equipment shall be complete, including all necessary auxiliary relays so as to require only wiring and connections to the equipment control circuit. Contacts for control of remote motor operated or electrically operated equipment shall be rated not less than 10 amperes on 120 volts unless otherwise specified herein.
5. Electrical enclosures shall be UL labeled, as a complete unit, following assembly. Internal wiring shall terminate at a terminal board. Wiring shall be sized in accordance with NEMA standards.

2.02 INSTRUMENTATION

A. Instrumentation Controller
   1. A modular single or dual channel controller that works with digital sensors and analog sensor modules shall be provided for the instrumentation and indicated herein and referenced on the drawings.
   2. Performance Requirements
      a. pH Sensor Module
         1) Measurement range: -2.00 to 14 pH
         2) Repeatability: ± 1% of range
         3) Response time: 0.5 s
         4) Temperature range: -20 to 200˚C
      b. Inductive conductivity sensor module
         1) Measurement range: 0.5 to 10,000 µS/cm
         2) Repeatability: ± 2% of reading
         3) Response time: 1 s
         4) Temperature range: -20 to 200˚C
      c. Turbidity
         1) Measurement range: 0.001 to 100
         2) Repeatability: +/- 1.0% or 0.002 NTU, whichever is greater.
   3. Operational criteria
      a. Temperature: -4.0 to 140˚F
      b. Relative Humidity: 0 to 95%, non-condensing
   4. Unit Requirements
      a. Controller shall be AC powered 100 to 240 Vac +/- 10%, 60 Hz.
      b. Controller shall use a menu-driven operation system with graphic dot matrix LCD with LED backlighting display.
      c. Controller shall be equipped with real-time clock, two security levels, data logger with RS-232 capability and a SD card reader for data download and controller software upload.
      d. Four electromechanical, UL rated, SPDT relays (Form C) shall be provided for user configurable contacts rated 100 to 230 Vac, 5 amp at 30 Vdc resistive maximum.
         1) The following can be programmed:
            i) Alarm
            ii) Warning
            iii) Timer/scheduled cleaning
            iv) Feeder control

v) Event control
vi) Pulse width modulation
vii) Frequency modulation

2) The following can be assigned:
i) Primary value measurement I
ii) Secondary value measurement I
iii) 3rd value measurement I
iv) 4th value measurement I
v) Primary value measurement II
vi) Secondary value measurement II
vii) 3rd value measurement II
viii) 4th value measurement II
ix) Real time clock
x) Calculated values

e. Two analog 0/4-20 mA outputs shall be provided standard with a maximum impedance of 500 ohms.

1) The following can be programmed:
i) Low alarm point
ii) Low alarm point deadband
iii) High alarm point
iv) High alarm point deadband
v) Off delay
vi) On delay
vii) Linear, Bi-linear, Logarithmic, and PID controls

2) The following can be assigned:
i) Primary value measurement I
ii) Secondary value measurement I
iii) 3rd value measurement I
iv) 4th value measurement I
v) Primary value measurement II
vi) Secondary value measurement II
vii) 3rd value measurement II
viii) 4th value measurement II
ix) Calculated values

f. The controller shall be capable of being equipped with four additional 4-20 mA outputs with a maximum impedance of 500 ohms.

g. The controller can be equipped with the following forms of communication:
1) MODBUS RS-232
2) MODBUS RS-485
3) Profibus DP

h. All user settings of the controller shall be retained for 10 years in flash memory.

i. The controller shall be equipped with a system check for:
1) Power up test (monitoring and shutdown)
2) Total power draw
3) Memory devices
4) Temperature mother board

5. Housing: polycarbonate, NEMA 4X enclosure, rated IP66

B. Chlorine Analyzer

1. Amperometric chlorine analyzer for continuous measurement of free chlorine in aqueous solutions.

2. Measurement Range: 0 to 20 ppm
3. Low Limit of Detection (LOD): 30 ppb (0.03 ppm) or better
4. Limit of Quantitation (LOQ): 90 ppb (0.09 ppm) or better
5. Repeatability/Precision: 30 ppb or 3%, whichever is greater
6. Response Time: ~140 s for 90% change (T_{90}) (at stable pH and Temp)
7. Interference: Monochloramine, Chloride Dioxide, Ozone, and chalk deposits
8. Drift: <10% with regular calibration
9. Specificity/Selectivity: Non-specific to a certain chlorine form, responds to any chlorine species.
10. Operational Criteria
    a. Sample temperature: 0 to 45˚C
    b. Sample flow required: 30 to 50 L/hour
    c. Sample pressure: 0.5 bar
    d. Operating temperature: 5 to 45˚C
    e. Operating humidity: 0 to 95% relative humidity, non-condensing
11. Analyzer consists of:
    a. Three-electrode amperometric chlorine sensor
    b. Chlorine sensor flow cell with integrated flow sensor
    c. pH flow cell with grab sample port
    d. Digital gateway for communication between probes and controller
    e. Sample conditioning kit, components and accessories for a complete operational system
    f. Stainless steel panel
12. The amperometric cell of the sensor consists of:
    a. Gold cathode
    b. Stainless steel counter electrode
    c. Silver/silver chloride reference electrode
    d. pH buffered electrolyte
    e. Sensor membrane to filter chlorine species selectively and to provide interface between the electrochemical cell and the sample
13. Wetted materials shall be as follows:
    a. Chlorine measuring cell: PVC
    b. Chlorine sensor body: PVC
    c. Chlorine sensor flow cell: Acrylic
    d. pH Sensor flow cell: PVC
14. The sensor interface to the controller shall be through a digital gateway.
15. The chlorine sensor shall automatically compensate for temperature utilizing an embedded temperature sensor.
16. The electrolyte shall provide internal, buffered pH compensation in the range of 4-9 pH units.
17. The panel assembly shall include a flow cell that integrates a flow meter and control valve.
18. Power requirements: 12 Vdc, 30 mA maximum, supplied by controller
19. Output: Two (2) standard optically isolated analog outputs, selectable as 4 to 20 milli-amp.
20. Refer to paragraph 2.02.A herein for controller requirements. Controller shall include a 4-20 mA signal to transmit chlorine reading to SCADA System.
21. HACH model CLF10sc or approved equal.

C. Turbidimeter
   1. Principle of Operation

a. The unit shall measure turbidity by directing a laser into the sample ot scatter off suspended particles. The light that is scattered at a 90° angle from the incident beam is reflected through a conical mirror in a 360° ring around the sample before it is captured by a detector. The amount of light scattered is proportional to the turbidity of the sample.

2. Range: 0-1000 NTU
3. Accuracy
   a. ± 2% or 0.01 NTU from 0-40 NTU
   b. ± 10% of reading from 40-1000 NTU based on Formazin primary standard
4. Resolution: 0.0001 NTU
5. Repeatability: Better than 1% of reading or ± 0.0006 NTU on Formazin at 25°C
6. Stray Light: <10 mNTU
7. Signal Average Time: 5 – 90 seconds
8. Response Time: T90 <30 seconds at 100 ml/min
9. Operational Criteria
   a. Sample flow rate: 100 – 1000 ml/min
   b. Sample temperature: 60°C maximum
   c. Sample pressure: 87 psi at 68°F
   d. Operating temperature: 0 to 50°C
   e. Operating humidity: 5 to 95 percent non-condensing
10. Sensor
    a. The low range online laser turbidimeter consists of a Class 1 650nm (EPA) or 850 nm (ISO) laser light source and 360° x 90° detection system with predictive diagnostics designed to continuously monitor turbidity in a sample stream. Automatic cleaning and flow measurement options are available.
11. Equipment
    a. Utilizes a laser-based 360° x 90° optical system that measures turbidity from multiple different angles.
    b. Continuous particle removal using a vortex created by the fluid path.
    c. Unit shall include capability to actively monitor all internal components and present diagnostics on the overall health of the turbidimeter and time to next required maintenance.
12. Turbidimeter shall be housed in a corrosion-resistant NEMA 4X/IP66 enclosure.
13. Turbidimeter shall operate using 120 volt selectable AC power and capable of operating continuously.
14. Accessories
    a. Flow sensor
    b. Automatic cleaning module
    c. Bubble trap
    d. Calibration/verification module
    e. Filters for zero point calibration.
    f. Formazin calibration kit for user prepared calibration.
15. Refer to paragraph 2.02.A herein for controller requirements. Controller shall include a 4-20 mA signal to transmit turbidity reading to SCADA System. Output span programmable over any portion of the NTU range.
16. Alarms: Three (3) SPDT alarm contacts.
17. Hach TU5400 sc or equal.

D. pH Analyzer
   1. The pH sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal

reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.

2. The sensor shall have a hex shaped body to facilitate mounting and shall be constructed of PEEK material.
3. The sensor shall have a convertible body style featuring 1-inch NPT threads on one end to mount into a flow cell body.
4. The built-in electronics of the sensor shall be completely encapsulated for protection from moisture and humidity.
5. The sensor signal shall have an integral temperature sensor. The pH sensor shall automatically compensate measured values for changes in process temperature.
6. Each sensor shall be provided with a flow cell with lock ring, sealing hub and o-ring for mounting sensor. The flow cell shall include a 3/8-inch inlet, ½-inch outlet, and 3/8-inch drain connections.
7. Range: -2 -14 pH.
8. Sensitivity: ± 0.01 pH
9. Stability: 0.03 pH per 24 hours, non-cumulative
10. Resolution: 0.01 pH
11. Operating temperature: -5 to 70˚C
12. Refer to paragraph 2.02.A herein for controller requirements. Controller shall include a 4-20 mA signal to transmit pH reading to SCADA System. Output span programmable over any portion of the pH range.
13. Alarms: Two (2) fully-adjustable set point sample concentration alarms. Analyzer system warning and shut-down alarms.
14. Refer to paragraph 2.02.A herein for controller requirements. Controller shall include a 4-20 mA signal to transmit pH reading to SCADA System.
15. HACH model DPD1P1 pH sensor or equal.

E. Conductivity Sensor

1. The electrodeless conductivity sensor shall measure from 0-200 to 0-2,000,000 microSiemens/cm and shall have a built in Pt 1000 RTD element to compensate measured conductivity for changes in process temperature.
2. The sensor shall be constructed of only one wetted body material which shall be PEEK.
3. The sensor shall be convertible style that can be directly fastened to the end of a pipe for immersion mounting.
4. Refer to paragraph 2.02.A herein for controller requirements. Controller shall include a 4-20 mA signal to transmit conductivity reading to SCADA System. Output span programmable over any portion of the conductivity range.
5. Convertible style sensor union mounting, CPVC.
6. Refer to paragraph 2.02.A herein for controller requirements. Controller shall include a 4-20 mA signal to transmit conductivity reading to SCADA System.
7. HACH model 3700 Inductive Conductivity Sensor or equal.

2.03 SUBMERSIBLE LEVEL SENSOR

A. Sensing Element

1. Element: Silicone diaphragm, wet/wet transducer
2. Range: 0-500 ft
3. Linearity and Hysteresis: ± 0.1% FS
4. Accuracy: ± 0.1% of full scale at constant temperature, ± 0.2% over 35°F to 70°F range.
5. Overpressure: Not to exceed 2 x full scale range.

6. Resolution: Infinite (Analog)
7. Outputs: 4-20 mA
8. Supply Voltage: 8 to 36 VDC
9. Operating Temperature: -40° to +185°F

B. Housing: 304L Stainless Steel, SS microscreen, with electronics fully encapsulated in marine grade epoxy.

C. Cable:
1. Conductors: 4 each 22 AWG
2. Material: Marine grade polyether jacket, polyethylene vent tube, full foil shield.

D. Sensor Display
1. Input Range: 4-20 mA
2. Accuracy: +0.05% of full scale
3. Operating Voltage: 10-36 VDC
4. Operating Temperature: 0° to 60°C
5. Weatherproof Enclosure

2.04 MAGNETIC FLOW METER

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a 304 stainless steel metering tube with PTFE liner, carbon steel flanges with EPDM gaskets and carbon steel coil cover.

C. The flow tube shall be provided with flush mounted electrodes. Ultrasonic electrode cleaning shall not be acceptable.

D. Grounding rings shall be provided for all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C. Meter and transmitter housings shall meet NEMA 4X requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Non-metallic transmitter housings shall not be acceptable.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.50% of rate over the flow velocity range of 0.3 to 10.0 m/s. Repeatability shall be 0.1% of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°C. Power supply shall be 115 VAC, 60 Hz.

M. All flow tubes shall have continuous submergence protection up to 30 ft (IP68). This requires the user to install sealed IP68 cable glands, conduit connections, or conduit plugs and provide pre-wired potted and sealed junction box to prevent the ingress of water. All options use sealed conduits to meet IP 68 protection requirements.

N. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

2.05 ULTRASONIC LEVEL DETECTOR

A. Power: 24 VDC, 115 VAC or 230 VAC, 50/60-Hz

B. Measuring Range: 1 to 39 ft

C. Output: The output signals shall be (2) Active 4-20 mA into a maximum 1000 ohms loop resistance, or digital outputs.

D. Relays: The system shall have six (6) SPDT relays rated to 5A at 250 VAC. Each relay will be operated by a software assignable set point with a 0-100% adjustable dead band for open and close. Each relay will be assignable for control or alarm. There shall be an acknowledge push-button on the front panel for acknowledging alarm set points. All set points and relays can be assigned to either of the two input channels in any combination. Relays can be assigned for fault conditions of 3.7 mA or 22 mA error signals. Relays may be assigned for Batch Sample Activation with a programmable momentary dry contact closure duration. Each relay will have a visible indication on the display denoting the relay state; configured or un-configured, energized or de-energized.

E. Enclosure: The 2-channel electronic transmitter shall be housed in a rugged Fiberglass Reinforced Polyester (FRP) indicating housing rated to NEMA 4X (IP-66)

for corrosion resistance and wash down service. The sensor(s) shall be completely encapsulated in a CPVC housing rated to NEMA 4X, NEMA 6 / 6P, IP-68, with a 25 ft. sealed flying lead. The sensor shall be capable of full submersion.

F. Sensor: The sensor(s) shall be supplied with a 25-foot flying lead allowing field termination and sensor lead extension via a standard 2-wire twisted shielded pair. The sensor(s) shall be capable of being remotely mounted up to 1200 feet from the transmitter. The sensor(s) shall be supplied with a ¾" and 2" NPT or 2" BSP process connection and be capable of being recessed in a 2 inch diameter nozzle up to 18 inches (0.45 m), which shall permit the system to measure level, volume or distance to the top of the vessel.

G. Operating Temperature and Temperature Compensation: The recommended operating temperature range for the sensor shall be from -40°F to 158°F (-40°C to +70°C). The electronic unit shall be capable of ambient temperature ranges of –40°F to 158°F (-40°C to +70°C). An internal temperature sensor shall provide temperature compensation for variations in the speed of sound due to temperature changes and shall be automatic over the entire operating range of the system.

H. Acoustic Beam: The electronic unit shall employ a nominal 50KHz operating frequency with a 10° acoustic beam angle (+/- 5° from transducer centerline).

I. Configuration and Display: System configuration shall be accomplished through a standard integral display with a 4-key, environmentally sealed membrane keypad and a 2-line, 7-digit, LCD display for level, distance, volume, totalization, temperature or milliamp output. The user may select any (or all) display parameters (level, distance, flow, etc.) and toggle to each or configure to continuously scroll through all display selections. Echo strength will be displayed concurrent with displayed level data. The system shall be capable of displaying level data in the following engineering units: feet, inches, meters, centimeters, millimeters, gallons per minute, cubic meters per hour, or percent. The configuration menu shall be password protected to prevent unauthorized changes.

J. Standard Software: System software will support level, distance, and volume. The system shall incorporate two (2) totalizers, one (1) nonresettable and one (1) user resettable.

K. Area Classification: The level measuring system shall be suitable for sensor installations in Class I, Div. 1 or Zone 0, or Zone 1 hazardous areas. The electronic enclosure will be suitable for Class I, Div. 2 (Zone 2) installations.

L. Manufacturers: The ultrasonic level / flow detector shall be manufactured by Rosemount, Siemens, Drexelbrook or equal.

2.06 PRESSURE GAUGE

A. Mounting Type: Gauges shall be of the stem mount type unless otherwise noted.

B. Construction: Gauges shall be of the bourdon tube type with 270 degrees clockwise pointer travel. Dials shall be white face with black numerals. Dial size shall be 4-1/2 inches. Connections for all gauges shall be male ½ NPT with square wrench flats. Wetted parts shall be corrosion resistant to the process fluid and shown unless otherwise specified shall be the manufacturer's best quality standard. The case shall be filled with glycerin and shall be black phenolic. Accuracy shall be +/- 0.5 percent of span.

C. Chemical Seal: Where specified or shown on the Drawings, the gauge, with optional locking device, shall be furnished with a diaphragm seal. The diaphragm seal shall have 316 stainless steel (minimum) top and bottom housing and a 316 stainless steel diaphragm welded to the top housing. When the process fluid or pressure is not compatible with 316 stainless steel, the manufacturer shall provide a diaphragm seal compatible with the process fluid. The process connections shall be a ¾-inch threaded connection with a flushing connection. The fill fluid shall be glycerin. A locking device shall be included from the factory on all fluid-filled instruments to prevent inadvertent loosening or removal from the seal.

D. Where no seal is specified, the gauge shall be supplied with a pressure limiting snubber to protect against surges and pulsations.

E. Manufacturers: The gauges shall be equal to Ashcroft, McDaniels, US Gauge or approved equal.

F. The diaphragm seals shall be field serviceable for oil filling and equal to Ashcroft, Mansfield and Green, FIT, Ametek or equal.

2.07 PRESSURE TRANSMITTER

A. Gage pressure transmitters shall be of the capacitance type, with a process isolated diaphragm with silicone oil fill, microprocessor based "smart' electronics, and field adjustable 30:1 input range.

B. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally.

C. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low copper aluminum body and 316 stainless steel process wetted parts.

D. Accuracy, including nonlinearity, hysteresis, and repeatability errors shall be plus or minus 0.10 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits.

E. Output shall be linear isolated 4-20 mA, 24 VDC. Power supply shall be 24 VDC, two wire design.

F. Each transmitter shall be furnished with a4 digit LCD indicator capable of displaying engineering units and/or milliamps, and mounting hardware as required.

G. Overload capacity shall be rated at a minimum of 25 Mpa. Environmental limits shall be 40 to 85°C at zero to one hundred percent (0-100%) relative humidity.

H. Each transmitter shall have a stainless steel tag with calibration data, attached to body.

I. The capacitance pressure sensor shall be mechanically, electrically and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing.

J. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section.

K. The electronics section shall correct the digital signal from the sensor, and convert it into a 4-20 mA analog signal for transmission to receiving devices.

L. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory, and shall be capable of communicating, via digital signal superimposed on the 4-20 mA output signal, with a remote interface device. Output signal damping shall be provided with and adjustable time constraint of 0-36 seconds.

M. Differential pressure units shall be provided with close coupled stainless steel three valve manifold assembly.

N. Gage pressure indicating transmitters shall be equal to Rosemount Model 3051CG, Siemens P DSIII, or approved equal.

2.08 PRESSURE SWITCH

A. Pressure switches shall be of watertight enclosure type. The switch element shall be Narrow Deadband 15A, 125/25 VAC type.

B. Units shall be waterproof, shockproof, and equipped with a single position dual throw switches 20 to 250 VAC, 50.60 Hz.

C. Any required mounting parts shall be provided. Switches shall be connected to a stainless steel pipe treated, with isolation valve for easy replacement.

D. Pressure switches shall be Ashcroft B4 or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Instrumentation and controls shall be securely mounted as recommended by the equipment manufacturer.

B. Electrical and control wiring shall be installed in accordance with the applicable sections of Division 16 of these specifications.

3.02 START-UP SERVICES

A. Provide the services of the manufacturer's representative to check the equipment installation, supervise initial start-up, and instruct the Owner's personnel in the proper operation and maintenance of the equipment. A minimum of two separate trips to the site will be required, each consisting of a minimum of two 8-hour working day.

B. Regardless of the time spent at the site, the services will not be considered complete until the system operates as intended for a minimum of one (1) week of plant operation.

C. A copy of tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Engineer.

3.03 FIELD CALIBRATION

A. Instrumentation shall be calibrated in the presence of the Engineer in accordance with specified range and accuracy. Certified test reports shall be filed with the Engineer. Process calibration, such as volumetric drawdown tests on flows and level measurements, shall be conducted on measuring systems as requested by the Engineer.

B. No form of energy shall be turned on to any part of the instrumentation system prior to receipt of the Engineer of a certified statement of approval of the installation from

the Contractor containing his supplier's authorization for turning on energy to the system.

3.04 PAINTING

A. Equipment shall be shop finished.

B. Provide sufficient touch-up paint to repair damage to the surface that may be incurred in shipping.

END OF SECTION

Instrumentation Schedule

ROEM is Harn R/O Systems
Calcite Manufacturer is Tonka

Magnetic Flow Meters		
Tag Number	**Service Description**	**Supplier**
FI/FIT-1116	Well 1 PD Flow Rate	Contractor
FI/FIT-1117	Well 1 BC Flow Rate	Contractor
FI/FIT-1216	Well 2 PD Flow Rate	Contractor
FI/FIT-1217	Well 2 BC Flow Rate	Contractor
FI/FIT-1316	Well 3 PD Flow Rate	Contractor
FI/FIT-1317	Well 3 BC Flow Rate	Contractor
FI/FIT-1416	Well 4 PD Flow Rate	Contractor
FI/FIT-1417	Well 4 BC Flow Rate	Contractor
FI/FIT-1516	Well 5 PD Flow Rate	Contractor
FI/FIT-1517	Well 5 BC Flow Rate	Contractor
FI/FIT-101	Raw Water Flow	Contractor
FI/FIT-135	Anti-Scalant Flow Rate	ROEM
FI/FIT-117	Combined Permeate Water Flow	Contractor
FI/FIT-120	Combined Concentrate Flow Rate	Contractor
FI/FIT-125	Cleaning Solution Flow Rate	ROEM
FI/FIT-167	Finished Water Flow Rate	Contractor
FI/FIT-208-1	RO Train No. 1 Stage 1 Permeate Flow	ROEM
FI/FIT-211-1	RO Train No. 1 Stage 2 Permeate Flow	ROEM
FI/FIT-217-1	RO Train No. 1 Concentrate Flow Rate	ROEM
FI/FIT-208-2	RO Train No. 2 Stage 1 Permeate Flow	ROEM
FI/FIT-211-2	RO Train No. 2 Stage 2 Permeate Flow	ROEM
FI/FIT-217-2	RO Train No. 2 Concentrate Flow Rate	ROEM
FI/FIT-439	Rinse Water Influent Flow Rate	Calcite Mfg.

Submersible Level Transducers		
Tag Number	**Service Description**	**Supplier**
LI/LIT-1118	Groundwater Level (Well 1 PD)	Contractor
LI/LIT-1119	Groundwater Level (Well 1 BC)	Contractor
LI/LIT-1218	Groundwater Level (Well 2 PD)	Contractor
LI/LIT-1219	Groundwater Level (Well 2 BC)	Contractor
LI/LIT-1318	Groundwater Level (Well 3 PD)	Contractor
LI/LIT-1319	Groundwater Level (Well 3 BC)	Contractor
LI/LIT-1418	Groundwater Level (Well 4 PD)	Contractor
LI/LIT-1419	Groundwater Level (Well 4 BC)	Contractor
LI/LIT-1518	Groundwater Level (Well 5 PD)	Contractor
LI/LIT-1519	Groundwater Level (Well 5 BC)	Contractor

Ultrasonic Level Detectors		
Tag Number	**Service Description**	**Supplier**
LI/LIT-103	Scale Inhibitor Day Tank Level	ROEM
LI/LIT-111	Permeate Tank Level	ROEM
LI/LIT-161	Ground Storage Tank No. 1 Level	Contractor
LI/LIT-170	Rinse Holding Tank Level	Contractor

Pressure Indicating Transmitters		
Tag Number	**Service Description**	**Supplier**
PI/PIT-1114	Well Discharge Pressure	Contractor
PI/PIT-1214	Well Discharge Pressure	Contractor
PI/PIT-1314	Well Discharge Pressure	Contractor
PI/PIT-1414	Well Discharge Pressure	Contractor
PI/PIT-1514	Well Discharge Pressure	Contractor
PI/PIT-102	Raw Water Pressure	Contractor
PI/PIT-116	Combined Permeate Water Pressure	Contractor
PI/PIT-205-1	RO Train No. 1 Feed Pump Discharge Pressure	ROEM
PI/PIT-209-1	RO Train No. 1 Stage 1 Concentrate Pressure	ROEM
PI/PIT-210-1	RO Train No. 1 Stage 2 Inlet Pressure	ROEM
PI/PIT-212-1	RO Train No. 1 Stage 2 Concentrate Pressure	ROEM
PI/PIT-214-1	RO Train No. 1 ERD Outlet Pressure	ROEM
PI/PIT-205-2	RO Train No. 2 Feed Pump Discharge Pressure	ROEM
PI/PIT-209-2	RO Train No. 2 Stage 1 Concentrate Pressure	ROEM
PI/PIT-210-2	RO Train No. 2 Stage 2 Inlet Pressure	ROEM
PI/PIT-212-2	RO Train No. 2 Stage 2 Concentrate Pressure	ROEM
PI/PIT-214-2	RO Train No. 2 ERD Outlet Pressure	ROEM
PI/PIT-180	Finished Water Discharge Pressure	Contractor

Differential Pressure Indicating Transmitters		
Tag Number	**Service Description**	**Supplier**
PDI/PDIT-110	Cartridge Filter Differential Pressure	Contractor
PDI/PDIT-127	Cartridge Filter Differential Pressure	ROEM
PDI/DPIT-323	Differential Pressure Switch	Contractor
PDI/PDIT-435	Calcite Vessel No. 1 Differential Pressure High Alarm	Calcite Mfg.
PDI/PDIT-436	Calcite Vessel No. 2 Differential Pressure High Alarm	Calcite Mfg.

Turbidity Analyzers		
Tag Number	**Service Description**	**Supplier**
AI/AIT-104	Raw Water Turbidity	Contractor

pH Analyzers		
Tag Number	**Service Description**	**Supplier**
AI/AIT-105	Raw Water pH	Contractor
AI/AIT-115	Combined Permeate Water pH	Contractor
AI/AIT-119	Combined Concentrate Water pH	Contractor
AI/AIT-124	Cleaning Solution pH	Contractor
AI/AIT-162	Treated Water pH	Contractor
AI/AIT-168	Finished Water pH	Contractor
AI/AIT-437	Calcite Filter Influent pH	Contractor

Conductivity Probes		
Tag Number	**Service Description**	**Supplier**
AI/AIT-106	Raw Water Conductivity	Contractor
AI/AIT-114	Combined Permeate Water Conductivity	Contractor
AI/AIT-118	Combined Concentrate Water Conductivity	Contractor

AI/AIT-216-1	RO Train No. 1 Concentrate Conductivity	ROEM
AI/AIT-218-1	RO Train No. 1 Permeate Conductivity	ROEM
AI/AIT-216-2	RO Train No. 2 Concentrate Conductivity	ROEM
AI/AIT-218-2	RO Train No. 2 Permeate Conductivity	ROEM

Chlorine Analyzers		
Tag Number	**Service Description**	**Supplier**
AI/AIT-163	Treated Water Chlorine Residual (Post Calcite)	Contractor
AI/AIT-169	Finished Water Chlorine Residual	Contractor
AI/AIT-438	Calcite Filter Influent CL2 Residual	Contractor

Pressure Switch		
Tag Number	**Service Description**	**Supplier**
PS-122	High Discharge Pressure Alarm	Contractor

SECTION 13445

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Provide a complete plant SCADA system including appurtenant equipment and accessories, as specified herein and integrate with the existing SCADA telemetry system.

B. The SCADA system shall be provided by a systems supplier. The system supplier shall be responsible for satisfactory installation and operation of the entire system.

C. Design and coordinate the SCADA system for proper operation with related equipment and materials furnished under other sections of these specifications.

D. Field inspect each location. Provide necessary contacts, relays, power supplies, grounding, signal converters required for a complete operating system.

1.02 SYSTEM DESCRIPTION

A. The existing SCADA System consists of the following major components:
   1. RTU-1 – Booster Pump Station: This unit controls the booster pump operation and level control of the ground storage tank and communicates via a licensed radio frequency of 466.4750 and a Yagi 450-470 MHz 9dB antenna.
   2. RTU-2 – Elevated Storage Tank – This unit transmits water tank level data to the SCADA System for control of the booster pump station operation and communicates via a licensed radio frequency of 461.4750 and an Omni 450-460 MHz 3dB antenna.
   3. RTU-3 – Master/Operations Building: This unit is located at the H2GO Operations Building and provides interface with the SCADA System computer for stop/start booster pump override and annunciation of alarm conditions through an autodialer. This unit communicates with the other RTUs via a licensed radio frequency of 466.4750 and a Yagi 450-470 MHz 9dB antenna.
   4. Each RTU utilizes an Allen Bradley Micrologix 1400 PLC processor.
   5. SCADA System computer with Wonderware Intouch Development Studio Small, v10.1A HMI software.

B. The work covered under this Section shall include, but not necessarily be limited to the following:
   1. All SCADA hardware and all items of control as indicated on the drawing.
   2. All Remote Terminal Units (RTU), Central Terminal hardware and software for incorporating a computer system to handle long term data acquisition and report generation requirements.

3. All supervision and engineering required for a complete and operable installation including testing and commissioning of all equipment and control loops as specified herein.
4. Testing and operational demonstrations as specified herein.
5. A training program as specified herein for the operating and maintenance personnel.
6. The electrical contractor shall provide all conduits, power wiring, signal wiring and connections to the system components required for the SCADA system.

C. Modifications to the existing SCADA System shall include the following:
1. Integrate all existing I/O data points, control features, and graphic screens into the new water treatment plant SCADA System.
2. Modify control strategy for existing ground storage tank and booster pump station as specified herein.
3. Primary control of the existing water distribution system shall be transferred to the new water treatment plant SCADA System.
4. Duplicate existing display screens and functionality into new SCADA System HMI software.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01330 Submittals:
1. The Shop Drawings shall be submitted in a two step process. The first submittal shall be informally reviewed by the engineer in conjunction with representative of the SCADA system supplier and the Owner. After this review, all comments shall be incorporated into the drawings and the required number of copies shall be forwarded for formal review and approval.
2. The Shop Drawings shall fully demonstrate that the equipment and services to be furnished will comply with the provisions of these specifications and shall provide a true and complete record of the equipment as manufactured and delivered. Submittals shall be bound in three-ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11-in x 17-in for inclusion within the binder.
3. The digital system hardware programmable controllers, computers and peripherals submittal shall provide complete
   a. A complete system block diagram(s) showing in schematic form, the interconnections between major hardware components such as; control centers, panels, power supplies, consoles, computer and peripheral devised, future telemetry equipment, local digital processors and like equipment. The block diagram shall reflect the total integration of all digital devices in the system and shall reflect any man/machine interface locations. All components shall be clearly identified with appropriate cross reference to the location of each.
   b. All interconnecting cabling requirements for digital components of the system including any data communication links.
4. Data sheet for each hardware component which shall include but not be limited to the following information.

a. Equipment Number and ISA tag number per the Loop Diagrams (as applicable).
b. Product (item) name used herein and on the Contract Drawings.
c. Manufacturer's complete model number.
d. Optional devices.
e. Auxiliary equipment.
f. Ancillary devices.
g. Location of device.
h. Input - output characteristics.
i. Range, size, and graduations.
j. Physical size with dimensions, enclosure NEMA classification and mounting details.
k. Materials of construction of all components.

5. Detailed drawings covering control consoles and enclosures which shall include:
   a. Cabinet assembly and layout Drawings to scale including front and interior layouts.
   b. Fabrication and painting specifications.
   c. Standard color samples for selection by the Engineer.
   d. Panel wiring diagrams showing:
      1) Power connections to equipment within and on the enclosure
      2) Combined Panel power draw requirements (volts, amps)
      3) Breaker sizes
      4) Fuse sizes
      5) Grounding.
6. The SCADA System software as well as all other software packages including maintenance program.
7. The logs, reports and process graphic displays shall be developed by the Supplier in conjunction with the Engineer and Owner. The calculations which are required to support them shall be developed and submitted in final printed form for approval.
8. Six sets of instruction manuals shall be supplied. Operating instructions shall incorporate a functional description of the entire system including the system schematics which reflect "As-Built" modifications. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
9. Operation and Maintenance Manuals: Submit complete Operation and Maintenance Manual for the entire system.
10. Warranty Data: Name, address, and phone number of agency that will make repair or replacement during warranty period.
11. Test Reports: Submit for the following:
    a. Field Test: Upon testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
12. After completion of the project, supplier shall furnish four complete sets of the test results incorporating any necessary changes for "record" drawings, etc. for Owner's record.

1.04 QUALITY ASSURANCE

A. Quality Assurance shall be as required in Section 01450, Quality Control and the following requirements:
   1. The Supplier shall have at least ten (10) operating systems and utilize the same equipment and programming as designed and fabricated by: Custom Controls Unlimited, Inc., MR Systems, Inc., Fortech, Inc, C2I, KW Controls, or TXI&C, Inc.
   2. Software: Latest version of Proficy HMI/SCADA iFix, Wonderware HMI/SCADA Solution, RS-View 32, VTScada or equal.
   3. PLC's: Allen Bradley CompactLogix

B. The Supplier shall be regularly engaged in the type of work called for and have the resources to successfully execute the Work. Resources shall be defined as capital facilities, personnel, plant and service. The Supplier shall have successfully completed the installation of control systems of a like magnitude and complexity and be able to furnish on request, experience records and personnel contacts for each installation. The referenced system shall have been in satisfactory operation for a sufficient period of time, but not less than two (2) years, to establish the reliability of the equipment proposed to be furnished. The supplier shall be a (VAR) Value Added Reseller of the software used.

C. The Supplier shall be responsible for the detailed design, installation and field connections to the existing equipment and the proper functioning of the SCADA system to be furnished under these Specifications. Conduct all tests including calibration and operational demonstrations to be performed under these specifications.

D. The Supplier shall also have in his employ permanent field service organization capable of providing the service and maintenance of the system.

E. The Contractor shall be responsible for providing accessories such as signal transducers, isolators, amplifiers, etc., that might be necessary for the final system design.

F. After panels are completely fabricated and tested, panels shall bear a U.L. 508 serialized label. The Supplier shall be a U.L. listed fabrication facility.

G. All of the equipment shall be of latest and proven design. Specifications and Drawings call attention to certain features, but do not purport to cover all details entering into the design of the SCADA system. The completed system shall be compatible with the functions required and the equipment furnished and installed by the Supplier.

1.05 DELIVERY, STORAGE AND HANDLING

A. The equipment shall be handled in accordance with Section 01600, Material and Equipment.

B. All equipment shall be stored in a conditioned environment to avoid condensation. All equipment shall be covered for protection from dust.

1.06 SPARE PARTS AND CALIBRATION EQUIPMENT

A. The system supplier shall include a supply of spare parts and calibration equipment. Spare parts shall include but not be limited to the following:
   1. One of each type PLC module used.
   2. One of each type of power supply used.
   3. One of each type circuit breaker used and three of each type of fuse used.
   4. Spare I/O Boards Digital
   5. Spare I/O Boards Analog
   6. One (1) spare surge arrestor.
   7. One digital Fluke volt/current meter with mA capability to be used for trouble shooting and calibration.

1.07 FCC LICENSE

A. The SCADA System supplier shall be responsible for collecting all information, generating all paperwork, and paying all fees required for obtaining the required FCC license on behalf of the Owner.

1.08 RADIO PATH ANALYSIS

A. The system supplier shall conduct a radio path analysis to determine the suitability of the system proposed for successful operation.

B. The results of the radio path analysis shall be submitted to the Engineer for review in a detailed report documenting the actual radio field test procedures and results, along with confirmation of the required antenna heights. The specific antenna heights, determined as a result of the radio path analysis, shall be identified and coordinated with the Engineer and Contractor. The costs associated with the field test shall be included with the telemetry system supplier's total bid price.

C. The approximate location of the existing radio sites is as follows:
   1. Booster Pump Station (RTU-1)
      a. 34° 12' 13.53" N Latitude, -78° 03' 29.38" W Longitude
   2. Elevated Tank (RTU-2)
      a. 34° 11' 42.83" N Latitude, -78° 00' 54.32" W Longitude
   3. Operations Building (RTU-3)
      a. 34° 14' 30.66" N Latitude, -78° 00' 42.01" W Longitude

D. The approximate location of the proposed radio sites is as follows:
   1. R.O. Water Treatment Plant
      a.
   2. Well Site No. 1
      a. 34° 12' 53.29" N Latitude, -78° 01' 51.94" W Longitude
   3. Well Site No. 2
      a. 34° 12' 12.19" N Latitude, -78° 03' 26.73" W Longitude
   4. Well Site No. 3
      a. 34° 5011' 47.64" N Latitude, -78° 04' 33.81" W Longitude
   5. Well Site No. 4
      a. 34° 13' 05.22" N Latitude, -78° 03' 40.06" W Longitude
   6. Well Site No. 5
      a. 34° 13' 57.97" Latitude, -78° 03' 35.48" W Longitude

PART 2 PRODUCTS

2.01 COMMUNICATION PROTOCOL

A. The intent of these specifications is to provide the Owner with an "open-architecture" telemetry system capable of being expanded in the future. The communication protocol of the system shall be Modbus RTU.

2.02 COMPUTER HARDWARE COMPONENTS

A. Provide two (2) desk top computers for the Water Treatment Plant with the following characteristics:
   1. The two (2) desk top computers that shall be configured in a primary/secondary server mode so if the primary computer fails, the secondary computer automatically takes over the functions of the primary without any loss of information.
   2. The computers shall be 8th generation Intel Core i5-8600 with vPro (3.10Ghz, up to 4.3Ghz with Turbo Boost, 9MB Cache), Windows 10 Pro 64, 85% 250 Watt power supply unit, 16GB DDR 2666Mhz, Integrated Intel HD graphics, 256BG Solid State Drive (2.5", SATA3, Opal), 1TB Hard Disk Drive (7200rpm, 3.5", SATA3), slim DVD-RW Multiburner, Integrated Intel Gigabit Ethernet, Black USB Traditional Keyboard, USB Mouse, Dust Shield for Tower, Internal Speaker Tower
   3. The desktop computers shall each include a 22" LCD flat screen monitor with 1920x1080 pixel resolution.
   4. Each desk top computer shall be equipped with an uninterruptable power supply (UPS) sized to maintain power to the computer and monitor for 60 minutes.
   5. All required local area network equipment (routers, switches, etc) required to connect the two desk top computers and the radio interface unit/master telemetry unit shall be provided. This equipment shall be provided with an uninterruptable power supply (UPS) sized to maintain power for 60 minutes.

B. Provide one (1) notebook type portable computer with the following characteristics:
   1. The laptop computer shall be supplied with required software, modem, and network interface required to remote access the CMS. The remote access shall use identical text and graphic interface as the CMS and allow the operation to make operational changes to the system.
   2. The laptop computer shall be Intel Quad-Core Ivey Bridge architecture, 8GB RAM, 1TB HDD minimum, one Gigabit Ethernet Network Interface, 802.11 b/g/n WiFi interface, CD/DVD drive, 15" diagonal display with native 1920x1080 resolution plus video output port capable of driving an independent 1920x1080 display via DVI or HDMI, minimum two USB 2.0 plus two USB 3.0 ports, and supplied with a USB to serial converter recommended by the PLC manufacturer if required for PLC or radio configuration. Operating system to be Windows 7 or Windows 8 as recommended by the SCADA software manufacturer.
   3. The laptop unit shall include an internal battery capable of operating the unit for 2 hours of uninterrupted service. The unit shall be supplied with an exterior power supply/charger that will charge the system while operating.

4. The laptop unit shall be supplied with a zippered carrying case that shall provide padded protection for the computer and an outside pocket for the AC adapter, cords, diskettes, and accessories.

C. Provide one (1) desk top computer for the BRWS H2GO Operations Building with the following characteristics:
   1. The computer shall be 8th generation Intel Core i5-8600 with vPro (3.10Ghz, up to 4.3Ghz with Turbo Boost, 9MB Cache), Windows 10 Pro 64, 85% 250 Watt power supply unit, 16GB DDR 2666Mhz, Integrated Intel HD graphics, 256BG Solid State Drive (2.5", SATA3, Opal), 1TB Hard Disk Drive (7200rpm, 3.5", SATA3), slim DVD-RW Multiburner, Integrated Intel Gigabit Ethernet, Black USB Traditional Keyboard, USB Mouse, Dust Shield for Tower, and Internal Speaker Tower.
   2. The desktop computer shall include a 22" LCD flat screen monitor with 1920x1080 pixel resolution.
   3. The computer shall be equipped with an uninterruptable power supply (UPS) sized to maintain power to the computer and monitor for 60 minutes.
   4. All required local area network equipment (routers, switches, etc) required to connect the desk top computer and the radio interface unit/master telemetry unit shall be provided. This equipment shall be provided with an uninterruptable power supply (UPS) sized to maintain power for 60 minutes.

2.03 SCADA SOFTWARE SUITE REQUIREMENTS

A. The Operating System
   1. The software shall operate under Windows 10 as recommended by the SCADA software manufacturer.
   2. The software shall be capable of supporting a tag count of 5,000 tags.
   3. One copy of the full function SCADA server development software and one copy of the full function SCADA server run-time software shall be provided. Also all required I/O drivers, alarm dialer, and remote access sub-systems shall be provided for up to five (5) simultaneous remote users.
   4. The SCADA Software Suite shall be a collection of software programs written for the express function of supervisory control, data accusation (telemetry), and Human to Machine interfacing.
   5. The SCADA Software Suite to be supply shall be a version offered by the software company tailored for operation in the Water/Wastewater industry.
   6. The SCADA Software Suite's manufacturer shall have been in business over twenty-five (25) years, offering the SCADA Software Suite for a minimum of twenty (20) years, with over one thousand (1000) systems operating.
   7. System shall employ a graphical user interface (GUI) as the human-machine interface (HMI). This graphical user interface shall allow operating personnel to perform all system functions without any knowledge of operating system commands.

8. System shall be configured such that, in the event power is lost and subsequently restored, server computers will automatically restart and begin full operation without user intervention.
9. System shall not require dedicated server computers for database management, reporting, historical data viewing, alarm management, security management, alarm dialout, or any other system services.
10. Following completion of the installation, system users, with appropriate privileges and appropriate system configuration training, shall be capable of making changes to the HMI without requiring the supplier's assistance.
11. System shall support Internet client connectivity without the use of 3rd party software.
12. System shall support scripting using an object-oriented scripting language.
13. Software help manuals shall be provided to assist operators and administrative personnel with daily operations and system configuration after system integration has been completed.
14. System shall support client connections via LAN, WAN, Internet, dial-in via modem and handheld-device connections via Wireless Application Protocol (WAP) or Mobile Web Browser.

B. User Interface
1. The software shall provide a graphical human machine interface (HMI) for the stations. It shall show all signals at the stations on the computer monitor accessible to the operator in a series of graphic pages and windows.
2. The graphics shall support layered elements, allowing the overlay of animated telemetry information (bars, meters, values) on graphics elements obtained from outside sources (i.e. Area map, or Station graphics). The SCADA Software Suite shall supply a minimum of 3600+ graphic symbols plus allow custom additions graphics as BMP, JPG, WMF, PNG, & EMF formats. Photorealistic Meters and complex group graphical objects shall also be supported.
3. System supplier shall create displays representing system processes and instrumentation. These displays shall be built with object-oriented graphical elements. Graphic displays to be provided under this contract shall include, but not be limited to, the following:
   a. System overview page. The equipment and instrumentation icons shall utilize a simple color scheme to represent their current status and alarm values. A legend describing the color scheme shall also be included on the screen.
   b. One display page for each major section of the system.
      1) Main Menu
      2) Raw Water Well Sites
         i) Well Site No. 1 screen
         ii) Well Site No. 2 screen
         iii) Well Site No. 3 screen
         iv) Well Site No. 4 screen
         v) Well Site No. 5 screen
      3) Water Treatment Plant System Overview

4) Water Treatment Plant flow summary: real-time and daily total flow for the following:
    i) Total Raw Water Flow
    ii) RO Train 1 raw feed, total permeate and concentrate flow
    iii) RO Train 2 raw feed, total permeate and concentrate flow
    iv) Total Permeate Flow
    v) Total Concentrate Flow
    vi) High Service Pump Station Total Water Pumped to the Distribution System
5) RO Train Water Treatment System
    i) RO Treatment Train 1
    ii) RO Treatment Train 2
6) RO Train Clean & Flush System
7) Sodium Hypochlorite Generation System
8) CO_2 Storage/Feed System
9) Calcite Facility
    i) Calcite Vessel No. 1
    ii) Calcite Vessel No. 2
10) Ground Storage Tank / High Service Pump Station
11) Rinse Storage Tank and Waste Pump Station
12) Scale Inhibitor Storage/Feed System
13) Caustic Storage/Feed System
14) Corrosion Inhibitor Storage/Feed System
15) Fluoride Storage/Feed System

c. Provide a display graphic screen of the existing Distribution System screen included on the Operations Building computer.
d. Supporting display pages, where necessary, for each equipment.
e. Alarms.
f. Historical/real-time data viewing.
g. On-demand report generation.
h. Operator notes/bulletin board interface.
i. Alarm dialer roster management.

4. System shall include a menu for navigating from one display to another. Menu shall be configurable to allow logical grouping of displays where necessary.
5. Color Codes
    a. When a pump/motor/mixer/etc. is running, the text and object color will be red.
    b. When a control valve is open, the text and object color will be red.
    c. When a pump/motor/mixer/etc. is off/ready, the text and object color will be green.
    d. When a control valve is closed, the text and object color will be green.
    e. When an alarm is active unacknowledged, the background of the text and object color will be red with yellow flashing.
    f. When an alarm is active acknowledged, the background of the text and object color will be yellow.
6. Displays shall use the color capabilities of the video display system to visually indicate status, value and alarm conditions of major components in the system. As the status of system components change, the color of the displayed symbol for the components shall change to denote status.

7. Operators, with sufficient security privileges, shall have access to system setpoints and control points and shall have the ability to modify these points without stopping and restarting the system. Setpoint values shall be validated for proper range by the system before they are accepted.
8. Means shall be provided to allow the operator to print graphical displays.
9. It shall be possible to display graphical representations of the station data with data from multiple stations viewable in the same window.
10. The contents of graphic windows shall be capable of stretching or shrinking to fit the window as the window is resized.
11. It shall be possible to display multiple graphical windows simultaneously.
12. There shall be no limit on the number of active values within any window.
13. There shall be no limit on the number of graphic pages or windows.
14. There shall be no limit on the number of stations or I/O in the system by system design. The supplied system shall be licensed for no less that 5000 tags, expandable as the system grows.
15. The system shall support communications drivers commonly found in water/wastewater telemetry applications, such as Modbus, Allen-Bradley, Siemens, Omron and OPC.

C. Communications
1. Communication diagnostics shall be included to aid the customer in the visualization of proper operations. Diagnostics shall include communication statistics, last error reported, and a method to log communications to a log file for post analysis by others.
2. Communication drivers to I/O devices shall support a level of abstraction to the communications hardware. An ability of this is to permit the selection of a backup serial port by changing the port reference only, and NOT all dependant drivers or I/O configurations.
3. Multiple communications protocols shall be possible over the same communications port. No communications driver shall explicitly prevent other protocols from using the same I/O port, thus allowing the use of one set of customer communications equipment, such as a radio modem/transceiver.
4. System shall allow independent configuration of polling frequencies and timing parameters for each remote I/O unit.
5. To optimize I/O communications for telemetry applications, the polling order shall be configurable and polling shall be asynchronous (if permitted by the remote telemetry unit), allowing the system to continue its polling sequence in the event a field device does not respond.
6. System shall permit grouping of polled devices to further optimize communications.
7. Operators shall be able to place any device in a fast-polling state. In this state, the device will be polled at a frequency higher than normal, allowing operators and maintenance staff to receive data more frequently during alarm and commissioning situations.

D. System Configuration
1. Configuration changes shall be possible without stopping the computers or the application. This shall include online Graphic Display development.

2. System configuration shall be protected from unauthorized changes by a password/passcode security system.
3. Configuration changes made on one computer shall be propagated to the other computers on the system without copying files, stopping applications, or restarting computers.
4. Changes to the configuration made while a computer is stopped shall be automatically updated when the computer is started without user intervention.
5. It shall be possible to determine the properties of any display or tag element by selecting it with the mouse. This shall be in real time, displaying the scaling, I/O address, and alarming parameters to the operator. Changes to this information shall be according to the users password profile, thus allowing visualization of configuration without permitting modification.
6. The modification of any properties on-line, will result in the simultaneous update of the configuration database, without the need for the restart of the application.
7. Tags representing field Inputs shall be automatically marked as 'questionable' upon creation, though they will continue to display the incoming values. Questionable flags shall be removable by users with sufficient privileges when values have been verified (commissioned) against field data.

E. Alarm Handling
1. Alarms shall be announced with an audible tone that shall repeat until the operator acknowledges the alarm.
2. An alarm window shall allow the operator to view all of the alarms in the system, all the unacknowledged alarms and all of the alarm history.
3. With proper security access rights, an operator shall have the ability to disable any alarm signal in the event of a faulty sensor, without the need to restart the application or computer.
4. A software autodialer shall be integral to the SCADA software package to prevent the need of additional configuration when new alarms are added in the future and to guarantee software compatibility with future software upgrades.
5. In the event of a high priority alarm, the system's autodialer shall dial out to a list of designated telephone numbers and upon entering of the correct security code via the telephone keypad, use text-to-speech to announce the active alarms. Up to 30 phone numbers shall be possible in the dial-out list at any one time with the dial-out list permitted to be changed at any time with a mouse click by a user with sufficient security privileges.
6. The system shall support multiple dial-out lists being active at once. This is provided for segregated annunciation of alarms according to different service needs. An example would be a dial-out roster active for equipment alarms and dial-out roster active for process alarms. There shall be no limitation on the number of active alarm rosters.
7. The system shall be capable of accepting incoming voice calls on a separate modem from the laptop dial in line. Incoming voice callers must enter a security number and shall be offered voice prompts to list both active and unacknowledged alarms as any individual station or for

the entire system, list the digital and analog status values at any individual station, or permit the turning on or off of any digital output at any station using the touch-tone keypad.

8. Acknowledgment of an alarm by phone shall record the name of the user that acknowledged the alarm.
9. As part of the alarm dial-out system, Pagers can also be used to notify operators of current alarm conditions, along with email/SMS messaging to computers or cell phones.

F. Reporting
   1. Automated reports for specified Water Management operations over an arbitrary group of I/O and time period shall be included.
   2. It shall be possible to generate a report of any group of inputs over any time range.
   3. All reports shall be available on-screen, sent via e-mail, on a printer, in an Excel spreadsheet, via an Excel Template, in an Access database or any ODBC compliant Database such as ORACLE.
   4. The system shall be capable of utilizing DDE to dynamically link real-time data to 3rd party software.
   5. A minimum of the most recent 100,000 alarm events shall be maintained in electronic form.
   6. The following reports shall be standard: Analog Summary, Radio Error Analysis, Radio Error Detail, Daily Snapshot, Derived Flow, Detail Report, Hourly Snapshot, Hourly Total, Pump Activity, Pump Discrepancy, and Rainfall Report.
   7. Reports generated by Internet client shall be able to be printed to a local printer.

G. Trending
   1. A plot of any analog value shall be possible with up to 12 simultaneous values possible on the same plot. Plot trends shall display live data coupled with historical data for the same tag point. Areas in the plot without a corresponding logging reference shall be shown as a gap in the plot line, and NOT a connection between the last two good points (which gives a false visualization of data).
   2. Plot data shall exportable from the trend screen, to printer, to an Excel spreadsheet, or any ODBC compliant Database.
   3. All data received from the connected instrumentation and remotes shall be recorded for historical purpose for a minimum of five years in electronic form and be available on-line during that period.
   4. It shall be possible to archive historical data on a monthly basis and restore that data for access by the reporting tools without stopping the system.
   5. It shall be possible to save groups of plot pens to enable fast retrieval in the future. There shall be no limit on the number of groups.

H. Security
   1. A password protected security system shall permit multiple users each with a set of privileges. Privileges for configuration, viewing and operation shall be enabled or disabled on an individual basis, via a security profile per user.

2. The Security system shall be a privilege based system versus a level based system, such that individual privileges are assigned on a user-by-user basis.
3. The Security system shall encrypt user passwords using an algorithm that shall render their file storage unreadable.
4. The security system shall permit the creation of user assigned privileges. A minimum of 10,000 additional application privileges shall be possible.
5. The application of security privileges shall be in real-time during a running session. Networked users whom have their security profiles altered will be affected immediately and not after a restart.
6. The security system shall be multi-session. It will validate multiple users simultaneously and record their session activity concurrently for all users.

I. Redundancy
1. Per paragraph 2.02.A.1, the system shall incorporate a secondary computer at the Water Treatment Plant with the ability to monitor and operate the system with all of the same capabilities as the primary SCADA computer.
2. The backup SCADA computer shall be capable of polling the system and act as a Hot-Backup system without human intervention should the Primary SCADA system fail.
3. There shall be multiple levels of redundancy possible, with backup computers being capable of load sharing operations. This shall permit the splitting of I/O acquisition across multiple backup computers.
4. The primary and backup computers shall permit on-line changes that are automatically synchronized without requiring a restart.
5. It shall be possible for multiple users to develop upon the same system simultaneously while running. User changes shall only be in effect on the local development station until propagated online to all other running stations, without requiring a restart or manual file copy operations. The SCADA software shall come complete with configuration management capabilities, noting which system elements are undergoing changes by station name.
6. In the event a primary SCADA computer failure the backup SCADA computer shall continue to operate and record all history and alarms. The restoration of the failed computer shall result in all missing alarm and history data being automatically transferred to the failed computer so that both computers have a duplicate history database.

J. Internet Connectivity
1. Internet connectivity shall be unlimited clients.
2. Internet connectivity shall not require the installation or configuration of a 3rd party Internet Server product.
3. On-line configuration changes shall be synchronized with Internet client interfaces without requiring the browser interface to be restarted.
4. Internet clients shall require only the latest version Microsoft Internet Explorer to communicate with the application. Internet clients shall require no software to be manually installed. Upon first contact with the Internet server serving the application, the Internet client shall automatically synchronize with the application and download any

necessary files. All subsequent connections to the server shall synchronize the Internet client with the server.

5. Internet client interfaces shall have graphical displays identical to the standard client and server interfaces and shall not require separate development time or a separate development interface.
6. Tools shall be provided, on the system server, to monitor Internet client connectivity and to disconnect users when necessary.

K. Application Upgrades/Support/Diagnostics/Debugging
   1. Users must have the capability to upgrade the base software product as new versions become available, without requiring the assistance of the manufacturer or a system integrator. Such upgrades shall not require changes to the existing application.
   2. Support must include phone and email contact.
   3. Training shall be available for users of all levels (i.e. Operators, System Integrators)
   4. Diagnostic/debugging tools shall be provided for;
      a. Server-to-server and server-to-client activity monitoring within the SCADA network
      b. Communication driver activity monitoring
      c. Script language debugging

L. Help Screens
   1. Each screen, where appropriate, shall include a built in help function. Display layouts will be standardized with the same function key utilized to access on screen help.

2.04 CONTROL FUNCTIONAL DESCRIPTION

A. General – Water Treatment Plant and Water Supply Wells
   1. The system integrator shall incorporate all control logic functions in the Reverse Osmosis Equipment Procurement Bid Document. This document is included in Appendix A of this Project Manual.
      a. Any changes to the RO Train Control Logic as a result of the specific Reverse Osmosis Equipment Manufacturer (ROEM) selected shall be approved by the Engineer.
   2. The SCADA system shall be the master controller of the water treatment plant (WTP) and supply well operation. The normal start and shutdown of water production will be initiated manually by the WTP operators at the SCADA System control room. There will be no automatic start of water production. The WTP and well operation may be automatically shutdown as a result of alarm conditions at the wells or WTP, as specified herein.
   3. Water production will be started only via manual operator control. The operation of the high service pumps will be independent of water production start or stop and will be based on start and stop signals from the water distribution system and the WTP ground storage tank level.
   4. Water Production Start-Up
      a. The WTP operators will pre-select the permeate flow rate, RO units to be operating, wells to be operating and other setpoints as described herein or in Appendix A to this Project Manual.
      b. When the operator selects the start button, the SCADA system shall sent start signals to the selected well site control panels and the

well site control panels will initial well pumps start-up and will control the well pump speed to reach the target total site flow rate.

c. The SCADA system will monitor total raw water flow rate (at the WTP raw water meter) and TDS water quality and operate the by-pass valve at the WTP.

d. When the raw water flow and TDS meet required setpoints, then the SCADA system will send a signal to start the scale inhibitor system. Once the scale inhibitor flow is steady, then the SCADA system shall send a start signal to the selected RO Treatment Train Instrument Panel(s).
   1) Only one train is allowed to start at a time.

e. Once the RO trains are operating and producing permeate, the SCADA system will send start signals and send 4-20 mA signals to reach pre-determined set points for each of the following systems:
   1) Sodium Hypochlorite system.
   2) CO2 feed system.
   3) Check that Calcite Tanks and selected calcite cells are in Service Mode.
   4) Fluoride feed system
   5) Caustic feed system
   6) Corrosion control feed system

5. Water Production Operation
   a. Once production is started the SCADA system shall monitor and maintain production rates until the operator manually shuts down the system or an automatic alarm shut-down is initiated.
   b. The RO Train Instrument Panels will monitor and control permeate and concentrate flowrates and send this information to the SCADA system for monitoring purposes.
   c. The SCADA system shall monitor and display all process systems as described in this section or in Appendix A.
6. Water Production Shut-Down
   a. Water production shutdown will be initiated by the operator. If two RO trains are operating, the operator shall select one of the two trains to shut down and go through a flushing cycle. The RO unit being shutdown will go through a flushing cycle after shutdown. The SCADA system shall adjust all chemical feed operations to adjust for the lower permeate flow as result of the first train shutdown.
   b. The operator would then manually select to shut-down the second train. After the second train shutdown, the other equipment and well sites would be automatically shut down. The second train shall also go through it's flushing cycle.
   c. If an alarm shutdown is initiated by the SCADA or RO Treatment Train Instrument Panel, then the SCADA system shall initiate an advisory or a sequenced shutdown. Normally only one train will shut at a time, unless there is a power failure or raw water feed TDS is exceeded in which case both RO Trains can be shut down simultaneously.
7. Water Treatment Plant Flow Monitoring and Trending
   a. The SCADA system shall continuously monitor and record total daily values for the following flows at the WTP

i) Total Raw Water Flow
ii) RO Train 1 raw feed, total permeate and concentrate flow
iii) RO Train 2 raw feed, total permeate and concentrate flow
iv) Total Permeate Flow
v) Total Concentrate Flow
vi) High Service Pump Station Total Water Pumped to the Distribution System
vii) Booster Pump Station Flow.

b. The SCADA system shall also provide an algorithm to display a recommended permeate production rate to be displayed on the SCADA screen based on an analysis of the previous day Finished Water Pumped Flow, the previous day Total Permeate Flow and previous day tank elevations. This analysis will include the following logic:
   1) Plot hourly trend of existing elevated and booster station ground storage tank water level, pump finished water flowrate, WTP ground storage tank water level and permeate flow for the previous day.
   2) Indicate number of low level alarms and shutdowns of High Service Pumps due to low WTP Ground Storage Tank level shutdown in the previous day.
   3) Indicate number of high level alarms and shutdowns of the RO Trains due to high WTP Ground Storage Tank level shutdown in the previous day.
   4) Calculate the previous 24 hour system water demand based on High Service Pump Station Water Pumped volume and any additional volume drop in the existing elevated storage tank and existing booster ground storage tank when the RO Treatment Trains and High Service Pumps were not operating.
   5) Compare Permeate Flow total daily volume for the previous 24-hour day and compare to calculated previous daily water demand volume. Provide recommended permeate flow rate for the next day based on meeting the previous day water demand volume.
      i) Algorithm shall include a comparison of hourly permeate flow, high service pump station pumped flow, and ground storage tank levels at the WTP. Algorithm will predict if increasing or decreasing the permeate flow will result in greater or lesser level fluctuation in the ground storage tank and elimination of low or high level alarms.

B. Off-Site Water Supply Well Sites (P&ID I-101)
   1. Description
      a. Ten off-site water supply wells located on five well sites (two wells per site) will provide raw water to the water treatment plant. Each well site one well that withdraws water from the PeeDee Aquifer (PD) and one that withdraws from the Black Creek Aquifer ((BC). The normal operation will to be to operate both wells simultaneously at controlled flow rates that result in a 40/60 flow split, such that 40% of the combined flow rate from each site is provided by the PD well and 60% of the combined flow rate is provided by the BC well.

Flow meters on each well pump discharge line will record flow from each well and the SCADA system will receive the flow data and send signals to the RTU to adjust the well pump speed to achieve the desired flow split.

b. The sequencing and order of well site start up and control is detailed in the Reverse Osmosis Process functional section in this specification as well operation and flow rate is set by the flow needs of the RO Treatment Trains.

c. HOA switches are provided on the door of each well site RTU panel. When the HOA switch at the Well Site Panel is set to the AUTO mode for each well pump at the site, the SCADA System shall control well pump start and stop and VFD speed for each pump.

2. Well Site Operation

a. The SCADA System will provide start/stop control for the well pumps. HOA switches are provided on the pump control panel for each well pump.

b. In Auto Mode, a signal will be sent from the SCADA System to start the selected well pumps along with a rate of flow setpoint to set the Target Flow Rate for each well pump. The HOA switch must be in the Auto position and the well pump must be included in the selected well group.

c. Well pump run status will be derived from comparing the well pump rate of flow with the corresponding well pump "Running" setpoint. If the flow is above the corresponding "Running" setpoint, the pump will be considered running and a status signal will be displayed on the SCADA System. If the flow does not rise above the setpoint within a preset "Well Pump Fail Delay" time, the pump will be considered failed. A digital input from the pump control panel to the well site RTU shall also be capable of indicating pump failure. The well pump "Running" setpoints shall be an adjustable percentage of the target well pump flow, set at 90%.

d. Each well site shall have an adjustable timer to control the operation of the two butterfly valves used for blow-off prior to pumping to the WTP.

1) When the blow off timer is started, the butterfly valve on the combined blow off line shall open and the butterfly valve on the combined raw water line shall close (blow-off position). The valves shall remain in blow-off position until the blow off timer expires, at which time the butterfly valve on the combined blow off line shall close and the butterfly valve on the combined raw water line shall open (service position).

e. When both valves are fully in blow-off position, the pump shall start and slowly ramp up to achieve the target flow rate. The rate at which the pump comes up to speed shall be adjustable.

f. A time delay start of 15 seconds shall be provided for the PD well pump motor. This is required to provide a staggered start in the event both motors are called to start while on standby generator power.

g. Rate of Flow Control

1) VFD controlled well pumps with local Hand-Off-Auto selectors are provided to regulate rate of flow from each well. When placed in Auto, the VFDs are controlled from the RTU at each well site based on signals from the SCADA System. When placed in Hand the pump will be called to run. In Hand, the pump speed is manually entered at the VFD panel.

3. Alarms and Shutdowns
   a. In Auto position, well pump shutdown shall be controlled by signals from the SCADA system. When the pumps are called to shut down, the VFDs shall gradually ramp down in order to control surge pressures in the raw water transmission system.
   b. Alarms
      1) Alarms will be displayed locally and on the SCADA System
      2) Pump Fail alarm shall shut down the well pump and send a signal to the SCADA system.
      3) VFD Fail alarm shall shut down the well pump and send a signal to the SCADA system.

C. Reverse Osmosis Process (P&ID I-102)
   1. The SCADA system logic will incorporate all control process logic as described in Appendix A, Section 13530.
   2. The WTP operators will need to enter process set-points into the SCADA system **before** the start button is enabled in the SCADA system for Water Production:
      a. Select input parameters per Appendix A Project Manual, Section 13530 Part 1.03. This includes the target permeate set point for each RO Train.
      b. The SCADA system shall calculate the total permeate flow target for the plant based on adding the RO Train permeate flow setpoints.
      c. Percent recovery setpoint. Default setting to be 80% for each RO Treatment Train Instrument Panel(s) in the SCADA system. **The percent recovery setting shall only be changed by authorized personnel by password protected access. The range of setting change shall be determined with the ROEM as part of initial programming.**
      d. Set pH setpoint for CO2 system feed control. Also enter in CO2 dose (lbs/hr) for optional permeate flow based dosing.
      e. Set chlorine dose setpoints (mg/L)
         1) Pre-chlorination (feed to permeate line or post calcite line). Set duty pump.
         2) Post-chlorination (after ground storage tank). Set duty/standby pump.
      f. Set fluoride dose setpoint (mg/L) and duty/standby pumps.
      g. Set caustic dose setpoint (mg/L) and duty/standby pumps.
      h. Set corrosion inhibitor dose setpoint (mg/L) and duty/standby pump.
   3. The WTP operators will **also** need to select the well sites for operation from the SCADA system **before** the start button is enabled in the SCADA system for Water Production. When permeate flow rate is input as described above, the SCADA System shall prompt the user to select the desired wells to operate by performing the following functions:

a. Display the number of well sites required for plant operation at the calculated total permeate flow rate. One well site is required for permeate flow rates between 1.3 and 1.7 MGD (single-train operation). Two well sites are required for permeate flow rates between 1.8 and 2.0 MGD (single-train operation) and between 2.6 and 3.4 MGD (dual-train operation). Three well sites are required for permeate flow rates between 3.4 and 4.0 MGD. **These values may need to be adjusted as necessary if well pump test results indicate different values are required.**

b. Display the well site groupings, which are listed below. Both wells (BC and PD) on a given site will operate together. For example, where Well Site 1 is listed below, this indicates operation of Wells 1BC and 1PD. Each group includes a primary, secondary, and tertiary well site. If only one well site is required as described above, only the Primary well site will operate. If two are required, the Primary and Secondary well sties will be used. If all three are required, then all wells in the group are used.

Well Group No.	Primary Well Site	Secondary Well Site	Tertiary Well Site
1.	5	1	2
2.	4	3	5
3.	1	2	4
4.	3	5	1
5.	2	4	3
6.	1	5	2
7.	3	4	5
8.	2	1	4
9.	5	3	1
10.	4	2	3
CUSTOM	Operator may select any combination of well sites		

1) Indicate which group was last used.
2) Indicate if any Well Site(s) in a group(s) are unavailable. A Well Site shall be considered unavailable if that Well Site had pumped a total volume at or above 1,080,000 gallons during the previous 24-hour day period. If a Well Site in a group is unavailable, the operator will be prompted to choose another Well Group No.
3) Prompt the user to select the desired well grouping from the list.

c. The system shall calculate and display the following Target Raw Water Flow Rates based on the Permeate Flow Rate setpoint, the Percent Recovery setpoint, and the selected well site grouping:
1) Target Total Raw Water Flow (gpm)
   i) Equal to the Permeate Flow Rate setpoint divided by the Percent Recovery setpoint and multiplied by 100
2) Target Primary Well Site Flow (gpm)
   i) Equal to the Total Raw Water Flow divided by the number of well sites to be operated.
3) Target Secondary Well Site Flow (gpm)
   i) If two or more well sites are to be operated, this is equal to the Primary Well Site Flow. Otherwise, this is zero.
4) Target Tertiary Well Site Flow (gpm)
   i) If three well sites are to be operated, this is equal to the Primary Well Site Flow. Otherwise, this is zero.
5) Target Primary BC Well Pump Flow (gpm)
   i) Equal to the Primary Well Site Flow multiplied by 0.6
6) Target Primary PD Well Pump Flow (gpm)
   i) Equal to the Primary Well Site Flow multiplied by 0.4
7) Target Secondary BC Well Pump Flow (gpm)
   i) Equal to the Secondary Well Site Flow multiplied by 0.6
8) Target Secondary PD Well Pump Flow (gpm)
   i) Equal to the Secondary Well Site Flow multiplied by 0.4
9) Target Tertiary BC Well Pump Flow (gpm)
   i) Equal to the Tertiary Well Site Flow multiplied by 0.6
10) Target Tertiary PD Well Pump Flow (gpm)

i) Equal to the Tertiary Well Site Flow multiplied by 0.4

4. Well Site System Operation Control
   a. SCADA system to monitor total influent raw water flow and total permeate flow at the WTP. If total raw water flow needs to be increased or decreased to meet the total permeate setpoint, the SCADA system shall send a signal to lower or raise the individual well site target flow value as follows:
      1) If one well site is operating, adjust the speed of the well pumps at that well site to achieve the target flow.
      2) If two well sites are operating, adjust the speed of the well pumps at each well site an equal amount to achieve the target flow.
      3) If three well sites are operating, adjust the speed of the well pumps at each well site equal amount to achieve the target flow.
   b. Well Site operation in response to RO Train shutdown or start-up
      1) When an RO Train is shut down or started up, a modified permeate setpoint and raw water flow setpoint will be calculated by the SCADA System and used for Well Site pump control.
      2) If raw water flow is required that is greater than the combined capacity of the currently operating well sites, the SCADA system will automatically start the Primary Well Site in the subsequent Well Site Group form the table list above.
      3) If the required raw water flow is less than the minimum flow setting for the last well site brought on-line in the Well Group, then the SCADA system will shut the last well site brought on line and shall adjust the well site flow rates to meet the target raw water flow rate at the other well sites.
   c. Well Site operation and Well Site operating hours
      1) SCADA System to record and display on each SCADA Well Site screen the following data:
         a. Well Site previous day volume pumped and cumulative volume pumped in each year.
         b. PD well pump previous daily volume pumped and pump hours, and cumulative volume pumped and cumulative pump hours for each year.
         c. PD well pump previous daily volume pumped and pump hours, and cumulative volume pumped and cumulative pump hours for each year.
         d. Operating well pump percent speed and flowrate for each pump to be displayed
      2) If any Well Site system that is in currently operating has pumped in excess of 1,080,000 gallons in a single 24-hour period, the SCADA system shall display an advisory alarm. The SCADA system shall then query the operator if that Well Site should be shutdown and another Well Site started.
5. RO Treatment Train Start-up
   a. The operator shall select the START button to produce water.
   b. SCADA system shall send raw water flow rate setpoint signal to each Well Site(s).

c. The SCADA system will open the feed water by-pass valve and the raw water will be monitored via the raw water feed panel.
d. PLC-1 will monitor the raw water flow, pressure, turbidity, pH, conductivity, and water temperature and transmit this data to the SCADA system for control. The SCADA system start by-pass timer and compare turbidity values to the setpoint.
e. Once the timer has timed out and the measured turbidity is less than the turbidity setpoint the SCADA system shall start the scale inhibitor system.
f. Once the scale inhibitor system is registering steady flow, send the start signal to the first RO Treatment Train and close by-pass valve. The RO Treatment Rain Instrument Panel shall perform start-up sequence for each RO Train as specified in Appendix A, Section 13530 Part 1.03.
g. If selected to operate, the second RO Treatment Train shall be started as specified in Appendix A, Section 13530 Part 1.03.

6. RO Treatment Train Operation
   a. The RO Treatment Train Instrument Panel shall operate the train(s) as specified in Appendix A, Section 13530, Part 1.04.
   b. All raw water feed parameters shall be monitored continuously and display on the SCADA system.
   c. Permeate total flow, line pressure, conductivity, and pH shall be continuously measured and displayed on the SCADA system.
   d. Concentrate total flow, conductivity, and pH shall be continuously measured and displayed on the SCADA system.
   e. The SCADA system shall also display all RO Treatment Train parameters as shown on P&ID I-102 and the I/O list.
7. RO Treatment Train Shut-Down
   a. RO Treatment Trains shall operate until manually shut down or shut down by alarm situation. See Appendix A, Section 13530 Part 1.05.

D. Reverse Osmosis Clean and Flush System (P&ID I-103)
1. The SCADA system logic will incorporate all flush and cleaning control process logic as described in Appendix A, Section 13530.
2. Flushing Operation
   a. Permeate water will be used for RO Treatment Train flushing upon shutdown of a train. Flushing of concentrate water out of the RO Vessels is required so that permeate water is on both sides of the membranes when the RO Treatment Trains are off.
   b. The permeate flush tank shall be filled from the permeate header pipe when one or more RO units are operating.
      1) The SCADA system shall control the motorized fill valve Open/Closed position based on the ultrasonic signal and a level setpoint entered into the SCADA system.
      2) The SCADA system will only allow the valve to Open when at least one RO Treatment Train is operating and the level is below the setpoint.
      3) When the tank level is above the set point the valve shall be Closed.
   c. RO flushing pump operation and RO Treatment Train valve operations during flushing will be initiated and controlled by the RO

Treatment Train Instrument Panel (See Appendix A, Section 13530).

1) Flush Pump Start/Stop signals will be transmitted to the pumps from the RO Treatment Train Instrument Panels via the SCADA System.
2) Motorized valve operation on the RO Treatment Train units for flushing operations shall be controlled directly by the RO Treatment Train Control panel(s).

3. RO Treatment Train Cleaning
   a. Cleaning of the membranes in an RO Treatment Train is expected to be performed approximately once/year. Cleaning is required to remove scale off the membranes.
   b. Only one RO unit will be cleaned at a time and the other RO unit will be operating during cleaning (to supply permeate water for chemical solution make-up).
   c. The cleaning solutions will be manually made-up in the cleaning tank using permeate water and citric acid powder and 35% caustic. The cleaning tank fill valve shall be manually opened and closed and the chemical added manual to the cleaning tank by the WTP operators.
   d. Cleaning requires the cleaning solution to be heated to approximately 100 degrees Fahrenheit (F). It is anticipated that heating the permeate to this temperature will require up to 4 hours per batch. Heating element control shall be by the control panel supplied by the heating element unit supplier.
   e. Cleaning Pump
      1) The Cleaning Pump shall be used for the following functions:
         i) Mix cleaning solution batches via a recycle loop
         ii) Feed cleaning chemical at high pressure to the membranes in a cleaning recycle loop.
         iii) Transfer spent cleaning solution to the waste tank.
      2) The operator shall manually close and open valves on the pump discharge line to change the desired pump function.
      3) Cleaning pump On/Off and speed control is set at the local control station.
   f. PLC-1 will monitor and display Cleaning Pump discharge line pressure, pH, flow and temperature during membrane cleaning and differential pressure across the cleaning system cartridge filter. Values to be displayed at PLC-1 and at the SCADA system.
   g. The Cleaning Pump Local Control Station (CP-1 LCS) will be used to turn the cleaning pump on/off and adjust the pump speed.
   h. Cleaning operation
      1) Cleaning shall be a manual operation performed by WTP operating staff.
      2) One acid and one caustic cleaning cycle will be performed on a batch basis for the membranes. One-third of the membranes will be cleaned at a time on a train, so a total of six chemical batches will be needed for each train cleaning.
      3) A typical single batch cleaning cycle will consist of the following:

i) Operator open cleaning tank fill valve and fill cleaning tank. Manually turn on heating element at heating element local control panel via On/Off button and heat to 100 F.
ii) Set pump discharge line valves to solution mix positions. Set pump speed at local control station.
iii) Operator manually add prescribed chemical amount to tank and mix tank contents by turning on Cleaning Pump via On/Off switch at local control panel. Mix chemical. Turn off cleaning pump when mixing complete and pH and temperature have stabilized based on Cleaning Solution panel readings.
iv) Manually set all valves on RO Treatment Train to clean specific membrane batch.
v) Manual change pump discharge line valves for membrane cleaning, set Cleaning Pump Speed and turn on Cleaning Pump.
vi) Continue pump operation until cleaning is considered complete by visual inspection and by monitoring of pH and temperature on Cleaning Solution panel. Turn off the Cleaning Pump.
vii) Set pump discharge line valves to positions for pumping spent cleaning solution to the waste tank. Set pump speed and turn on Cleaning Pump and empty cleaning tank.
viii) Repeat the above sequence for five additional cleaning batch runs for one RO Treatment Train.

E. On-Site Sodium Hypochlorite Generation System (P&ID I-104)
1. Description
a. The purpose of this system is to generate a 0.8% solution of sodium hypochlorite using water, salt, and electrolytic cells. The generator system will be supplied on a skid with an integral sodium hypochlorite generator control panel (PLC-3) supplied by the equipment manufacturer. The hypochlorite solution will be fed to two dosing points: Prior to the carbon dioxide feed point (pre-chlorination) and after the finished water storage tank (post-chlorination).
b. The sodium hypochlorite generator, storage tanks, softened water feed, hydrogen dilution blowers, and metering pumps shall be controlled by PLC-3 as specified in Specification Section 11265 of this project manual and as shown on the P&IDs.
2. Operation - Sodium Hypochlorite Generator System
a. The sodium hypochlorite generator on/off operation shall be controlled based on high and low level in the hypochlorite storage tanks and not be dependent on whether the WTP is producing water. Operation shall be as described in Specification Section 11265.
b. Operating and alarm functions shall be displayed at PLC-3 and the SCADA System.
c. Alarms and/or shutdown of the sodium hypochlorite generation system shall **not** shutdown the metering pumps.
3. Operation – Metering Pumps

a. Metering pump on/off and speed control shall be controlled by signals sent by the SCADA system and received and executed by PLC-3. Metering pump speed shall be controlled by 4-20 mA signals from the SCADA System. Metering pump stroke length adjustment shall be manually set by the operator.
   1) Alarm shutdown of the metering pump operation shall only occur if low level setpoint conditions are detected in **both** of the hypochlorite storage tanks.
   2) There is a provision to use the dilution panel to manual fill the hypochlorite tanks in the event of hypochlorite generator failure. This would be a manual operation performed and monitored by the WTP operators.

b. The SCADA System shall include an enable/disable switch for each Metering Pump. This switch shall be settable by the operator from the SCADA System. A selector switch shall also be provided to allow use of Pump Number 2 for pre-chlorination or post-chlorination service. However, the normal function of the pumps shall be as follows:
   1) Metering Pump No 1: Pre-chlorination
   2) Metering Pump No 2: Post-chlorination
   3) Metering Pump No 3 Post-chlorination
   4) The operator shall be responsible for manually resetting meter pump discharge valves to allow switch of pump functions for Pump No 2.
   5) SCADA Screen shall have a selector switch to set Metering Pump No 2 or 3 for lead/back-up service.

c. Pre-chlorination Metering Pump Control
   1) This pump shall only operate when one or more RO Treatment Trains are operating and be off if no RO Treatment Trains are operating. See Appendix A, Specification Section 13530 for RO Treatment Train operation.
   2) Pump on/off timing shall be controlled by the SCADA System. Pump shall be allowed to start/stop if enabled at the SCADA System screen.
   3) The SCADA system shall determine the pump speed to provide a variable gallons/hour feed rate using an algorithm based on the following inputs:
      i) Metering Pump maximum capacity (gal/hr). Operator input based on pump pulley settings.
      ii) Permeate total flowrate
      iii) Chlorine dose setpoint (0.5 to 2 mg/L) in 0.25 increments.
      iv) Sodium Hypochlorite percent by weight (0.8%)
      v) Sodium Hypochlorite density (lbs/gal)
      vi) Pump percent stroke length (operator manual input)
   4) Pump fail shall trigger advisory alarm, but **not** shut down the RO Treatment Trains.
   5) An alarm shall be displayed at the SCADA system if the chemical pump is called to stop by the SCADA system and the pump run signal indicates the pump has not stopped.

d. Post-chlorination Meter Pump Control

1) This pump shall operate when the Finished Water Pumps operate.
2) Pump on/off timing shall be controlled by the SCADA System. Pump shall be allowed to start/stop if enabled at the SCADA System screen.
3) The SCADA system shall determine the pump speed to provide a variable gallons/hour feed rate using an algorithm based on the following inputs:
   i) Metering Pump maximum capacity (gal/hr). Based on pump pulley settings.
   ii) Total finished water flowrate
   iii) Chlorine dose setpoint (0.5 to 4 mg/L).
   iv) Sodium Hypochlorite percent by weight (0.8%)
   v) Sodium Hypochlorite density (lbs/gal)
   vi) Pump percent stroke length (operator manual input)
4) Metering Pump fail shall trigger alarm in SCADA and shut down the operation of the High Service Pumps. This alarm can be manually reset if the operator selects the back-up metering pump as the lead post-chlorination pump. The Finished Water Pumps will need to be restarted to resume operation.
5) An advisory alarm shall be displayed at the SCADA system if the chemical pump is called to stop by the SCADA system and the pump run signal indicates the pump has not stopped.

F. Carbon Dioxide (CO_2) Storage and Feed System (P&ID I-105)
1. Description
   a. The purpose of this system is to create a carbonic acid solution from carbon dioxide gas and water and inject this solution into the permeate line prior to the calcite tanks. The carbonic acid feed rate will normally be controlled by a pH set point, but can also be controlled based on an operator settable desired pound/hour dosing rate. The CO_2 system will be supplied with an integral pressurized feed solution panel (PSF) for mixing water and carbon dioxide gas to produce the carbonic acid for injection. An integral mixing quill is also supplied. Carbon dioxide will be fed at one dosing point as shown on the Drawings.
   b. The control operation of the carbon dioxide gas storage tank, refrigeration unit, vaporizer unit and PSF control panel is as specified in Specification Section 11975 of this project manual and as shown on the P&IDs. SCADA System shall incorporate all functions, signals, and alarms in Section 11975 as well as those specified herein.
   c. The SCADA system shall include an operator selector switch to allow selection of carbon dioxide feed by either 1) pH setpoint (normally 5 to 5.5) or 2) carbon dioxide dosage (~ 25 mg/L).
      1) The 4 to 20 mA range setting for pH or for carbon dioxide dosage shall be set at system start-up and shall be adjustable via password protected input.
      2) There shall be two 4-20 mA scale settings: one for pH and one for dose.
2. Operation – Carbon Dioxide Feed System

a. This carbon dioxide feed system shall only operate when one or more RO Treatment Trains are operating and be off if no RO Treatment Trains are operating. Operating signals received by PLC-1 shall transmit signals to the SCADA system. The SCADA system shall send a control signal to turn on and off the carbon dioxide feed system per the RO Treatment Train operation as specified in Appendix A, Section 13530. The SCADA system shall automatically adjust the carbon dioxide feed rate.

b. On the SCADA system, the operator shall select carbon dioxide feed control by either pH control or dosage control. Normal operation shall be by pH control.
   1) For pH control, the pH analyzer on the permeate line (AIT179) shall provide a signal to the SCADA system which will be used to monitor and adjust the 4-20 mA signal to the PSF panel.
   2) For dose control, The SCADA system shall determine the carbon dioxide pounds/hour (lbs/hr) feed rate to send to the PSF using an algorithm based on the following inputs:
      i) PSF maximum capacity (lb/hr) as listed in Specification Section 11975.
      ii) Permeate total flowrate (mgd)
      iii) Carbon Dioxide dose setpoint (15 to 30 mg/L input range).
      iv) Carbon Dioxide percent by weight (100%)
      v) Water density (lbs/gal)
      vi) SCADA system shall determine mA signal for permeate total flowrate and dosage and send signal to PSF for control valve adjustment.

c. The on/off and PSF control valve operation of the carbon dioxide feed shall be controlled by a 4-20 mA signal from the SCADA System to the PSF panel.

d. The carbon dioxide feed system shall continue to operate as long as one or more RO Treatment Trains are operating and shall automatically adjust to meet pH or mg/L CO_2 setpoints. When zero total permeate flow is detected the PSF control valve shall be completely shut.

3. Alarms and Shutdowns
   a. Incorporate all alarms in Section 11975 into SCADA system.
   b. A low CO_2 storage tank level shall trigger an alarm and a "Carbon Dioxide Feed System Failure" signal to the SCADA System.
   c. Carbon Dioxide Feed System Failure shall trigger RO Treatment Train shutdown per Appendix A, Section 13530.

G. Calcite System (P&ID I-106)
   1. Description
      a. The purpose of this system is to add hardness and carbonate alkalinity to the permeate water to bring the water to a neutral pH and non-corrosive condition by dissolution of crushed solid calcite. The carbonic acid feed to the permeate and detention time in the calcite cells will drive the calcite dissolution process. The permeate will flow upwards in the calcite cells. There are three calcite cells per calcite vessel for a total of six cells to be controlled.

b. The calcite cells can remain in service mode with the RO Treatment Trains off. The water in the cells will chemically equilibrate with the permeate and reach a saturation state. There is a standpipe in the ground storage tank that will maintain the cells full of water.
c. Calcite loading, rinsing, or backwashing operation will only be allowed for one calcite cell at a time.
d. The system is to be controlled by PLC-4 which is to be supplied by the Calcite Vessel manufacturer. A description of the control operation of the system is provided in Specification Section 13203 of this project manual and as shown on the P&IDs. SCADA System shall incorporate all functions, signals, and alarms in Specification Section 13203, P&ID I-106, and those specified herein.

2. Operation – Calcite System
   a. The operation of the Calcite System shall be controlled by PLC-4 and system information transmitted to the SCADA system.
   b. The operator shall input into PLC-4 the alarm setpoints for calcite bed level for each calcite cell. Typically, this will be set for 6 inches below full bed depth.
   c. Service Operation
      1) Service Operation shall be the normal operating mode for the calcite cells.
      2) The calcite cells to be in Service Mode shall be selected manually by the operator at PLC-4. The cells in service and not in service shall be displayed on the SCADA system.
   d. Backwash Operation
      1) Backwash Operation shall be selected for use by the operator if excess differential pressure across a calcite cell is detected and the cell needs a backwash rate higher than the Rinse Operation rate.
      2) Backwash Operation shall be manually set by the operator at PLC-4.
      3) Backwash rate (gpm/sq ft) and duration shall be set by the operator at PLC-4.
      4) The operator shall select the START BACKWASH button on PLC-4 and PLC-4 shall control backwash operation from start to finish.
      5) Backflush water shall be supplied by the WTP finished water piping. PLC-4 shall receive signals from backwash/rinse water supply flow meter FIT 439 and send 4-20 mA signals to the supply butterfly valve 440 to modulate and control flow via the operator entered setpoint. The SCADA system shall display all this information.
   e. Calcite Loading Operation
      1) Calcite loading shall be conducted when the calcite bed level in a cell has dropped approximately 6 inches from full level.
      2) The calcite bed level will be continually measured by the calcite sensor in each cell.
      3) Calcite Loading Operation shall be a manual operation set by the operator at PLC-4.
   f. Rinse Operation

1) Rinse Operation shall be selected for use by the operator after calcite loading of a cell is completed
2) Rinse Operation shall be manually set by the operator at PLC-4.
3) Rinse rate (gpm/sq ft) and duration shall be set by the operator at PLC-4.
4) The operator shall select the START RINSE button on PLC-4 and PLC-4 shall control backwash operation from start to finish.
5) Rinse water shall be supplied by the WTP finished water piping. PLC-4 shall receive signals from backwash/rinse water supply flow meter FIT 439 and send 4-20 mA signals to the supply butterfly valve 440 to modulate and control flow via the operator entered setpoint. The SCADA system shall display all this information.
6) After rinsing, the cell valves shall set to a closed position and the operator will need to manually set the service mode for the cell.

3. Alarms and Shutdowns
   a. Incorporate all alarms in Section 13203 into SCADA system.

H. Ground Storage Tank, High Service Pumps, & Elevated Storage Tank (P&ID I-107)
1. Description
   a. A 1.0 MG Ground Storage Tank (GST) is provided for finished water storage. The SCADA System shall continuously monitor and trend the level in the GST.
   b. Three (3) High Service Pumps (HSP) are provided (one lead pump, one lag pump, and one standby) to pump finished water from the Ground Storage Tank to the distribution system.
   c. Normal operation of the HSPs will require a minimum level in the ground storage tank. Provided that the ground storage tank is above the minimum required level, start-stop operation of the HSPs will be based on the level in the existing elevated tank.
   d. Piston actuated pump control valves with electronic controllers are included on the discharge of each high service pump to minimize pressure surges associated with starting and stopping of the pumps.
   e. The SCADA System shall continuously monitor and trend the level in the existing elevated storage tank. The following adjustable, password-protected elevated tank level setpoints shall be provided:
      1) Elevated Tank Full
      2) Elevated Tank High Level Alarm
      3) HSP OFF
      4) Lead HSP ON
      5) Lag HSP ON
      6) Elevated Tank Low Level Alarm
      7) Elevated Tank Empty
   f. The SCADA System shall continuously monitor the level in the ground storage tank. The following adjustable, password-protected ground storage tank level setpoints shall be provided:
      1) Ground Storage Tank Full

2) Ground Storage Tank High Level Alarm
3) Ground Storage Tank Approaching High Level Alarm
4) Ground Storage Tank Approaching Low Level Alarm
5) Ground Storage Tank Low Level Alarm
6) HSP Restore
7) HSP OFF
8) Ground Storage Tank Empty

2. Operation
   a. The SCADA System will provide start/stop control for the High Service Pumps No. 1, No. 2, and No. 3. Hand-Off-Auto switches are provided on the pump control valve panel. A local emergency pump stop pushbutton for each pump is included at the High Service Pumps.
      1) Auto mode. In Auto mode the pumps shall be controlled based on the elevated tank level in the water distribution system. When the tank level falls below the "Lead HSP ON" setpoint, the high service pump that the system has chosen to be the lead pump will be called to start. The lead pump will continue to operate until the level of the elevated tank rises above the "HSP OFF" setpoint. In the event that the level of the elevated tank continues to fall with the lead pump operating and reaches the "Lag HSP ON" setpoint, the lag pump will be called to start. The lead and lag pumps will continue to operate until the level of the elevated tank rises above the "HSP OFF" setpoint. Both the lead and lag pumps will also be stopped if the level in the Ground Storage Tank falls below the "HSP OFF" setpoint. The pumps will remain off until the level of the Ground Storage Tank rises above the "HSP Restore" setpoint.
      2) Hand mode. In Hand mode the pump will operate when the operator places the selected pump in Hand Mode. The pump will continue to run until the operator places the pump in Off mode. If the pump or pumps are in Hand Mode and the level in the Ground Storage Tank falls below the HSP OFF level, an alarm will be generated at the SCADA panel and at PLC-1.
   b. Control Sequence:
      1) Pump shall start upon either turning the HOA switch to the "Hand" position or by remote contact closure with HOA switch in the "Auto" position. With the pump control valve LOR switch in "Remote," a valve delay timer sequence shall be initiated simultaneously with the pump start. Initiation of the valve delay timer shall be signaled on the pump control valve electronic controller LCD touchscreen panel and the SCADA System HMI.
      2) When the pump discharge pressure exceeds the static system head as set on the pump discharge pressure switch, and prior to the expiration of the valve delay timer, the emergency solenoid pilot on the pump control valve shall be energized and the control valve panel and the SCADA System HMI shall indicate that the pump discharge pressure exceeds the static system pressure.

3) Failure of the pump to produce sufficient pressure to satisfy the pressure switch setting within the valve delay timer setting shall cause an alarm to be activated indicating insufficient pump pressure, the pump shall be shut down, and the standby pump shall be placed into operation. A manual reset of the HOA switch shall be required to restart the pump.
4) Once the valve delay timer expires under normal conditions, the normal solenoid pilot on the pump control valve shall be energized, the pump control valve shall start to open and the valve initiate timer delay sequence shall begin. Actuation of the valve initiate timer shall be indicated on the control valve LCD panel and the SCADA System HMI. The time interval shall be operator adjustable and shall be set to exceed the time required to open the pump control valve. At the expiration of the timer the pump control valve shall be in the full open position and the limit switch shall have closed. The full valve open position shall be indicated for the duration of the pumping operation. In the event the limit switch is open (indicating a no pump situation) the pump shall shut down, an alarm shall be signaled, and the standby pump shall be placed into operation.
5) The normal pump shutdown sequence shall be initiated by either manually turning the HOA switch to the "OFF" position or by opening of the remote contacts with the HOA switch in the "Auto" position. The normal solenoid pilot valve shall be de-energized causing the pump control valve to start closing.
6) The limit switch, for which the contacts are still closed, shall continue to energize the emergency close solenoid valve and the pump shall continue to run.
7) When the pump control valve reaches 95% closed, the limit switch shall open, de-energizing the emergency close solenoid valve and the pump shall be shut down. Once the valve is fully closed and the pump shut down, the system shall indicate the pump off condition.
8) Pumps shall automatically alternate between Lead, Lag, and Standby between cycles.
9) A time delay start of 15 seconds shall be provided for the lag pump motor. This is required to provide a staggered start in the event both motors are called to start while on standby generator power.
10) The sodium hypochlorite feed pump will be electronically interlocked with the high service pump control circuit to run when either or both of the HSPs are running.

3. Alarms and Shutdowns
   a. The SCADA System will enunciate an advisory alarm condition when the following level conditions occur in the Ground Storage Tank:
      1) Tank level falls below the Ground Storage Tank Low Level setpoint.
      2) Tank level rises above the Ground Storage Tank Approaching High Level setpoint.

3) Tank level falls below the Ground Storage Tank Approaching Low Level setpoint.
4) Tank level rises above the Ground Storage Tank High Level setpoint.
5) Tank level rises above the Ground Storage Tank Full setpoint.

b. Alarm Shutdown
1) In the event the pump discharge pressure is not able to maintain the pressure switch setting during pump operation, the normal and emergency solenoid pilots on the pump control valve shall de-energize, the pump control valve shall close, the pump shall be shut down, and an alarm shall be signaled indicating a loss of pump pressure. A manual reset of the HOA switch shall be required to restart the pump.
2) In the event of low pump suction pressure or if the level in the ground storage tank falls below the "HSP OFF" level, the normal and emergency solenoid pilots on the pump control valve shall de-energize, the pump control valve shall close, the pump shall be shut down and an alarm shall be signaled indicating low suction pressure conditions. A manual reset of the HOA switch shall be required to restart the pump.
3) In the event of a power failure, the normal and emergency solenoid pilots on the pump control valve shall be de-energized simultaneously allowing rapid closure of the pump control valve through the valve piloting. The valve closure rate under emergency conditions, albeit faster than the closure rate during normal conditions, shall be capable of manual adjustment such that system surge conditions will be minimized.
4) In the event of power failure, even momentary, a five minute delay period shall be initiated as soon as power is restored. During the power failure delay period, it shall not be possible to have an automatic pump restart. Pump start delay shall be indicated on the SCADA System HMI. Once the delay period has expired, a normal pump sequence shall be initiated if a local or remote pump start command exists. It will be possible to cancel the delay period by a manual reset of the HOA switch. The time delay period shall be operator adjustable from 6 seconds to 10 minutes at a minimum.
5) Pumps shall automatically shut down upon loss of phase, low suction pressure, thermal overload, under voltage, loss of discharge pressure, control valve failure, and limit switch failure.
6) Pumps shall automatically shut down upon failure of the Sodium Hypochlorite feed pumps.

I. Rinse Storage Tank (P&ID I-108)
1. Description
a. The Rinse Storage Tank is used to store rinse/backwash water from Calcite Cell rinse/backwash operation. Flow is by gravity to the tank and two submersible Waste Pumps (WP-1 and WP-2) are used to pump the water from the tank to the sanitary sewer. Pumps shall start and stop based on level in the Rinse Tank.

b. A submersible mixer is also provided in the tank to allow mixing of the tank contents. Mixer On/Off control is provided by the local control station near the mixer.
c. The following adjustable tank level setpoints shall be entered into the SCADA System:
    1) Pump On
    2) Pump Off
    3) Rinse Storage Tank Low Level
    4) Rinse Storage Tank High Level
    5) Rinse Storage Tank Overflow Level
    6) Setpoint access shall be password protected.
d. Rinse Storage Tank water level shall be continuously displayed at the SCADA System

2. Operation
    a. Pump Control. The SCADA System will provide start/stop control based on level for the submersible rinse tank effluent pumps. On/Off/Remote switches are provided on the MCC RO to provide local manual control of the pumps.
        1) Remote mode. In this mode, the pumps shall be controlled by the SCADA System based on the level in the Rinse Storage Tank. Only one pump is allowed to operate at a time. When the tank level rises above the "Pump On" setpoint, the pump that the system has chosen as the lead pump will be called to start. The pump will continue to operate until the tank level falls below the "Pump Off" setpoint. In the event that the tank level continues to rise while the lead pump is operating and reaches the "Lag Pump On" setpoint, the lag pump will start. The lag pump will continue to operate until the tank level falls below the "Pump OFF" setpoint.
        2) Pumps shall automatically alternate between lead and lag each cycle.
        3) Local mode. In this mode pump on/off control will be at the MCC RO. When place in Hand, the selected pump will operate until turned off.
    b. The run status for each pump will be generated from the check valve limit switch on the discharge of each pump. If the limit switch is activated, a pump run signal will be generated and will be displayed on the SCADA System. If the limit switch is not activated after the "Waste Pump Fail Delay" time has elapsed, a pump fail alarm will be generated for the pump. Upon failure of the lead pump, the lag pump will automatically be called to start. The failed pump will be locked out of operation until manually reset. A pump fail reset push-button shall be provided in the SCADA System to reset the pump fail condition.
    c. Mixer Control. The SCADA System will provide start/stop control for the Rinse Storage Tank Mixer. A Hand-Off-Auto switch is provided on the mixer control panel to provide local manual control of the mixer. When placed into Auto mode, the mixer shall be controlled manually through the SCADA System. Mixer run status shall be displayed.
3. Alarms and Shutdown

1) Following alarms shall be displayed at the SCADA system
   i) Pump Fail (thermal overload and seal failure)
   ii) Rinse Tank Low Level
   iii) Rinse Tank Overflow Level
   iv) Mixer Fault

J. Scale Inhibitor Feed System (P&ID I-109)
1. Description
   a. The purpose of this system is to scale inhibitor to the raw water to prevent scaling of the RO membranes. The scale inhibitor will be fed to the raw water prior to the cartridge filters. If low flow of scale inhibitor is detected at any time (FIT 135), the RO Treatment Trains will be shut down per Appendix A, Specification Section 11245 and 13530.
   b. The SCADA system logic will incorporate all control process logic for the scale inhibitor feed system as described in Appendix A, Specification Sections 11245 and13530, P&ID I-109, and specified herein.
   c. PLC-1 will receive and transmit all signals from the feed system and transmit to SCADA system for process control.
   d. The operator shall enter the scale inhibitor dose setpoint (mg/L) into the SCADA system. The SCADA system shall determine the required metering pump dosing rate (gal/hr) and control the scale inhibitor metering pump speed via 4-20 mA signal.
   e. PLC-1 and the SCADA system shall monitor chemical tank liquid level and scale inhibitor flow and display at the SCADA system.
      1) SCADA system shall include operator changeable setpoints for Low Chemical Tank Liquid Level and Low Scale Inhibitor Flow.
   f. Scale inhibitor delivery and tank loading will be a manually process completed by the operators.
2. Operation – Scale Inhibitor Feed System
   a. This scale inhibitor feed system shall be turned on/off by signals received from the SCADA system and transmitted to PLC-1. The SCADA system shall send a control signal to turn the metering pump on and off per the RO Treatment Train operation as specified in Appendix A, Section 13530. Metering pump on/off and metering pump speed adjustment shall be per Appendix A, Section 11245. The SCADA system shall automatically adjust the scale inhibitor metering pump speed to reach and maintain the dose setpoint based on raw water feed flow.
3. Alarms and Shutdowns
   a. The SCADA system shall incorporate all alarms per Appendix A, Section 11245.
   b. SCADA system also to continuously display chemical tank liquid level, metering pump estimated flow rate (from the pump), and scale inhibitor flow from flow meter FIT 135.
   c. An advisory alarm shall be displayed at the SCADA system if the chemical pump is called to stop by the SCADA system and the pump run signal indicates the pump has not stopped.

K. Caustic Feed System (P&ID I-110)
1. Description

a. The purpose of this system is to increase the pH of the treated water after the calcite vessels have added hardness and carbonate alkalinity. The caustic feed system shall only operate when one or more RO Treatment Trains are operating.
b. The SCADA system logic will incorporate all control process logic for the caustic feed system as described in Appendix A, Specification Sections 13530 and Specification Section 11240, P&ID I-110, and specified herein.
c. PLC-1 will receive and transmit all signals from the feed system and transmit to SCADA system for process control.
d. SCADA system shall have duty/standby selector switch for each metering pump.
e. The operator shall enter the caustic dose setpoint (mg/L) and stroke length into the SCADA system. The SCADA system shall determine the required metering pump dosing rate (gal/hr) and control the caustic metering pump speed.
f. PLC-1 and the SCADA system shall monitor chemical tank liquid level and caustic flow and display at the SCADA system.
g. The feed system will include two feed pumps, but a metering pump skid that will allow addition of a third future caustic pump is provided. This third pump would feed caustic to a vault to the finished water after the finished water flow meter. The on/off and pump speed of this future pump would be controlled by the High Service Pumps operation. **The SCADA system integrator is to incorporate control of this future third pump into the SCADA system.**
h. The caustic system also includes a large bubble compressed air mixing system that will be used to mix 50% caustic delivered to the water treatment plant with dilution water to produce a final 25% by weight solution caustic solution. This system shall be controlled an local control panel only that will not be connected to the SCADA System.

2. Operation – Caustic Feed System (after Calcite Facility)
   a. The SCADA system shall send a control signal to turn the duty metering pump on and off per the RO Treatment Train operation as specified in Appendix A, Section 13530. Caustic metering pump speed adjustment shall be by the SCADA system.
      1) This pump shall only operate when one or more RO Treatment Trains are operating and be off if no RO Treatment Trains are operating.
      2) Pump on/off timing shall be controlled by the SCADA System.
      3) The SCADA system shall determine the pump speed to provide a variable gallons/hour feed rate using an algorithm based on the following in puts:
         i) Metering pump maximum capacity (gal/hr) as selected by the operator (based on values in Specification Section 11240).
         ii) Permeate total flowrate
         iii) Caustic dose setpoint (0 to 7.0 mg/L).
         iv) Caustic solution strength percent by weight (25%)
         v) Caustic density (lbs/gal at solution strength)

vi) Pump percent stroke length (operator manual input)
vii) SCADA system shall determine and send 4-20 mA signal to the duty pump.

b. Pump fail shall trigger shut down alarm for the RO Treatment Trains.
c. An alarm shall be displayed at the SCADA system if the chemical pump is called to stop by the SCADA system and the pump run signal indicates the pump has not stopped.
d. The SCADA system shall compare computed metering pump feed rate to measured feed rate. If measured rate differs by more than 5% display an advisory alarm.

3. Operation – Future Caustic Feed (after High Service Pumps)
   a. This future pump shall operate when the High Service Pumps operate. Provide enable/disable selection switch for this pump in the SCADA system.
   b. Pump on/off shall be controlled by the SCADA System.
   c. The SCADA system shall determine the pump speed to provide a variable gallons/hour feed rate using an algorithm based on the following inputs:
      1) Metering Pump maximum capacity (gal/hr) as selected by the operator.
      2) Total finished water flowrate
         i) Caustic dose setpoint (mg/L).
         ii) Caustic solution strength percent by weight (25%)
         iii) Caustic density (lbs/gal at solution strength)
         iv) Pump percent stroke length (operator manual input)
         v) SCADA system shall determine and send 4-20 mA signal to the pump.
   d. Metering Pump fail shall trigger an alarm in SCADA and shut down the operation of the High Service Pumps. This alarm can be manually reset if the operator selects the back-up metering pump as the lead post-chlorination pump. The Finished Water Pumps will need to be restarted to resume operation.

4. Alarms and Shutdowns
   a. The SCADA system shall incorporate all alarms per Appendix A, Section 13530 and Specification Section 11242.

L. Fluoride Feed System (P&ID I-111)
1. Description
   a. The purpose of this system is to dose fluoride, in the form of hydrofluorosilicic acid, to the treated water after the calcite vessels. The fluoride feed system shall only operate when one or more RO Treatment Trains are operating. The feed system equipment will be housed in a small FRP enclosure north of the Calcite Facility area.
   b. The SCADA system logic will incorporate all control process logic for the fluoride feed system as described in Appendix A, Specification Sections 13530 and Specification Section 11243, P&ID I-111, and specified herein.
   c. PLC-1 will receive and transmit all signals from the feed system and transmit to SCADA system for process control.

d. SCADA system shall have duty/standby selector switch for each metering pump.
e. The operator shall enter the fluoride dose setpoint (mg/L) and stroke length into the SCADA system. The SCADA system shall determine the required metering pump dosing rate (gal/hr) and control the metering pump speed.
f. PLC-1 and the SCADA system shall monitor chemical tank liquid level and display at the SCADA system.
g. The feed system will include two feed pumps on a pre-engineered and pre-packaged skid

2. Operation – Fluoride Feed System (after Calcite Facility)
   a. The SCADA system shall send a control signal to turn the duty metering pump on and off per the RO Treatment Train operation as specified in Appendix A, Section 13530. Metering pump speed adjustment shall be by the SCADA system.
      1) This pump shall only operate when one or more RO Treatment Trains are operating and be off if no RO Treatment Trains are operating.
      2) Pump on/off shall be controlled by the SCADA System.
      3) The SCADA system shall determine the pump speed to provide a variable gallons/hour feed rate using an algorithm based on the following inputs:
         i) Metering pump maximum capacity (gal/hr) as selected by the operator (based on values in Specification Section 11243).
         ii) Permeate total flowrate
         iii) Fluoride dose setpoint (0.7 mg/L).
         iv) Fluoride solution strength percent by weight (25%)
         v) Fluoride density (lbs/gal at solution strength)
         vi) Pump percent stroke length (operator manual input)
         vii) SCADA system shall determine and send 4-20 mA signal to the duty pump.
   b. Pump fail shall trigger advisory alarm for the RO Treatment Trains.
   c. The SCADA system shall compare computed metering pump feed rate to measured feed rate. If measured rate differs by more than 5% display an advisory alarm.
3. Alarms and Shutdowns
   a. The SCADA system shall incorporate all alarms per Appendix A, Section 13530 and Specification Section 11243.
   b. An alarm shall be displayed at the SCADA system if the chemical pump is called to stop by the SCADA system and the pump run signal indicates the pump has not stopped

M. Corrosion Inhibitor Feed System (P&ID I-112)
1. Description
   a. The purpose of this system is to dose polyphosphate corrosioin inhibitor to the treated water after the calcite vessels. The purpose of this chemical is to provide corrosion resistance in the water distribution system. The corrosion inhibitor feed system shall only operate when one or more RO Treatment Trains are operating.

b. The SCADA system logic will incorporate all control process logic for the corrosion inhibitor feed system as described in Appendix A, Specification Sections 13530 and Specification Section 11242, P&ID I-112, and specified herein.
c. PLC-1 will receive and transmit all signals from the feed system and transmit to SCADA system for process control.
d. SCADA system shall have duty/standby selector switch for each metering pump.
e. The operator shall enter the corrosion inhibitor dose setpoint (mg/L) and stroke length into the SCADA system. The SCADA system shall determine the required metering pump dosing rate (gal/hr) and control the metering pump speed.
f. PLC-1 and the SCADA system shall monitor chemical tank liquid level and display at the SCADA system.
g. The feed system will include two feed pumps on a pre-engineered and pre-packaged skid

2. Operation – Fluoride Feed System (after Calcite Facility)
   a. The SCADA system shall send a control signal to turn the duty metering pump on and off per the RO Treatment Train operation as specified in Appendix A, Section 13530. Metering pump speed adjustment shall be by the SCADA system.
      1) This pump shall only operate when one or more RO Treatment Trains are operating and be off if no RO Treatment Trains are operating.
      2) Pump on/off shall be controlled by the SCADA System.
      3) The SCADA system shall determine the pump speed to provide a variable gallons/hour feed rate using an algorithm based on the following inputs:
         i) Metering pump maximum capacity (gal/hr) as selected by the operator (based on values in Specification Section 11242).
         ii) Permeate total flowrate
         iii) Corrosion Inhibitor dose setpoint (1.0 to 2.5 mg/L).
         iv) Corrosion Inhibitor solution strength percent by weight (35%)
         v) Corrosion Inhibitor density (lbs/gal at solution strength)
         vi) Pump percent stroke length (operator manual input)
         vii) SCADA system shall determine and send 4-20 mA signal to the duty pump.
   b. Pump fail shall trigger shutdown alarm for the RO Treatment Trains.
   c. An alarm shall be displayed at the SCADA system if the chemical pump is called to stop by the SCADA system and the pump run signal indicates the pump has not stopped.
   d. The SCADA system shall compare computed metering pump feed rate to measured feed rate. If measured rate differs by more than 5% display an advisory alarm.
3. The SCADA system shall incorporate all alarms per Appendix A, Section 13530 and Specification Section 11242.

N. Instrument Control Panels (P&ID I-113)
   1. General Description

a. There will be nine (9) instrument control panels as depicted in P&ID I-113: The purpose of the instrument panels is to provide real-time readouts of key parameters at the local instrument panels and at the SCADA system. These parameters are used for process and water quality monitoring purposes.

2. Raw Water Panel (Instrument Panel 1)
   a. Panel 1 – displays as shown on P&ID I-113.
   b. Raw feed water turbidity, pH, and conductivity will be measured at the panel and signal transmitted to PLC-1 and the SCADA system.
   c. Cartridge filter dPIT shall be measured and displayed at the Raw Water Feed, PLC-1 and SCADA System.
   d. Cartridge filter pressure gauge panel display at Raw Water Panel only.
3. RO Instrument Train Control and Instrument Panel (RO Train Panels 1 and 2)
   a. These panels will be provided by the ROEM as part of the Appendix A RO Equipment Procurement. These panels are used for RO Treatment Train monitoring and control.
   b. Data to be transmitted from these panels to the SCADA system for each RO Treatment Train unit as shown on P&ID I-102. See Appendix A, Specification Section 13550 for information on ROEM supplied instrumentation and signal output.
4. Combined Permeate and Concentrate Panels (Instrument Panels 2 and 3)
   a. Panel 2 – combined permeate water quality measurement
   b. Panel 3 – combined concentrate water quality measurement.
   c. Real-time pH and conductivity measurements to be measured at each of these panels during RO Treatment Train operation and transmitted to PLC-1, and the SCADA system.
   d. The SCADA system shall open the sample in feed solenoid valve on each panel when the RO Treatment trains are in operation. The valve shall be closed when the RO Treatment Trains are not in operation.
5. Cleaning Solution Panel (Instrument Panel 4)
   a. Panel 4 – cleaning solution temperature and pH measurement.
   b. Real-time pH and conductivity measurements to be measured at this panel and displayed at the local panel only for manual monitoring by the operator during RO Treatment Train cleaning.
   c. The sample for this panel will be provided under pressure from the cleaning pump discharge line when the pump is on and when the solenoid valve is open. This solenoid valve will normally be closed when the cleaning pump is off and open when the cleaning pump is on.
   d. Finished water supply to flush out sampling sensor when cleaning operation is ended. A manual on/off valve shall be used for this flushing.
6. Residual Chlorine/pH Panels (Instrument Panels 5, 6, 7)
   a. Panel 5 – measure permeate water quality prior to the calcite vessels.
   b. Panel 6 – measure treated water quality after the chemical feed vault prior to the finished water ground storage tank.

c. Panel 7 – measure finished water quality being pumped by the High Service Pumps prior to post-chlorination feed.
d. Real-time chlorine residual and pH measurements to be measured at the panels and the data transmitted to PLC-1 and the SCADA system. Data will be transmitted only when the "sample in" valves are open.
e. The SCADA system shall open the "sample in" feed solenoid valve on Panels 5 and 6 when the RO Treatment trains are in operation. The solenoid valve shall be closed when the RO Treatment Trains are not in operation.
f. The SCADA system shall open the "sample in" feed solenoid valve on Panel 7when the High Service Pumps are in operation. The solenoid valve shall be closed when the High Service Pumps are not in operation.
g. These panels require constant flow across the sensors and thus a separate finished water line is provided with a solenoid valve. The SCADA system shall control these valves. The solenoid valve shall be open when the "sample in" line is closed and shall be closed when the "sample in" valve is open.

O. Existing Off-Site Ground Storage Tank and Booster Pump Station
1. Description
a. An existing Off-Site 0.5 MG ground storage tank (GST) will be utilized for finished water storage. The SCADA System shall continuously monitor and trend the level in the 0.5 MG GST.
b. An existing duplex booster pump (BPS) station will be utilized to pump finished water from the existing 0.5 MG GST to the distribution system.
c. The High Service Pumps and the ground storage tank at the WTP site will serve as the main supply of finished water to the distribution system while the WTP is operational. When the WTP is shut down by Plant Staff and stops producing water for the day, the 0.5 MG GST and BPS station will begin to operate to supplement finished water supply to the distribution system in conjunction with the High Service Pumps. The BPS will be reconfigured through valve arrangements at the site to divert water flow to the western portion of the distribution system. Primary control shall be to operate the BPS during the overnight hours (while the RO plant is not operating) to promote water turn over in the 0.5 MG GST and to help the existing 1.0 mg elevated tank maintain normal operating levels overnight for the remainder of the distribution system. A secondary control strategy will be to operate the BPS in response to a high demand condition if pressure drops to 35 psi in the western portion of the distribution system.
d. The 0.5 MG GST is supplied by a 10-inch electrically-actuated butterfly valve. The SCADA System shall control the operation of the supply valve based upon level in the tank and indicate the status (open or closed) of the valve.
2. Operation
a. The SCADA System will provide start/stop and permissive control for the BP station. Hand-Off-Auto switches are provided on the BP

pump control panel. In Auto mode, the pumps shall require a permissive condition to operate. The SCADA System shall issue a permissive condition when operation at the water treatment plant is ceased for the day and the 0.5 MG GST, 1.0 MG GST and elevated tank are full following RO Plant shutdown. The BPS shall then be controlled based on existing elevated tank level and the 0.5 MG GST level. When the level in the elevated storage tank falls below the "Lead PUMP ON" setpoint, the BP that the system has chosen to be the lead pump will be called to start. The BP will continue to operate until the level of the elevated tank rises above the "PUMP OFF" setpoint. In the event that the level of the elevated tank continues to fall with the lead pump operating and reaches the "Lag PUMP ON" setpoint, the lag booster pump will be called to start. The lead and lag pumps will continue to operate until the level of the elevated tank rises above the "PUMP OFF" setpoint. Should the level of the elevated tank continue to fall with the lead and lag booster pumps operating and reach the "HSP ON" setpoint, the high service pump selected by the system to be the lead pump will be called to start. All pumps will continue to operate until the level of the elevated tank rises above the "BSP/HSP OFF" setpoint. Both the lead and lag booster pumps will be stopped if the level in the Off-Site GST falls below the "BP OFF" setpoint. If this occurs, the 0.5 MG GST will be filled per Paragraph 2.c below.

b. In the event system pressure in the western portion of the distribution system drops to 35 psi at any time and the BPS is in a permissive condition, the lead BP will be called to start.

c. The SCADA System will provide open/close operation of the electrically-actuated butterfly valve. The valve shall open when the level in the Off-Site GST falls below the "BP OFF" level, and shall remain open until the level in the Off-Site GST rises above the "Fill STOP" setpoint, at which time the valve shall close completely.

2.05 DEVICE IDENTIFICATION LEGEND

A. XXX-YYZZ-A
   1. XXX indicates "Device Description using ISA Standards"
   2. YY indicates "Process (Loop Number) and/or PLC Number"
   3. ZZ indicates "Equipment of Device Number associated with process"
   4. –A (Optional when needed) indicates "Multiple devices associated with other equipment that has the same process number"

B. Example: RO Train No. 1 Stage 1 Flow Meter – FIT-208-1
   1. FIT = Flow Indicating Transmitter
   2. 2 = PLC No. 2
   3. 08 = Equipment Number 8
   4. -1 = Train Number 2

2.06 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. The PLC shall provide all of the local inputs and outputs required per the RTU schedule. The PLC shall be capable of receiving control parameters from the CMS and local control via its own programmable logic.

B. The PLC shall have all electronic components housed in a card rack. The card rack components shall be plug-in and interchangeable without calibration and be mounted for easy operator access.

C. Each card rack assembly shall contain its own plug-in power supply. Card edge connectors and their mating edgeboard connectors shall be gold plated or gold flashed. All I/O wiring shall be accomplished via plug-in terminal blocks.

D. The PLC Central Processing Unit shall be a plug-in card providing all data processing and short-term data storage for the system. The CPU card shall include a combination of RAM, PROM, and EEPROM memory. The EEPROM will be used to store the current operation database and maintain this database without the use of batteries. The EEPROM module shall be operator removable without special tools to allow cloning and safe storage of programs. Dual inline package type memories are not acceptable. The CPU shall have a minimum of 12K words of non-volatile or battery backed memory for program storage and 4K words of RAM memory for scratch and storage. The CPU shall have LED indicators for run, fault, forced I/O, battery low, and com port activity. The CPU shall have multiple programmable communications ports including an RS-232 port for communications to remote RTUs and additional serial, Ethernet or USB ports for programming and communication with local I/O and the Operator Interface Display. Sufficient ports shall be provided such that it is not necessary to disconnect any other devices to connect to the programming laptop.

E. The discrete input cards shall provide a maximum of 32 optically isolated inputs per card. The input card shall provide a 24 VDC excitation to remote sensors and switches.

F. The discrete output cards shall provide a minimum of 4 relay isolated contacts wired to PLC clamps or plug-in relays located in the PLC panel. The contacts from plug-in relays shall be wired to terminal blocks for interfacing with remote devices and remote panels.

G. The PLC shall contain the total number of analog I/O points as indicated in the RTU Schedule. Analog I/O shall include 0-5 VDC input, 0-5 VDC isolated input, RTD thermocouple input, 4-20 mA isolated input and 4-20 isolated output. Each analog shall be converted to digital with 12 bit resolution, then automatically scaled, without making manual calculations or entering constants, by the unit's CPU to either a 10 bit or 12 bit for transmission. Signal conditioners shall be provided to convert signals to a 4-20 mA signal where necessary.

H. All I/O modules shall be individually replaceable without removing power to the unit.

I. Power supply shall be 120 VAC.

2.07 RTU PANEL CONSTRUCTION

A. A control panel shall be furnished for each RTU as specified herein. The panel shall be UL approved after complete fabrication and shop testing.

B. Construction: Construction of RTUs for the well sites shall be for outdoor service, dust tight, weatherproof, completely enclosed cubicle formed from steel. The panel shall be NEMA 4X, type 304 stainless steel.
   1. Panel structure shall be suitably braced and of sufficient strength to support all equipment mounted on or within, withstand handling and shipment, and maintaining alignment. Top, sides, and rear shall be fabricated from steel not less than U.S. 12 gauge.
   2. Door shall be essentially full height, having turned back edges and additional bracing to assure rigidity and prevent sagging. Fast operating latches shall hold door securely compressed at top side, and bottom against rubber gaskets. Door shall be padlockable.
   3. The bottom shall be open and components shall be arranged for external wiring conduit and piping to enter from below.
   4. Panel dimensions and general instrument arrangement shall be as required to contain radio transmitter, PLC, power supply, battery backup and I/0 modules.
   5. RTUs for outdoor locations shall be mounted on the electrical equipment rack as indicated in the electrical drawings.

C. Panel Wiring: All internal instrument and component device wiring shall be furnished by the manufacturer.
   1. With exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be no less than 14 AWG stranded copper, insulated for not less than 600 volts with a moisture and head resistant material and flame-retardant non-metallic covering.
   2. Terminal blocks for external connections shall be fabricated complete with marking strip, covers, and pressure connectors. A terminal shall be provided for each conductor of external circuits plus one ground for each shielded cable. All wiring shall be grouped or cabled and firmly supported to the panel. Not less than 8 inches clearance shall be provided between the terminal strips and the base for conduit and wiring space. No less than 25 percent spare terminals shall be provided. All electronic control type circuits shall be shielded. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be located for easy maintenance. Fuses and/or circuit breaker panel may be located in the main motor control center for easy access.

D. Device Identification: All devices within the panel shall be permanently identified. The device and terminal identifications shall agree with those shown on the equipment drawings.
   1. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends as indicated within these specifications, and shall be made of laminated phenolic material. Nameplates shall be secured firmly to the panel.

E. Arrangements: Panel instruments and control devices shall be arranged in a logical configuration from an operator's standpoint. Preliminary arrangement layouts of the front of panels shall be submitted for review before panel designs are completed.

F. Nameplates: Nameplates, where specified for panels, shall be approximately one inch by three inches constructed of black and white 3/16" high extending

through the black face into the white layer. Nameplates for field mounted equipment shall be provided with engraving similar to their related panel mounted controls.

G. Interior Lighting: Illumination of panel interiors shall be provided. Fixtures shall be enclosure manufacturer's standard offering fluorescent or LED type with common on-off switch near the door. Duplex grounded receptacles with outside type gasketed covers shall be provided for service and maintenance tools at a convenient location close to control panel.

H. Battery Backup: The remote units indicated shall be supplied with battery back-up operation. The rechargeable batteries shall be the sealed solid gelled electrolyte types, designed for float or standby service. Batteries shall be sized to maintain a minimum of 8-hour service. The remote shall include a charging module to recharge the batter when power is resumed, maintain the charge between outages, and provide a low voltage cutoff to protect the battery from excessive discharge during prolonged outages. All discrete, analog, and pulse inputs shall continue to function on battery backup.

I. Factory Test: Panel shall be factory tested electrically by the panel fabricator before shipment.

2.08 SURGE PROTECTION

A. Surge suppressors for connections to AC power supply circuits shall be assemblies that are constructed as multistage devices. The first stage shall be a high energy metal oxide varistor element. The second stage shall consist of fast-acting high power bipolar silicon avalanche devices. First and second stages shall be interconnected through a series air core inductor of sufficient current-carrying capacity to permit a continuous operating current of 15 amperes.

B. Surge suppressors for analog signal circuits shall have a circuit consisting of a 3-electrode gas tube and silicone avalanche device to clamp each line to ground. High-energy gas tube and silicon avalanche devices shall be separated by series impedance. Surge suppressors limit line-to-ground and line-to-line voltage to 30 volts on 24 V DC circuits.

2.09 RADIOS

A. The UHF radios required for the new remote sites shall be similar make and model of the existing UHF radios. Contractor shall verify existing units accordingly.

B. UHF radios shall have the following characteristics:
   1. Frequency Range – 450 – 512 MHz
   2. Supply Voltage – 10-30 VDC
   3. Duty Cycle – 100%
   4. Power Output – 1-10 W Adjustable
   5. Operating Temperature - -30° to + 70°C
   6. Data Interface – Ethernet: 10 BaseT Auto-MDIX RJ-45; Serial: RS-232 DB-9
   7. FCC Approval – FCC, designed to meet UL Class 1 Div II

2.10 COMMUNICATIONS

A. General: The RTU shall support the establishment of a sophisticated data communication network for SCADA applications utilizing a variety of radio or line communication links. The RTU must be a true multi-port device and be able to communicate simultaneously with hierarchies above it (multiple central stations), with hierarchies parallel to it (RTU to RTU) and hierarchies below it (master/slave RTUs).

B. Data Protocol: Data communications shall utilize a secure, smart protocol designed in accordance with the Open System Interconnection (OSI) model as defined by the International Organization for Standardization (ISO). The protocol must include all seven layers of the OSI model and facilitate communications between all stations in the system and support:
   1. Multi level access control to insure high levels of data privacy
   2. Multiple logical sessions to allow simultaneous application execution
   3. Packet oriented with high efficiency variable length messages
   4. Ability to transfer complete programs and historical data from RTU to centrals or between RTUs
   5. Support high data security techniques, frame synchronization, dynamically assigned CRC codes (32 bit) and other sophisticated recovery and error detection procedures

C. The protocol should allow flexible, efficient communications for transmission of data, complete programs, databases or other parameters. Complete configuration and diagnostic programs shall be transferable from/to the Central site or from RTU to RTU (full data upload/download capability). Complete RTU/system debugging shall be allowed without visiting each remote site. The protocol shall support a complex hierarchical system structures of multiple host computers and sub-master stations. Its detail structure, however shall be transparent to the system user and allow him to concentrate upon the application.

D. Communication Methods: In addition to the simplistic master/slave polling configuration, the RTU shall operate in a number of more efficient contention formats the may be required by point to multipoint networks. The RTU must support quiescent operation and initiate data transmissions under the following conditions:
   1. Report by Exception - Automatically transmit upon defined exception condition(s); analog, digital or any combination
   2. Timed Transmission - Automatically transmit data on programmed time interval

E. Special Communication Requirements: In addition to the communication methods above, the RTU must also support the following special modes:
   1. Shared Transceiver Mode: each RTU shall be able to share its communications transceiver (radio, wireline, etc) with other RTUs.
   2. Store & Forward Repeater: each RTU shall be able to receive information from other sites, store it in memory and then transmit (relay) the data to another site.
   3. Network Interface Node: each RTU shall be able to function as an interconnection point between different communication systems; e.g., radio to line, between different radio frequencies, etc.

4. Broadcast (Set Call): any change in RTU or system data e.g. time synchronization, control mode switching, setpoint change, or wide area command may be automatically transmitted to a dynamically defined set of locations.

F. Wireline Communication Channels: The RTU shall support a number of communication options over traditional two or four-wire voice grade phone lines. The RTU shall have optionally available different internal modems to support point to point, party line ,as well as auto-answer/dial-up operation. General line characteristics required:
   1. Operating Mode: Synchronous/Asynchronous
   2. Transmission Mode: Half or full duplex
   3. Baud rate: 1200/2400 dependent upon line
   4. Output impedance: 600 ohm or high impedance, balanced
   5. Input signal level: 0 Dbm to -30 Dbm

G. Serial Data Channels: The RTU shall also be able to communicate via a number of different serial interfaces. Communication to an external DTE/DCE device shall be supported for RS-232 and RS-485.

H. External Communication Devices: The RTU shall be able to operate with a number of external communication devices.

I. The RTU shall be capable of interfacing to a fiber optic (FO) link via a FO RS-232 modem. These devices, e.g. Fibronics FM630 allows transmission up to 6 km at data rates up to 19.2 kbps.

J. The RTU shall be able to interface to a 64 kbps digital microwave (bi-directional PCM) transmission channel according to CCITT G.703 or G.704 by means of an external interface or directly to the digital microwave service channel via RS-232 for use in microwave alarm applications.

K. Communications Summary
   1. In-plant SCADA communications shall be over a dedicated pair Fiber Optic network or Ethernet as indicated on the drawings.
   2. Remote site SCADA communications shall be over UHF 450-512 MHz radios.

2.11 NETWORK MANAGEMENT SOFTWARE

A. Provide a network management and configuration software for monitoring of industrial networks with up to 25 nodes (IP addresses). Provide Industrial HiVision by Belden/Hirschmann, or equal.

B. Software shall provide network diagnostics and at a minimum the following features:
   1. Topology recognition based on LLDP (Link Layer Discovery Protocol, IEEE802.1AB) and Learned Address Tables. Switches, routers, WLAN devices, unmanaged switches/hubs, and end devices are supported. Can also map networks behind a router. Path availability calculation.
   2. Graphical status representation for devices, links, power supplies, fans, and any other device sub-component. Status displays for third party products. All statuses are configurable. Supports multiple topology windows and a network hierarchy view. User configurable event log. Customizable event actions.

3. Compatible modules and components: MACH 4000/1000/100, MICE, PowerMICE, RS2, EAGLE20, RS20/30/40, RSR, RSB, MICE20/30, OCTOPUS, LION, GigaLION, BAT54 Access Point and Client, BAT300, SPIDER, any third party SNMP capable device, and ICMP (Ping) capable device.
4. Event generation for polling and SNMPv1 trap support.
5. Alarm and event logging. Alarm actions such as message window, email, SMS and start executable.
6. SCADA/Process visualization: OPC Server Map device and connection states as well as device properties. Can be used inside SCADA systems via the OPC Date Access 2.0/3.0 interface.
7. ActiveX Control Graphical User Interface can be reused inside SCADA systems via an ActiveX control.
8. Supported protocols: HiDiscovery, ICMP (Ping), SNMPv1, SNMPv3, OPC DA 2.0/3.0
9. Configuration functions: Individual device configuration. Configuration of multiple devices simultaneously. Configuration of identical parameters across multiple device types simultaneously. Firmware update of multiple devices.

2.12 NETWORK COMMUNICATIONS EQUIPMENT

A. The Ethernet switches and Fiber Optic Transceivers shall be an industrial, managed switch compliant to IEEE 802.3 and shall include the following features:
   1. Manufactured by Hirschmann, RS20 series.
   2. The switches health, diagnostics and status shall be PLC addressable in the PLC data tables and monitored by the SCADA system and displayed continuously. Any alarms from the units shall be displayed, shown in the alarm summary and historically recorded.
   3. Manufacturer shall offer a family of similar switches that vary based on the port type and quantity similar to Hirschmann Compact OpenRail. Switches will have a web-based graphical user interface for configuration that is common to all products in the family. The family will include switches of 4,8,16 & 24 port varieties at 10/100 M baud. Two (2) additional Giga-Bit ports shall be optional for high speed backbone or ring configurations on the 8, 16 & 24 port versions.
   4. Switches shall employ "line speed" switching fabric to ensure full bandwidth capacity.
   5. Switches shall be designed for DIN-rail mounting.
   6. Redundant 24 VDC power supply inputs; power supply failure is indicated by LED and fault relay.
   7. Fanless design.
   8. Supports a device discovery protocol which provides the following functionality:
      a. Windows-based utility to list all supported switches on the network.
      b. Set the switch's IP address through the Ethernet network (serial connection to each switch is not required).
      c. Launch the configuration web page for the switch.
      d. Read/write or read-only access.
   9. Capable of ring-based media redundancy with the following functionality:

a. Network recovery within 300 ms in case of media failure with up to 50 switches in the ring. 30 ms update for Giga-Bit rings.
b. Redundant link configured by DIP switch – no software configuration changes required.
c. Any ring ports may be connected together (to prevent wiring errors).
d. One time configuration (redundant link does not change if switches are added to the ring).

10. Other media redundancy protocols shall include RSTP.
11. Configuration of switch may be accomplished via:
    a. Web interface (with built-in help files)
    b. SNMP-based network management software
    c. Auto-configuration adapter (external flash memory device)
    d. Command Line Interface (CLI)
12. Broadcast limiter to prevent broadcast storms and protect network devices.
13. Packet Prioritization using COS and QOS with 8 priorities and 4 queues.
14. IGMP snooping (multicast filtering) with IGMP querier V1, 2 & 3.
15. Diagnostics include RMON and up to eight (8) trap management stations. Fault conditions can be independently reported to the management station, including: cold/warm start, link up/down, power supply failure, redundancy mechanisms, authentication violation, RMON thresholds, port security, indicator contact.
16. Supports port-based and overlapping VLANs
17. MAC or IP address-based port security.
18. RJ45 ports shall be 10/100 Base-TX and support auto-negotiation and auto-crossover.
19. Fiber optic ports shall be available in a variety of fiber and connector types as required by the application. (Multimode or Singlemode fiber with SC, ST or SFP (LC) (Giga-Bit) style connectors)
20. Input voltage range: 9.6 – 60 volt DC and 18-30 volt AC
21. Minimum operating temperature range: 0˚C to 60˚C.
22. Optional operating temperature range must be available at: -40˚C to 70˚C
23. Humidity: 10% to 95% (non-condensing)
24. Protection Class: IP 20
25. Approvals: cUL508, cUL1604 Class 1 Division 2

B. Provide router for DSL connection to the plant network for remote client. Provide router with security options and firewall configurations. Provide VPN configuration for remote diagnostics and connection to the plant LAN. Provide a Cisco ASA5505 or equal.

2.13 NETWORK INTERCONNECTING CABLES AND HARDWARE

A. Provide Cat-6 UTP Ethernet Cable as directed on the plans. Cable shall be equal to Belden #6NP4P24-BL (blue).

B. Provide 62.5/125 micron 12-fiber loose-tube or tight buffer, gel free type fully waterblocked all-dielectric cable construction, requiring no bonding or grounding, fiber optics cable suitable for outdoor use in conduit and duct bank. Cable shall be Corning Cable System 012KW4-T4130D20 for multi-mode applications and 069EW4-T4101D20 for single-mode applications or equal as manufactured by OCC, Siecor, Commscope, or equal.

C. Provide Fiber Optics patch panel interconnect box for each location where fiber optics terminations are to be made. Provide a wall-mountable interconnect center to provide strain relief and protection for up to 12 fiber terminations via LC, ST, or SC connectors. The wall mounted fiber optics interconnection box shall be Siecor # WIC-012-15 for indoor applications or Siecor # EDC-012 environmental distribution center with two # EDC-CP1-015 connector panels for outdoor applications.

D. Provide rack mounted type patch panels where applicable.

E. Provide fiber optics jumpers between the fiber optics interconnect box and the fiber optic transceivers. Jumpers shall be 2-fiber, 62.5/125 micron prefabricated jumper cable assemblies with ST-Type to duplex SC (Ceramic) connectors. Fiber optics jumpers shall be ANIXTER #15201X, length to be determined by Systems Integrator.

F. Terminations: All fiber terminations shall be the responsibility of the system supplier.

2.14 RADIO COMMUNICATIONS

A. The telemetry system shall be specifically designed for radio channel data communications between the remote sites and the Water Treatment Plant site. All of the equipment required for operation of the system shall be directly owned by the Owner and included as part of this contract. Systems using third party repeaters, trunking masters, or leased equipment will not be allowed.

B. The system supplier shall be responsible for investigating and supplying the proper radiofrequency to provide reliable communications. The RTU's shall monitor for the channel to avoid data collisions with other RTU's during data communications.

C. To facilitate system layout and future expansion all RTU's shall be able to implement store-and-forward communications to relay data and commands from other RTU's as required to establish the desired path. Any RTU shall be able to provide automatic antenna switching as part of their relaying operations.

D. RADIO ANTENNA & COAXIAL CABLE

1. The radio antennas at locations other than radio repeater sites shall be a seven element Yagi, constructed with 3/8" diameter aluminum rod elements and 1-1/16" diameter aluminum pipe element support. The antenna shall have a minimum 10 db forward gain with a 20.0db front-to-back ratio. The antenna shall be wind rated for a 100-MPH wind speed.
2. The radio antennas for radio repeater sites shall be a 6dB gain Omnidirectional collinear with vertical polarization, constructed with a long life weather resistant fiberglass radio dome. The antenna shall be DC grounded for lightning protection and shall have a minimum rated wind velocity of 100 mph. The antenna shall have a minimum vertical beamwidth of 15 degrees and a maximum VSWR at system frequency of 1.5:1.
3. Provide a 6-foot section of "super flexible" transmission cable at each radio antenna port. Antennas shall be cabled to the transmitter

enclosure connection by a low loss coaxial cable with cellular polyethylene (foam) dielectric. The coaxial cable shall have a braided copper shield coverage of 97% and a long life weather resistant polyvinyl chloride jacket. The antenna coaxial cable connection shall be a constant impedance weatherproof Type N connector, taped with a weather resistant electrical tape to insure a lifetime watertight assembly.

4. Coaxial connection to remote enclosures shall be by means of a coaxial type bulkhead lightning arrestor. The units shall be rated at 1 kilowatt with a minimum 500V and maximum 2000V breakdown voltage.
5. The height and position of the antennas shall be as determined by the radio path survey and in coordination with the Engineer. The antennas shall be mounted in a manner that is consistent with FCC rules and regulations and provides adequate signal fade margin as described earlier. Antennas must be a minimum of 15 feet above ground and mounted as follows:
   a. The antenna shall be mounted on a Class II power pole with a 1-1/2" galvanized mast secured to the side of the pole and extending 5' above the pole. A 1 1/2" rigid conduit with a weather-head shall be provided from the RTU to the mast for the coaxial cable.
   b. If necessary, a bracketed antenna tower shall be supplied where required by radio path study. The tower shall be assembled from 20 sections built on a 12-1/2" equilateral triangle design. Tower sections shall be constructed of 1-1/4" steel tubing with continuous solid steel rod "zigzag" cross bracing electrically welded to the tubing. The entire 10' sections shall be Hot-Dip Galvanized after fabrication for long life.

2.15 I/O MASTER LIST

A. The quantity of digital inputs and outputs and analog inputs and outputs is an estimated quantity. These can vary depending on the equipment and software selected by the manufacturer. It is, therefore, the intent of these specifications that the manufacturer provides all required inputs and outputs for a complete and operable system. The number of spare input and outputs shall be 25% minimum for each signal type.

SEE ATTACHED I/O MASTER LIST

PART 3 EXECUTION

3.01 EXAMINATION

A. The SCADA System supplier shall furnish trained field service personnel to install all conduits, communication cables, RTU's, radio antennas and final terminations as required for a complete and operational system.

3.02 INSTALLATION

A. The SCADA System supplier shall furnish trained field service personnel to install all conduits, communication cables, RTU's, radio antennas and final terminations as required for a complete and operational system.

B. All equipment shall be installed according to the manufacturer's recommendations.

C. Electrical and control wiring shall be installed in accordance with the applicable sections of Division 16 of these specifications.

3.03 FIELD CALIBRATION

A. All SCADA System components shall be calibrated in the presence of the Engineer in accordance with the range and accuracy specified herein.

B. No form of energy shall be turned on to any part of the SCADA System components prior to receipt by the Engineer or a certified statement of approval of the installation from the SCADA system supplier.

3.04 SCADA SYSTEM START-UP

A. The SCADA manufacturer shall furnish the services of a qualified technical service representative to perform the supervisory service required during start-up of SCADA System components.

B. Services of a field service technician shall be provided for not less than ten (10) 8-hour mandays for the purpose of placing all equipment into operation.

C. The minimum days specified above do not relieve the manufacturer of providing sufficient service to place the system in satisfactory operation.

3.05 TRAINING

A. The SCADA manufacturer shall furnish the services of a factory service representative for not less than three (3) 8-hour mandays for the purpose of operator training.

B. Training shall be performed on site.

C. Three months after the system has been placed into operation, the SCADA manufacturer shall furnish the services of a factory service representative for one (1) 8-hour day to conduct follow-up training with the Owner's personnel. The follow-up training shall be conducted on-site and consist of reviewing the operation and maintenance of the system. The Owner shall be contacted a minimum of two weeks in advance prior to scheduling the training session to allow proper coordination.

END OF SECTION

I/O Master List							
Description	Tag Number	DI	DO	AI	AO	Function	Location
Well 1 PD Call to Start	YC-1100		1			Start/Stop Well Pump	RTU-4
Well 1 PD Run Status	YI-1101	1				On/Off Status	RTU-4
Well 1 PD Remote Status	YI-1102	1				Pump in Remote Mode	RTU-4
Well 1 PD VFD Failure	YA-1103A	1				Alarm	RTU-4
Well 1 PD Pump Failure	YA-1103B	1				Alarm	RTU-4
Well 1 PD VFD Speed Control	SIC-1104				1	Adjust VFD speed	RTU-4
Well 1 PD VFD Speed Feedback	SI-1105			1		Indicate speed	RTU-4
Well Combined Blow-off Valve Remote Status	YI-1106	1				Valve in Remote Mode	RTU-4
Well Combined Blow-off Valve Open/Close	ZC-1106		1			Control Valve Open/Close	RTU-4
Well Combined Blow-off Valve Open Status	ZIO-1106	1				Indicate Valve Open	RTU-4
Well Combined Blow-off Valve Closed Status	ZIC-1106	1				Indicate Valve Closed	RTU-4
Well 1 BC Call to Start	YC-1107		1			Start/Stop Well Pump	RTU-4
Well 1 BC Run Status	YI-1108	1				On/Off Status	RTU-4
Well 1 BC Remote Status	YI-1109	1				Pump in Remote Mode	RTU-4
Well 1 BC Pump Failure	YA-1110A	1				Alarm	RTU-4
Well 1 BC VFD Failure	YA-1110B	1				Alarm	RTU-4
Well 1 BC VFD Speed Control	SIC-1111				1	Adjust VFD speed	RTU-4
Well 1 BC VFD Speed Feedback	SI-1112			1		Indicate speed	RTU-4
Well Combined Discharge Valve Remote Status	YI-1113	1				Valve in Remote Mode	RTU-4
Well Combined Discharge Valve Open/Close	ZC-1113		1			Control Valve Open/Close	RTU-4
Well Combined Discharge Valve Open Status	ZIO-1113	1				Indicate Valve Open	RTU-4
Well Combined Discharge Valve Closed Status	ZIC-1113	1				Indicate Valve Closed	RTU-4
Well Discharge Pressure	AI-1114			1		Indicate Pressure	RTU-4
Well Discharge Pressure High	YI-1114A	1				Alarm	RTU-4
Well Discharge Pressure Low	YI-1114B	1				Alarm	RTU-4
Panel Alarm	YA-1115	1				Alarm	RTU-4
Well 1 PD Flow Rate	FI-1116			1		Indicate flow rate	RTU-4
Well 1 BC Flow Rate	FI-1117			1		Indicate flow rate	RTU-4
Groundwater Level (Well 1 PD)	LI-1118			1		Indicate Level	RTU-4
Groundwater Level (Well 1 BC)	LI-1119			1		Indicate Level	RTU-4
Loss of Phase	YA-1120	1				Alarm	RTU-4
Loss of Power	YA-1121	1				Alarm	RTU-4
24VDC Power Fail	YA-1122	1				Alarm	RTU-4
RTU Power Fail	YA-1123	1				Alarm	RTU-4
UPS Battery Low	YA-1124	1				Alarm	RTU-4

Well 2 PD Call to Start	YC-1200		1			Start/Stop Well Pump	RTU-5
Well 2 PD Run Status	YI-1201	1				On/Off Status	RTU-5
Well 2 PD Remote Status	YI-1202	1				Pump in Remote Mode	RTU-5
Well 2 PD VFD Failure	YA-1203A	1				Alarm	RTU-5
Well 2 PD Pump Failure	YA-1203B	1				Alarm	RTU-5
Well 2 PD VFD Speed Control	SIC-1204				1	Adjust VFD speed	RTU-5
Well 2 PD VFD Speed Feedback	SI-1205			1		Indicate speed	RTU-5
Well Combined Blow-off Valve Remote Status	YI-1206	1				Valve in Remote Mode	RTU-5
Well Combined Blow-off Valve Open/Close	ZC-1206		1			Control Valve Open/Close	RTU-5
Well Combined Blow-off Valve Open Status	ZIO-1206	1				Indicate Valve Open	RTU-5
Well Combined Blow-off Valve Closed Status	ZIC-1206	1				Indicate Valve Closed	RTU-5
Well 2 BC Call to Start	YC-1207		1			Start/Stop Well Pump	RTU-5
Well 2 BC Run Status	YI-1208	1				On/Off Status	RTU-5
Well 2 BC Remote Status	YI-1209	1				Pump in Remote Mode	RTU-5
Well 2 BC Failure	YA-1210A	1				Alarm	RTU-5
Well 2 BC VFD Failure	YA-1210B	1				Alarm	RTU-5
Well 2 BC VFD Speed Control	SIC-1211				1	Adjust VFD speed	RTU-5
Well 2 BC VFD Speed Feedback	SI-1212			1		Indicate speed	RTU-5
Well Combined Discharge Valve Remote Status	YI-1213	1				Valve in Remote Mode	RTU-5
Well Combined Discharge Valve Open/Close	ZC-1213		1			Control Valve Open/Close	RTU-5
Well Combined Discharge Valve Open Status	ZIO-1213	1				Indicate Valve Open	RTU-5
Well Combined Discharge Valve Closed Status	ZIC-1213	1				Indicate Valve Closed	RTU-5
Well Discharge Pressure	AI-1214			1		Indicate Pressure	RTU-5
Well Discharge Pressure High	YI-1214A	1				Alarm	RTU-5
Well Discharge Pressure Low	YI-1214B	1				Alarm	RTU-5
Panel Alarm	YA-1215	1				Alarm	RTU-5
Well 2 PD Flow Rate	FI-1216			1		Indicate flow rate	RTU-5
Well 2 BC Flow Rate	FI-1217			1		Indicate flow rate	RTU-5
Groundwater Level (Well 2 PD)	LI-1218			1		Indicate Level	RTU-5
Groundwater Level (Well 2 BC)	LI-1219			1		Indicate Level	RTU-5
Loss of Phase	YA-1220	1				Alarm	RTU-5
Loss of Power	YA-1221	1				Alarm	RTU-5
24VDC Power Fail	YA-1222	1				Alarm	RTU-5
RTU Power Fail	YA-1223	1				Alarm	RTU-5
UPS Battery Low	YA-1224	1				Alarm	RTU-5
Well 3 PD Call to Start	YC-1300		1			Start/Stop Well Pump	RTU-6
Well 3 PD Run Status	YI-1301	1				On/Off Status	RTU-6
Well 3 PD Remote Status	YI-1302	1				Pump in Remote Mode	RTU-6

Well 3 PD VFD Failure	YA-1303A	1				Alarm	RTU-6
Well 3 PD Pump Failure	YA-1303B	1				Alarm	RTU-6
Well 3 PD VFD Speed Control	SIC-1304				1	Adjust VFD speed	RTU-6
Well 3 PD VFD Speed Feedback	SI-1305			1		Indicate speed	RTU-6
Well Combined Blow-off Valve Remote Status	YI-1306	1				Valve in Remote Status	RTU-6
Well Combined Blow-off Valve Open/Close	ZC-1306		1			Control Valve Open/Close	RTU-6
Well Combined Blow-off Valve Open Status	ZIO-1306	1				Indicate Valve Open	RTU-6
Well Combined Blow-off Valve Closed Status	ZIC-1306	1				Indicate Valve Closed	RTU-6
Well BC Call to Start	YC-1307		1			Start/Stop Well Pump	RTU-6
Well 3 BC Run Status	YI-1308	1				On/Off Status	RTU-6
Well # BC Remote Status	YI-1309	1				Pump in Remote Mode	RTU-6
Well 3 BC Failure	YA-1310A	1				Alarm	RTU-6
Well 3 BC VFD Failure	YA-1310B					Alarm	RTU-6
Well 3 BC VFD Speed Control	SIC-1311				1	Adjust VFD speed	RTU-6
Well 3 BC VFD Speed Feedback	SI-1312			1		Indicate speed	RTU-6
Well Combined Discharge Valve Remote Status	YI-1313	1				Valve in Remote Status	RTU-6
Well Combined Discharge Valve Open/Close	ZC-1313		1			Control Valve Open/Close	RTU-6
Well Combined Discharge Valve Open Status	ZIO-1313	1				Indicate Valve Open	RTU-6
Well Combined Discharge Valve Closed Status	ZIC-1313	1				Indicate Valve Closed	RTU-6
Well Discharge Pressure	AI-1314				1	Indicate Pressure	RTU-6
Well Discharge Pressure High	YI-1314A	1				Alarm	RTU-6
Well Discharge Pressure Low	YI-1314B	1				Alarm	RTU-6
Panel Alarm	YA-1315	1				Alarm	RTU-6
Well 3 PD Flow Rate	FI-1316			1		Indicate flow rate	RTU-6
Well 3 BC Flow Rate	FI-1317			1		Indicate flow rate	RTU-6
Groundwater Level (Well 3 PD)	LI-1318			1		Indicate Level	RTU-6
Groundwater Level (Well 3 BC)	LI-1319			1		Indicate Level	RTU-6
Loss of Phase	YA-1320	1				Alarm	RTU-6
Loss of Power	YA-1321	1				Alarm	RTU-6
24VDC Power Fail	YA-1322	1				Alarm	RTU-6
RTU Power Fail	YA-1323	1				Alarm	RTU-6
UPS Battery Low	YA-1324	1				Alarm	RTU-6
Well 4PD Call to Start	YC-1400		1			Start/Stop Well Pump	RTU-7
Well 4 PD Run Status	YI-1401	1				On/Off Status	RTU-7
Well 4 PD Remote Status	YI-1402	1				Pump in Remote Mode	RTU-7
Well 4 PD VFD Failure	YA-1403A	1				Alarm	RTU-7
Well 4 PD Pump Failure	YA-1403B	1				Alarm	RTU-7
Well 4 PD VFD Speed Control	SIC-1404				1	Adjust VFD speed	RTU-7

Well 4 PD VFD Speed Feedback	SI-1405			1		Indicate speed	RTU-7
Well Combined Blow-off Valve Remote Status	YI-1406	1				Valve in Remote Status	RTU-7
Well Combined Blow-off Valve Open/Close	ZC-1406		1			Control Valve Open/Close	RTU-7
Well Combined Blow-off Valve Open Status	ZIO-1406	1				Indicate Valve Open	RTU-7
Well Combined Blow-off Valve Closed Status	ZIC-1406	1				Indicate Valve Closed	RTU-7
Well 4 BC Call to Start	YC-1407		1			Start/Stop Well Pump	RTU-7
Well 4 BC Run Status	YI-1408	1				On/Off Status	RTU-7
Well 4 BC Remote Status	YI-1409	1				Pump in Remote Mode	RTU-7
Well 4 BC Failure	YA-1410A	1				Alarm	RTU-7
Well 4 BC VFD Failure	YA-1410B	1				Alarm	RTU-7
Well 4 BC VFD Speed Control	SIC-1411				1	Adjust VFD speed	RTU-7
Well 4 BC VFD Speed Feedback	SI-1412			1		Indicate speed	RTU-7
Well Combined Discharge Valve Remote Status	YI-1413	1				Valve in Remote Status	RTU-7
Well Combined Discharge Valve Open/Close	ZC-1413		1			Control Valve Open/Close	RTU-7
Well Combined Discharge Valve Open Status	ZIO-1413	1				Indicate Valve Open	RTU-7
Well Combined Discharge Valve Closed Status	ZIC-1413	1				Indicate Valve Closed	RTU-7
Well Discharge Pressure	AI-1414				1	Indicate Pressure	RTU-7
Well Discharge Pressure High	YI-1414A	1				Alarm	RTU-7
Well Discharge Pressure Low	YI-1414B	1				Alarm	RTU-7
Panel Alarm	YA-1415	1				Alarm	RTU-7
Well 4 PD Flow Rate	FI-1416			1		Indicate flow rate	RTU-7
Well 4 BC Flow Rate	FI-1417			1		Indicate flow rate	RTU-7
Groundwater Level (Well 4 PD)	LI-1418			1		Indicate Level	RTU-7
Groundwater Level (Well 4 BC)	LI-1419			1		Indicate Level	RTU-7
Loss of Phase	YA-1420	1				Alarm	RTU-7
Loss of Power	YA-1421	1				Alarm	RTU-7
24VDC Power Fail	YA-1422	1				Alarm	RTU-7
RTU Power Fail	YA-1423	1				Alarm	RTU-7
UPS Battery Low	YA-1424	1				Alarm	RTU-7
Well 5 PD Call to Start	YC-1500		1			Start/Stop Well Pump	RTU-8
Well 5 PD Run Status	YI-1501	1				On/Off Status	RTU-8
Well 5 PD Remote Status	YI-1502	1				Pump in Remote Mode	RTU-8
Well 5 PD VFD Failure	YA-1503A	1				Alarm	RTU-8
Well 5 PD Pump Failure	YA-1503B	1				Alarm	RTU-8
Well 5 PD VFD Speed Control	SIC-1504				1	Adjust VFD speed	RTU-8
Well 5 PD VFD Speed Feedback	SI-1505			1		Indicate speed	RTU-8
Well Combined Blow-off Valve Remote Status	YI-1506	1				Valve in Remote Status	RTU-8
Well Combined Blow-off Valve Open/Close	ZC-1506		1			Control Valve Open/Close	RTU-8

Well Combined Blow-off Valve Open Status	ZIO-1506	1				Indicate Valve Open	RTU-8
Well Combined Blow-off Valve Closed Status	ZIC-1506	1				Indicate Valve Closed	RTU-8
Well 5 BC Call to Start	YC-1507		1			Start/Stop Well Pump	RTU-8
Well 5 BC Run Status	YI-1508	1				On/Off Status	RTU-8
Well 5 BC Remote Status	YI-1509	1				Pump in Remote Mode	RTU-8
Well 5 BC Failure	YA-1510A	1				Alarm	RTU-8
Well 5 BC VFD Failure	YA-1510B					Alarm	RTU-8
Well 5 BC VFD Speed Control	SIC-1511				1	Adjust VFD speed	RTU-8
Well 5 BC VFD Speed Feedback	SI-1512			1		Indicate speed	RTU-8
Well Combined Discharge Valve Remote Status	YI-1513	1				Valve in Remote Status	RTU-8
Well Combined Discharge Valve Open/Close	ZC-1513		1			Control Valve Open/Close	RTU-8
Well Combined Discharge Valve Open Status	ZIO-1513	1				Indicate Valve Open	RTU-8
Well Combined Discharge Valve Closed Status	ZIC-1513	1				Indicate Valve Closed	RTU-8
Well Discharge Pressure	AI-1514				1	Indicate Pressure	RTU-8
Well Discharge Pressure High	YI-1514A	1				Alarm	RTU-8
Well Discharge Pressure Low	YI-1514B	1				Alarm	RTU-8
Panel Alarm	YA-1515	1				Alarm	RTU-8
Well 5 PD Flow Rate	FI-1516			1		Indicate flow rate	RTU-8
Well 5 BC Flow Rate	FI-1517			1		Indicate flow rate	RTU-8
Groundwater Level (Well 5 PD)	LI-1518			1		Indicate Level	RTU-8
Groundwater Level (Well 5 BC)	LI-1519			1		Indicate Level	RTU-8
Loss of Phase	YA-1520	1				Alarm	RTU-8
Loss of Power	YA-1521	1				Alarm	RTU-8
24VDC Power Fail	YA-1522	1				Alarm	RTU-8
RTU Power Fail	YA-1523	1				Alarm	RTU-8
UPS Battery Low	YA-1524	1				Alarm	RTU-8
Raw Water Flow	FI-101			1		Indicate flow rate	PLC-1
Raw Water Pressure	PI-102			1		Indicate raw water pressure	PLC-1
Scale Inhibitor Day Tank Level	LI-103			1		Indicate	PLC-1
Scale Inhibitor Feed Pump No. 1 Enable Start	YC-103-1		1			Start feed pump	PLC-1
Scale Inhibitor Feed Pump No. 1 Run Status	YI-103A-1	1				Run Status	PLC-1
Scale Inhibitor Feed Pump No. 1 Remote Status	YI-103-B-1	1				Pump in Remote Mode	PLC-1
Scale Inhibitor Feed Pump No. 1 Alarm	YA-103-1	1				Alarm	PLC-1
Scale Inhibitor Feed Pump No. 1 Speed Control	SIC-103-1				1	Adjust feed rate	PLC-1
Scale Inhibitor Feed Pump No. 1 Speed Feedback	SI-103-1			1		Speed feedback	PLC-1
Scale Inhibitor Feed Pump No. 2 Enable Start	YC-103-2		1			Start feed pump	PLC-1
Scale Inhibitor Feed Pump No. 2 Run Status	YI-103A-2	1				Run Status	PLC-1
Scale Inhibitor Feed Pump No. 2 Remote Status	YI-103B-2	1				Pump in Remote Mode	PLC-1

Scale Inhibitor Feed Pump No. 2 Alarm	YA-103-2	1				Alarm	PLC-1
Scale Inhibitor Feed Pump No. 2 Speed Control	SIC-103-2				1	Adjust feed rate	PLC-1
Scale Inhibitor Feed Pump No. 2 Speed Feedback	SI-103-2			1		Speed feedback	PLC-1
Scale Inhibitor Flow Rate	FI-135					Indicate flow rate	PLC-1
Raw Water Turbidity	AI-104			1		Indicate raw water turbidity	PLC-1
Raw Water pH/Temperature	AI-105			1		Indicate raw water pH and temperature	PLC-1
Raw Water Conductivity	AI-106			1		Indicate raw water conductivity	PLC-1
Raw Water Feed Valve Remote Status	YI-108	1				Valve in Remote Mode	PLC-1
Raw Water Feed Valve Open/Close	ZC-108		1			Control Valve Open/Close	PLC-1
Raw Water Feed Valve Open Status	ZIO-108	1				Indicate Valve Open	PLC-1
Raw Water Feed Valve Closed Status	ZIC-108	1				Indicate Valve Closed	PLC-1
Raw Water Bypass Valve Remote Status	YI-109	1				Valve in Remote Mode	PLC-1
Raw Water Bypass Valve Open/Close	ZC-109		1			Control Valve Open/Close	PLC-1
Raw Water Bypass Valve Open Status	ZIO-109	1				Indicate Valve Opened	PLC-1
Raw Water Bypass Valve Closed Status	ZIC-109	1				Indicate Valve Closed	PLC-1
Cartridge Filter Differential Pressure	PDI-110			1		Indicate filtered water pressure	PLC-1
Permeate Tank Level	LI-111			1		Indicate tank level	PLC-1
Permeate Tank Inlet Valve Open/Close	ZC-112		1			Control Valve Open/Close	PLC-1
Permeate Tank Inlet Valve Open Status	ZIO-112	1				Indicate Valve Open	PLC-1
Permeate Tank Inlet Valve Closed Status	ZIC-112	1				Indicate Valve Closed	PLC-1
Flush Pump No. 1 Enable Start	YC-113-1		1			Start feed pump	PLC-1
Flush Pump No. 1 Run Status	YI-113A-1	1				Run Status	PLC-1
Flush Pump No. 1 Remote Status	YI-113-B-1	1				Pump in Remote Mode	PLC-1
Flush Pump No. 1 Alarm	YA-113-1	1				Alarm	PLC-1
Flush Pump No. 2 Enable Start	YC-113-2		1			Start feed pump	PLC-1
Flush Pump No. 2 Run Status	YI-113A-2	1				Run Status	PLC-1
Flush Pump No. 2 Remote Status	YI-113B-2	1				Pump in Remote Mode	PLC-1
Flush Pump No. 2 Alarm	YA-113-2	1				Alarm	PLC-1
Combined Permeate Water Conductivity	AI-114			1		Indicate combined permeate conductivity	PLC-1
Combined Permeate Water pH	AI-115			1		Indicate combined permeate pH	PLC-1
Combined Permeate Water Pressure	PI-116			1		Indicate combined permeate pressure	PLC-1
Combined Permeate Water Flow	FI-117			1		Indicate combined permeate flow rate	PLC-1
Combined Concentrate Water Conductivity	AI-118			1		Indicate combined concentrate conductivity	PLC-1
Combined Concetrate Water pH	AI-119			1		Indicate combined concentrate pH	PLC-1
Combined Concetrate Flow Rate	FI-120					Indicate combined concentrate flow rate	PLC-1
Cleaning Pump Discharge Pressure High	YA-126	1				High Pressure alarm	PLC-1
Cleaning Pump Enable Start	YC-123		1			Start feed pump	PLC-1
Cleaning Pump Run Status	YI-123A	1				Run Status	PLC-1

Cleaning Pump Remote Status	YI-123B	1				Pump in Remote Mode	PLC-1
Cleaning Pump Permissive Status	YI-123C		1			Pump Available to run	PLC-1
Cleaning Pump Alarm	YA-123	1				Alarm	PLC-1
Cleaning Pump Speed Control	SIC-123				1	Adjust feed rate	PLC-1
Cleaning Pump Speed Feedback	SI-123			1		Speed feedback	PLC-1
Cleaning Solution pH/Temperature	AI-124			1		Indicate pH and temperature	PLC-1
Cleaning Solution Flow Rate	FI-125			1		Indicate flow rate	PLC-1
Cartridge Filter Differential Pressure	DPI-127			1		Indicate differential pressure	PLC-1
Spent Cleaning Solution Tank pH	AI-128		1			Indicate pH	PLC-1
Corrosion Inhibitor Storage Tank Level	LI-129			1		Indicate	PLC-1
Corrosion Inhibitor Feed Pump No. 1 Enable Start	YC-130-1		1			Start feed pump	PLC-1
Corrosion Inhibitor Feed Pump No. 1 Run Status	YI-130A-1	1				Run Status	PLC-1
Corrosion Inhibitor Feed Pump No. 1 Remote Status	YI-130B-1	1				Pump in Remote Mode	PLC-1
Corrosion Inhibitor Feed Pump No. 1 Alarm	YA-130-1	1				Alarm	PLC-1
Corrosion Inhibitor Feed Pump No. 1 Speed Control	SIC-130-1				1	Adjust feed rate	PLC-1
Corrosion Inhibitor Feed Pump No. 1 Speed Feedback	SI-130-1			1		Speed feedback	PLC-1
Corrosion Inhibitor Feed Pump No. 2 Enable Start	YC-130-2		1			Start feed pump	PLC-1
Corrosion Inhibitor Feed Pump No. 2 Run Status	YI-130A-2	1				Run Status	PLC-1
Corrosion Inhibitor Feed Pump No. 2 Remote Status	YI-130A-2	1				Pump in Remote Mode	PLC-1
Corrosion Inhibitor Feed Pump No. 2 Alarm	YA-130-2	1				Alarm	PLC-1
Corrosion Inhibitor Feed Pump No. 2 Speed Control	SIC-130-2				1	Adjust feed rate	PLC-1
Corrosion Inhibitor Feed Pump No. 2 Speed Feedback	SI-130-2			1		Speed feedback	PLC-1
Corrosion Inhibitor Flow Rate	FI-136			1		Indicated flow rate	PLC-1
Caustic Storage Tank Level	LI-131			1		Indicate	PLC-1
Caustic Feed Pump No. 1 Enable Start	YC-133-1		1			Start feed pump	PLC-1
Caustic Feed Pump No. 1 Run Status	YI-133A-1	1				Run Status	PLC-1
Caustic Feed Pump No. 1 Remote Status	YI-133B-1	1				Pump in Remote Mode	PLC-1
Caustic Feed Pump No. 1 Alarm	YA-133-1	1				Alarm	PLC-1
Caustic Feed Pump No. 1 Speed Control	SIC-133-1				1	Adjust feed rate	PLC-1
Caustic Feed Pump No. 1 Speed Feedback	SI-133-1			1		Speed feedback	PLC-1
Caustic Feed Pump No. 2 Enable Start	YC-133-2		1			Start feed pump	PLC-1
Caustic Feed Pump No. 2 Run Status	YI-133A-2	1				Run Status	PLC-1
Caustic Feed Pump No. 2 Remote Status	YI-133B-2	1				Pump in Remote Mode	PLC-1
Caustic Feed Pump No. 2 Alarm	YA-133-2	1				Alarm	PLC-1
Caustic Feed Pump No. 2 Speed Control	SIC-133-2				1	Adjust feed rate	PLC-1
Caustic Feed Pump No. 2 Speed Feedback	SI-133-2			1		Speed feedback	PLC-1
Caustic Feed Flow Rate	FI-134			1		Indicated flow rate	PLC-1
Cleaning Solution Tank Mixer On/Off	YC-135		1			Start Mixer	PLC-1
Cleaning Solution Tank Mixer Run Status	YI-136	1				Run Status	PLC-1

Cleaning Solution Tank Mixer Alarm	YA-137	1				Alarm	PLC-1
CO_2 Storage Tank Low Pressure	YA-151	1				Alarm	PLC-1
CO_2 Storage Tank High Pressure	YA-152	1				Alarm	PLC-1
CO_2 System On/Off	YC-153		1			Start/Stop Feed System	PLC-1
CO_2 System Run Signal	YI-154		1			Start/Stop Feed System	PLC-1
RO Permeate pH	AO-437				1	Indicate pH for CO_2 Control	PLC-1
Low pH Alarm	YA-156	1				Alarm	PLC-1
High pH Alarm	YA-157	1				Alarm	PLC-1
Low Water Pressure Alarm	YA-158	1				Alarm	PLC-1
High CO_2 Level	YA-159	1				Alarm	PLC-1
CO_2 Gas Detector Signal	AI-160			1		Indicate CO_2 Level	PLC-1
Ground Storage Tank No. 1 Level	LI-161			1		Indicate	PLC-1
Treated Water pH	AI-162			1		Indicate	PLC-1
Treated Water Chlorine Residual	AI-163			1		Indicate	PLC-1
High Service Pump No. 1 Start/Stop	YC-164A-1		1			Start/Stop Pump	PLC-1
High Service Pump No. 1 Pump Control Valve Open/Close	YC-164B-1	1				Open/Close Valve	PLC-1
High Service Pump No. 1 Run Status	YI-164A-1	1				On/Off Status	PLC-1
High Service Pump No. 1 Pump Control Valve Panel Remote Status	YI-164B-1	1				Control Valve Panel in Remote Mode	PLC-1
High Service Pump No. 1 Thermal Overload	YA-164A-1	1				Alarm	PLC-1
High Service Pump No. 1 Pump Control Valve Low Pressure at Start-up	YA-164B-1	1				Alarm	PLC-1
High Service Pump No. 1 Pump Control Valve Fail to Open	YA-164C-1	1				Alarm	PLC-1
High Service Pump No. 1 Pump Control Valve Close w/out Command	YA-164D-1	1				Alarm	PLC-1
High Service Pump No. 1 Pump Control Valve Loss of Pressure	YA-164E-1	1				Alarm	PLC-1
High Service Pump No. 1 Pump Control Valve Power Fail Delay Restart	YA-164F-1	1				Alarm	PLC-1
High Service Pump No. 1 Pump Control Valve Not Closed, No Start-up	YA-164G-1	1				Alarm	PLC-1
High Service Pump No. 1 Pump Control Valve Failed to Close	YA-164H-1	1				Alarm	PLC-1
High Service Pump No. 2 Start/Stop	YC-164A-2		1			Start/Stop Pump	PLC-1
High Service Pump No. 2 Pump Control Valve Open/Close	YC-164B-2		1			Open/Close Valve	PLC-1
High Service Pump No. 2 Run Status	YI-164A-2	1				On/Off Status	PLC-1
High Service Pump No. 2 Pump Control Valve Panel Remote Status	Y1-164B-2	1				Control Valve Panel in Remote Mode	PLC-1
High Service Pump No. 2 Thermal Overload	YA-164A-2	1				Alarm	PLC-1
High Service Pump No. 2 Pump Control Valve Low Pressure at Start-up	YA-164B-2	1				Alarm	PLC-1
High Service Pump No. 2 Pump Control Valve Fail to Open	YA-164C-2	1				Alarm	PLC-1
High Service Pump No. 2 Pump Control Valve Close w/out Command	YA-164D-2	1				Alarm	PLC-1
High Service Pump No. 2 Pump Control Valve Loss of Pressure	YA-164E-2	1				Alarm	PLC-1
High Service Pump No. 2 Pump Control Valve Power Fail Delay Restart	YA-164F-2	1				Alarm	PLC-1
High Service Pump No. 2 Pump Control Valve Not Closed, No Start-up	YA-164G-2	1				Alarm	PLC-1

High Service Pump No. 2 Pump Control Valve Failed to Close	YA-164H-2	1				Alarm	PLC-1
High Service Pump No. 3 Start/Stop	YC-164A-3		1			Start/Stop Pump	PLC-1
High Service Pump No. 3 Pump Control Valve Open/Close	YC-164B-3		1			Open/Close Valve	PLC-1
High Service Pump No. 3 Run Status	YI-164A-3	1				On/Off Status	PLC-1
High Service Pump No. 3 Pump Control Valve Panel Remote Status	YI-164B-3	1				Control Valve Panel in Remote Mode	PLC-1
High Service Pump No. 3 Thermal Overload	YA-164A-3	1				Alarm	PLC-1
High Service Pump No. 3 Pump Control Valve Low Pressure at Start-up	YA-164B-3	1				Alarm	PLC-1
High Service Pump No. 3 Pump Control Valve Fail to Open	YA-164C-3	1				Alarm	PLC-1
High Service Pump No. 3 Pump Control Valve Close w/out Command	YA-164D-3	1				Alarm	PLC-1
High Service Pump No. 3 Pump Control Valve Loss of Pressure	YA-164E-3	1				Alarm	PLC-1
High Service Pump No. 3 Pump Control Valve Power Fail Delay Restart	YA-164F-3	1				Alarm	PLC-1
High Service Pump No. 3 Pump Control Valve Not Closed, No Start-up	YA-164G-3	1				Alarm	PLC-1
High Service Pump No. 3 Pump Control Valve Failed to Close	YA-164H-3	1				Alarm	PLC-1
High Service Pumps Loss of Phase	YA-165	1				Alarm	PLC-1
High Service Pumps Loss of Power	YA-166	1				Alarm	PLC-1
High Service Pump Discharge Pressure	PI-180			1		HSP Discharge Pressure	PLC-1
Finished Water Flow Rate	FI-167			1		Indicate	PLC-1
Finished Water pH	AI-168			1		Indicate	PLC-1
Finished Water Chlorine Residual	AI-169			1		Indicate	PLC-1
Rinse Holding Tank Level	LI-170			1		Indicate	PLC-1
Rinse Holding Tank Mixer Start/Stop	YC-171		1			Start/Stop Mixer	PLC-1
Rinse Holding Tank Mixer Run Status	YI-172	1				Run Status	PLC-1
Rinse Holding Tank Mixer Remote Status	Y1-173	1				Mixer in Remote Mode	PLC-1
Rinse Holding Tank Mixer Alarm	YA-174	1				Alarm	PLC-1
Waste Pump No. 1 Start/Stop	YC-175		1			Start/Stop Pump	PLC-1
Waste Pump No. 1 Run Status	YI-175A	1				On/Off	PLC-1
Waste Pump No. 1 Remote Status	YI-175B	1				Pump in Remote Mode	PLC-1
Waste Pump No. 1 Thermal Overload	YA-175A	1				Alarm	PLC-1
Waste Pump No. 1 Seal Failure	YA-175B	1				Alarm	PLC-1
Waste Pump No. 1 Limit Switch	YA-175C	1				Alarm	PLC-1
Waste Pump No. 2 Start/Stop	YC-176		1			Start/Stop Pump	PLC-1
Waste Pump No. 2 Run Status	YI-176A	1				On/Off	PLC-1
Waste Pump No. 2 Remote Status	YI-176B	1				Pump in Remote Mode	PLC-1
Waste Pump No. 2 Thermal Overload	YA-176A	1				Alarm	PLC-1
Waste Pump No. 2 Seal Failure	YA-176B	1				Alarm	PLC-1
Waste Pump No. 2 Limit Switch	YA-176C	1				Alarm	PLC-1
Generator Run	YI-177	1				On/Off Status	PLC-1
Generator Failure	YA-178	1				Alarm	PLC-1
Calcite Filter Influent pH	AI-179A			1		Indicate influent pH	PLC-1

Calcite Filter Influent CL2 Residual	AI-179B			1		Indicate influent chlorine residual	PLC-1
Emergency Eyewash/Shower (EES-1) Flow Switch (Lab)	YA-180	1				Flow Alarm	PLC-1
Emergency Eyewash/Shower (EES-2) Flow Switch (RO Treatment)	YA-181	1				Flow Alarm	PLC-1
Emergency Eyewash/Shower (EES-3) Flow Switch (Scale Inhibitor)	YA-182	1				Flow Alarm	PLC-1
Emergency Eyewash/Shower (EES-4) Flow Switch (Hypochlorite)	YA-183	1				Flow Alarm	PLC-1
Emergency Eyewash/Shower (EES-5) Flow Switch (Caustic)	YA-184	1				Flow Alarm	PLC-1
Emergency Eyewash/Shower (EES-6) Flow Switch (Corrosion Inhibitor)	YA-185	1				Flow Alarm	PLC-1
Emergency Eyewash/Shower (EES-7) Flow Switch (Shop/Storage)	YA-186	1				Flow Alarm	PLC-1
Plant Water Flow Rate	FI-187			1		Indicate flow rate	PLC-1
Emergency Eyewash/Shower (EES-8) Flow Switch (Fluoride)	YA-188	1				Flow Alarm	PLC-1
Fluoride Storage Tank No. 1 Level	LI-189			1		Indicate level	PLC-1
Fluoride Day Tank Weight/Volume	LI-501			1		Indicate volume and translate to level	PLC-1
Fluoride Storage Tank No. 2 Level (Future)	LI-502			1		Indicate level	PLC-1
Fluoride Day Tank High Level	YA-503	1				High tank level alarm	PLC-1
Fluoride Day Tank Low Level	YA-504	1				Low tank level alarm	PLC-2
Fluoride Feed Pump No. 1 Enable Start	YC-190-1		1			Start feed pump	PLC-1
Fluoride Feed Pump No. 1 Run Status	YI-190A-1	1				Run Status	PLC-1
Fluoride Feed Pump No. 1 Remote Status	YI-190B-1	1				Pump in Remote Mode	PLC-1
Fluoride Feed Pump No. 1 Alarm	YA-190-1	1				Alarm	PLC-1
Fluoride Feed Pump No. 1 Speed Control	SIC-190-1				1	Adjust feed rate	PLC-1
Fluoride Feed Pump No. 1 Speed Feedback	SI-190-1			1		Speed feedback	PLC-1
Fluoride Feed Pump No. 2 Enable Start	YC-190-2		1			Start feed pump	PLC-1
Fluoride Feed Pump No. 2 Run Status	YC-190-2	1				Run Status	PLC-1
Fluoride Feed Pump No. 2 Remote Status	YI-190A-2	1				Pump in Remote Mode	PLC-1
Fluoride Feed Pump No. 2 Alarm	YI-190B-2	1				Alarm	PLC-1
Fluoride Feed Pump No. 2 Speed Control	SIC-190-2				1	Adjust feed rate	PLC-1
Fluoride Feed Pump No. 2 Speed Feedback	SI-190-2			1		Speed feedback	PLC-1
Fluoride Feed Flow Rate	FI-191			1		Indicate flow rate	PLC-1
Trench Sump Pump High Level	YA-192	1				Alarm	PLC-1
Pre-Calcite Instrument Panel – Process Sample Solenoid Valve	YC-193		1			Open/Close Valve	PLC-1
Pre-Calcite Instrument Panel – Finished Water Solenoid Valve	YC-194		1			Open/Close Valve	PLC-1
Treated Water Instrument Panel – Process Sample Solenoid Valve	YC-195		1			Open/Close Valve	PLC-1
Treated Water Instrument Panel – Finished Water Solenoid Valve	YC-196		1			Open/Close Valve	PLC-1
Finished Water Instrument Panel – Process Water Solenoid Valve	YC-197		1			Open/Close Valve	PLC-1
Finished Water Instrument Panel – Finished Water Solenoid Valve	YC-198		1			Open/Close	PLC-1
RO Train No. 1 Raw Water Feed Valve Remote Status	YI-201-1	1				Valve in Remote Mode	PLC-2-1
RO Train No. 1 Raw Water Feed Valve Open/Close	ZC-201-1		1			Control Valve Open/Close	PLC-2-1
RO Train No. 1 Raw Water Feed Valve Open Status	ZIO-201-1	1				Indicate Valve Open	PLC-2-1

RO Train No. 1 Raw Water Feed Valve Closed Status	ZIC-201-1	1				Indicate Valve Closed	PLC-2-1
RO Train No. 1 Flush Water Feed Valve Remote Status	YI-202-1	1				Valve in Remote Mode	PLC-2-1
RO Train No. 1 Flush Water Feed Valve Open/Close	ZC-202-1		1			Control Valve Open/Close	PLC-2-1
RO Train No. 1 Flush Water Feed Valve Open Status	ZIO-202-1	1				Indicate Valve Open	PLC-2-1
RO Train No. 1 Flush Water Feed Valve Closed Status	ZIC-202-1	1				Indicate Valve Closed	PLC-2-1
RO Train No. 1 Feed Pump Low Suction Pressure	YA-203-1	1				Alarm	PLC-2-1
RO Train No. 1 Feed Pump Call to Run	YC-204-1		1			Start/Stop Pump	PLC-2-1
RO Train No. 1 Feed Pump Run Status	YI-204A-1	1				On/Off Status	PLC-2-1
RO Train No. 1 Feed Pump Remote	YI-204B-1	1				Pump in Remote Status	PLC-2-1
RO Train No. 1 Feed Pump Failure	YA-204-1	1				Alarm	PLC-2-1
RO Train No. 1 Feed Pump Speed Command	SIC-204-1				1	Pump Speed Control	PLC-2-1
RO Train No. 1 Feed Pump Speed Feedback	SI-204-1			1		Indicate speed	PLC-2-1
RO Train No. 1 Feed Pump Discharge Pressure	PI-205-1			1		Indicate	PLC-2-1
RO Train No. 1 Feed Pump Discharge Pressure High	YA-206-1	1				Alarm	PLC-2-1
RO Train No. 1 Inlet Valve Remote Status	YI-207-1	1				Valve in Remote Mode	PLC-2-1
RO Train No. 1 Inlet Valve Open/Close	ZC-207-1		1			Control Valve Open/Close	PLC-2-1
RO Train No. 1 Inlet Valve Open Status	ZIO-207-1	1				Indicate Valve Open	PLC-2-1
RO Train No. 1 Inlet Valve Closed Status	ZIC-207-1	1				Indicate Valve Closed	PLC-2-1
RO Train No. 1 Stage 1 Permeate Flow	FI-208-1			1		Indicate flow rate	PLC-2-1
RO Train No. 1 Stage 1 Concentrate Pressure	PI-209-1			1		Indicate pressure	PLC-2-1
RO Train No. 1 Stage 2 Inlet Pressure	PI-210-1			1		Indicate pressure	PLC-2-1
RO Train No. 1 Stage 2 Permeate Flow	FI-211-1			1		Indicate flow rate	PLC-2-1
RO Train No. 1 Stage 2 Concentrate Pressure	PI-212-1			1		Indicate pressure	PLC-2-1
RO Train No. 1 ERD Outlet Pressure	PI-214-1			1		Indicate pressure	PLC-2-1
RO Train No. 1 Concentrate Valve Remote Status	YI-218-1	1				Valve in Remote Mode	PLC-2-1
RO Train No. 1 Concentrate Valve Open/Close	ZC-218-1		1			Control Valve Open/Close	PLC-2-1
RO Train No. 1 Concentrate Valve Open Status	ZIO-218-1	1				Indicate Valve Open	PLC-2-1
RO Train No. 1 Concentrate Valve Closed Status	ZIC-218-1	1				Indicate Valve Closed	PLC-2-1
RO Train No. 1 Concentrate Conductivity	AI-216-1			1		Indicate conductivity	PLC-2-1
RO Train No. 1 Concentrate Flow Rate	FI-217-1			1		Indicate flow rate	PLC-2-1
RO Train No. 1 Permeate Conductivity	AI-215-1			1		Indicate conductivity	PLC-2-1
RO Train No. 2 Raw Water Feed Valve Remote Status	YI-201-2	1				Valve in Remote Mode	PLC-2-2
RO Train No. 2 Raw Water Feed Valve Open/Close	ZC-201-2		1			Control Valve Open/Close	PLC-2-2
RO Train No. 2 Raw Water Feed Valve Open Status	ZIO-201-2	1				Indicate Valve Open	PLC-2-2
RO Train No. 2 Raw Water Feed Valve Closed Status	ZIC-201-2	1				Indicate Valve Closed	PLC-2-2
RO Train No. 2 Flush Water Feed Valve Remote Status	YI-202-2	1				Valve in Remote Mode	PLC-2-2
RO Train No. 2 Flush Water Feed Valve Open/Close	ZC-202-2		1			Control Valve Open/Close	PLC-2-2
RO Train No. 2 Flush Water Feed Valve Open Status	ZIO-202-2	1				Indicate Valve Open	PLC-2-2

RO Train No. 2 Flush Water Feed Valve Closed Status	ZIC-202-2	1				Indicate Valve Closed	PLC-2-2
RO Train No. 2 Feed Pump Low Suction Pressure	YA-203-2	1				Alarm	PLC-2-2
RO Train No. 2 Feed Pump Call to Run	YC-204-2		1			Start/Stop Pump	PLC-2-2
RO Train No. 2 Feed Pump Run Status	YI-204A-2	1				On/Off Status	PLC-2-2
RO Train No. 2 Feed Pump Remote	YI-204B-2	1				Pump in Remote Status	PLC-2-2
RO Train No. 2 Feed Pump Failure	YA-204-2	1				Alarm	PLC-2-2
RO Train No. 2 Feed Pump Speed Command	SIC-204-2				1	Pump Speed Control	PLC-2-2
RO Train No. 2 Feed Pump Speed Feedback	SI-204-2			1		Indicate speed	PLC-2-2
RO Train No. 2 Feed Pump Discharge Pressure	PI-205-2			1		Indicate	PLC-2-2
RO Train No. 2 Feed Pump Discharge Pressure High	YA-206-2	1				Alarm	PLC-2-2
RO Train No. 2 Inlet Valve Remote Status	YI-207-2	1				Valve in Remote Mode	PLC-2-2
RO Train No. 2 Inlet Valve Open/Close	ZC-207-2		1			Control Valve Open/Close	PLC-2-2
RO Train No. 2 Inlet Valve Open Status	ZIO-207-2	1				Indicate Valve Open	PLC-2-2
RO Train No. 2 Inlet Valve Closed Status	ZIC-207-2	1				Indicate Valve Closed	PLC-2-2
RO Train No. 2 Stage 1 Permeate Flow	FI-208-2			1		Indicate flow rate	PLC-2-2
RO Train No. 2 Stage 1 Concentrate Pressure	PI-209-2			1		Indicate pressure	PLC-2-2
RO Train No. 2 Stage 2 Inlet Pressure	PI-210-2			1		Indicate pressure	PLC-2-2
RO Train No. 2 Stage 2 Permeate Flow	FI-211-2			1		Indicate flow rate	PLC-2-2
RO Train No. 2 Stage 2 Concentrate Pressure	PI-212-2			1		Indicate pressure	PLC-2-2
RO Train No. 2 ERD Outlet Pressure	PI-214-2			1		Indicate pressure	PLC-2-2
RO Train No. 2 Concentrate Valve Remote Mode	YI-218-2	1				Valve in Remote Mode	PLC-2-2
RO Train No. 2 Concentrate Valve Open/Close	ZC-218-2		1			Control Valve Open/Close	PLC-2-2
RO Train No. 2 Concentrate Valve Open Status	ZIO-218-2	1				Indicate Valve Open	PLC-2-2
RO Train No. 2 Concentrate Valve Closed Status	ZIC-218-2	1				Indicate Valve Closed	PLC-2-2
RO Train No. 2 Concentrate Conductivity	AI-216-2			1		Indicate conductivity	PLC-2-2
RO Train No. 2 Concentrate Flow Rate	FI-217-2			1		Indicate flow rate	PLC-2-2
RO Train No. 2 Permeate Conductivity	AI-215-2			1		Indicate conductivity	PLC-2-2
Hydrogen Gas Detector	YA-301	1				Alarm	PLC-3
Brine Tank Level	LI-302			1		Indicate tank level	PLC-3
Brine Pump Speed Control	SIC-303				1	Pump speed control	PLC-3
Brine Pump Call to Run	YC-303		1			Start/Stop Brine Pump	PLC-3
Water Supply Solenoid Valve	YC-304		1			Open/Close Valve	PLC-3
Water Supply to Brine Tank Solenoid Valve	YC-305		1			Open/Close Valve	PLC-3
Water Supply to Control Valve Solenoid Valve	YC-306		1			Open/Close Valve	PLC-3
Dilution Water Flow Rate	FI-307			1		Indicate flow rate	PLC-3
Temperature Switch Cell No. 1	YA-308	1				Indicate temperature setpoint reached	PLC-3
Temperature Switch Cell No. 2	YA-309	1				Indicate temperature setpoint reached	PLC-3
Temperature Switch Cell No. 3	YA-310	1				Indicate temperature setpoint reached	PLC-3

Temperature Switch Cell No. 4	YA-311	1				Indicate temperature setpoint reached	PLC-3
Temperature Switch Cell No. 5	YA-312	1				Indicate temperature setpoint reached	PLC-3
Level Switch Cell No. 1	YI-313	1				Indicate level setpoint reached	PLC-3
Level Switch Cell No. 2	YI-314	1				Indicate level setpoint reached	PLC-3
Level Switch Cell No. 3	YI-315	1				Indicate level setpoint reached	PLC-3
Level Switch Cell No. 4	YI-316	1				Indicate level setpoint reached	PLC-3
Level Switch Cell No. 5	YI-317	1				Indicate level setpoint reached	PLC-3
Temperature Sensor Cell No. 5	TI-318			1		Indicate temperature	PLC-3
Rectifier Primary	YC-319		1				PLC-3
Rectifier SS	YC-320		1				PLC-3
Rectifier Bypass	YC-321		1				PLC-3
Rectifier Amps	AI-322			1		Indicate amps	PLC-3
Differential Pressure Switch	YA-323	1				Alarm	PLC-3
Hypochlorite Storage Tank No. 1 Level	LI-324			1		Indicate tank level	PLC-3
Hypochlorite Storage Tank No. 2 Level	LI-325			1		Indicate tank level	PLC-3
Blower No. 1 Enable	YC-326		1			Start/Stop Blower	PLC-3
Blower No. 2 Enable	YC-327		1			Start/Stop Blower	PLC-3
Blower Current Switch	YI-328	1					PLC-3
Metering Pump No. 1 Call to Run	YC-329-1		1			Start/Stop Pump	PLC-3
Metering Pump No. 1 Run Status	YI-329-1	1				On/Off Status	PLC-3
Metering Pump No. 1 VFD Fault	YA-329-1	1				Alarm	PLC-3
Metering Pump No. 1 VFD Speed Control	SIC-329-1				1	Pump Speed Control	PLC-3
Metering Pump No. 2 Call to Run	YC-329-2		1			Start/Stop Pump	PLC-3
Metering Pump No. 2 Run Status	YI-329-2	1				On/Off Status	PLC-3
Metering Pump No. 2 VFD Fault	YA-329-2	1				Alarm	PLC-3
Metering Pump No. 2 VFD Speed Control	SIC-329-2				1	Pump Speed Control	PLC-3
Metering Pump No. 3 Call to Run	YC-329-3		1			Start/Stop Pump	PLC-3
Metering Pump No. 3 Run Status	YI-329-3	1				On/Off Status	PLC-3
Metering Pump No. 3 VFD Fault	YA-329-3	1				Alarm	PLC-3
Metering Pump No. 3 VFD Speed Control	SIC-329-3				1	Pump Speed Control	PLC-3
Calcite Filter No. 1 (Cell 1) Permeate Influent Valve Remote Status	YI-411-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 1) Permeate Influent Valve Open/Close	ZC-411-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 1) Permeate Influent Valve Open Status	ZIO-411-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 1) Permeate Influent Valve Closed Status	ZIC-411-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 1) Treated Water Effluent Valve Remote Status	YI-412-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 1) Treated Water Effluent Valve Open/Close	ZC-412-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 1) Treated Water Effluent Valve Open Status	ZIO-412-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 1) Treated Water Effluent Valve Closed Status	ZIC-412-1	1				Indicate Valve Closed	PLC-4

Calcite Filter No. 1 (Cell 1) Backwash Influent Valve Remote Stautus	YI-413-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 1) Backwash Influent Valve Open/Close	ZC-413-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 1) Backwash Influent Valve Open Status	ZIO-413-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 1) Backwash Influent Valve Closed Status	ZIC-413-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 1) Backwash Water Effluent Valve Remote Mode	YI-414-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 1) Backwash Water Effluent Valve Open/Close	ZC-414-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 1) Backwash Water Effluent Valve Open Status	ZIO-414-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 1) Backwash Water Effluent Valve Closed Status	ZIC-414-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 2) Permeate Influent Valve Remote Status	YI-421-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 2) Permeate Influent Valve Open/Close	ZC-421-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 2) Permeate Influent Valve Open Status	ZIO-421-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 2) Permeate Influent Valve Closed Status	ZIC-421-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 2) Treated Water Effluent Valve Remote Status	YI-422-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 2) Treated Water Effluent Valve Open/Close	ZC-422-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 2) Treated Water Effluent Valve Open Status	ZIO-422-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 2) Treated Water Effluent Valve Closed Status	ZIC-422-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Influent Valve Remote Mode	YI-423-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Influent Valve Open/Close	ZC-423-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Influent Valve Open Status	ZIO-423-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Influent Valve Closed Status	ZIC-423-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Water Effluent Valve Remote Status	YI-424-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Water Effluent Valve Open/Close	ZC-424-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Water Effluent Valve Open Status	ZIO-424-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 2) Backwash Water Effluent Valve Closed Status	ZIC-424-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 3) Permeate Influent Valve Remote Status	YI-431-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 3) Permeate Influent Valve Open/Close	ZC-431-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 3) Permeate Influent Valve Open Status	ZIO-431-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 3) Permeate Influent Valve Closed Status	ZIC-431-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 3) Treated Water Effluent Valve Remote Status	YI-432-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 3) Treated Water Effluent Valve Open/Close	ZC-432-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 3) Treated Water Effluent Valve Open Status	ZIO-432-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 3) Treated Water Effluent Valve Closed Status	ZIC-432-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 3) Backwash Influent Valve Remote Status	YI-433-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 3) Backwash Influent Valve Open/Close	ZC-433-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 3) Backwash Influent Valve Open Status	ZIO-433-1	1				Indicate Valve Open	PLC-4
Calcite Filter No. 1 (Cell 3) Backwash Influent Valve Closed Status	ZIC-433-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 3) Backwash Water Effluent Valve Remote Mode	YI-434-1	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 1 (Cell 3) Backwash Water Effluent Valve Open/Close	ZC-434-1		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 1 (Cell 3) Backwash Water Effluent Valve Open Status	ZIO-434-1	1				Indicate Valve Open	PLC-4

Calcite Filter No. 1 (Cell 3) Backwash Water Effluent Valve Closed Status	ZIC-434-1	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 1) Permeate Influent Valve Remote Status	YI-411-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 1) Permeate Influent Valve Open/Close	ZC-411-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 1) Permeate Influent Valve Open Status	ZIO-411-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 1) Permeate Influent Valve Closed Status	ZIC-411-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 1) Treated Water Effluent Valve Remote Status	YI-412-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 1) Treated Water Effluent Valve Open/Close	ZC-412-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 1) Treated Water Effluent Valve Open Status	ZIO-412-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 1) Treated Water Effluent Valve Closed Status	ZIC-412-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Influent Valve Remote Status	YI-413-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Influent Valve Open/Close	ZC-413-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Influent Valve Open Status	ZIO-413-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Influent Valve Closed Status	ZIC-413-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Water Effluent Valve Remote Status	YI-414-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Water Effluent Valve Open/Close	ZC-414-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Water Effluent Valve Open Status	ZIO-414-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 1) Backwash Water Effluent Valve Closed Status	ZIC-414-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 2) Permeate Influent Valve Remote Status	YI-421-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 2) Permeate Influent Valve Open/Close	ZC-421-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 2) Permeate Influent Valve Open Status	ZIO-421-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 2) Permeate Influent Valve Closed Status	ZIC-421-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 2) Treated Water Effluent Valve Remote Status	YI-422-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 2) Treated Water Effluent Valve Open/Close	ZC-422-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 2) Treated Water Effluent Valve Open Status	ZIO-422-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 2) Treated Water Effluent Valve Closed Status	ZIC-422-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Influent Valve Remote Status	YI-423-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Influent Valve Open/Close	ZC-423-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Influent Valve Open Status	ZIO-423-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Influent Valve Closed Status	ZIC-423-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Water Effluent Valve Remote Status	YI-424-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Water Effluent Valve Open/Close	ZC-424-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Water Effluent Valve Open Status	ZIO-424-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 2) Backwash Water Effluent Valve Closed Status	ZIC-424-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 3) Permeate Influent Valve Remote Status	YI-431-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 3) Permeate Influent Valve Open/Close	ZC-431-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 3) Permeate Influent Valve Open Status	ZIO-431-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 3) Permeate Influent Valve Closed Status	ZIC-431-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 3) Treated Water Effluent Valve Remote Status	YI-432-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 3) Treated Water Effluent Valve Open/Close	ZC-432-2		1			Control Valve Open/Close	PLC-4

Calcite Filter No. 2 (Cell 3) Treated Water Effluent Valve Open Status	ZIO-432-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 3) Treated Water Effluent Valve Closed Status	ZIC-432-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Influent Valve Remote Status	YI-433-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Influent Valve Open/Close	ZC-433-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Influent Valve Open Status	ZIO-433-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Influent Valve Closed Status	ZIC-433-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Water Effluent Valve Remote Status	YI-434-2	1				Valve in Remote Mode	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Water Effluent Valve Open/Close	ZC-434-2		1			Control Valve Open/Close	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Water Effluent Valve Open Status	ZIO-434-2	1				Indicate Valve Open	PLC-4
Calcite Filter No. 2 (Cell 3) Backwash Water Effluent Valve Closed Status	ZIC-434-2	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 Differential Pressure High Alarm	PDAH-435	1				High differential pressure alarm	PLC-4
Calcite Filter No. 2 Differential Pressure High Alarm	PDAH-436	1				High differential pressure alarm	PLC-4
Rinse Water Influent Flow rate	AI-439			1		Indicate rinse water flow rate	PLC-4
Calcite Rinse Water Valve Remote Status	YI-440	1				Valve in Remote Mode	PLC-4
Calcite Rinse Water Valve Open/Close	ZC-440		1			Control Valve Open/Close	PLC-4
Calcite Rinse Water Valve Open Status	ZIO-440	1				Indicate Valve Open	PLC-4
Calcite Rinse Water Valve Closed Status	ZIC-440	1				Indicate Valve Closed	PLC-4
Calcite Filter No. 1 (Cell 1) Inlet Gate Remote Status	YI-441	1				Indicate Remote Status	PLC-4
Calcite Filter No. 1 (Cell 1) Inlet Gate Open/Close	ZC-441		1			Control Gate Open/Close	PLC-4
Calcite Filter No. 1 (Cell 1) Inlet Gate Open Status	ZIO-441	1				Indicate Gate Open	PLC-4
Calcite Filter No. 1 (Cell 1) Inlet Gate Closed Status	ZIC-441	1				Indicate Gate Closed	PLC-4
Calcite Filter No. 1 (Cell 2) Inlet Gate Remote Status	YI-442	1				Indicate Remote Status	PLC-4
Calcite Filter No. 1 (Cell 2) Inlet Gate Open/Close	ZC-442		1			Control Gate Open/Close	PLC-4
Calcite Filter No. 1 (Cell 2) Inlet Gate Open Status	ZIO-442	1				Indicate Gate Open	PLC-4
Calcite Filter No. 1 (Cell 2) Inlet Gate Closed Status	ZIC-442	1				Indicate Gate Closed	PLC-4
Calcite Filter No. 1 (Cell 3) Inlet Gate Remote Status	YI-443	1				Indicate Remote Status	PLC-4
Calcite Filter No. 1 (Cell 3) Inlet Gate Open/Close	ZC-443		1			Control Gate Open/Close	PLC-4
Calcite Filter No. 1 (Cell 3) Inlet Gate Open Status	ZIO-443	1				Indicate Gate Open	PLC-4
Calcite Filter No. 1 (Cell 3) Inlet Gate Closed Status	ZIC-443	1				Indicate Gate Closed	PLC-4
Calcite Filter No. 2 (Cell 1) Inlet Gate Remote Status	YI-444	1				Indicate remote status	PLC-4
Calcite Filter No. 2 (Cell 1) Inlet Gate Open/Close	ZC-444		1			Control gate open/close	PLC-4
Calcite Filter No. 2 (Cell 1) Inlet Gate Open Status	ZIO-444	1				Indicate gate open	PLC-4
Calcite Filter No. 2 (Cell 1) Inlet Gate Closed Status	ZIC-444	1				Indicate gate closed	PLC-4
Calcite Filter No. 2 (Cell 2) Inlet Gate Remote Status	YI-445	1				Indicate remote status	PLC-4
Calcite Filter No. 2 (Cell 2) Inlet Gate Open/Close	ZC-445		1			Control gate open/close	PLC-4
Calcite Filter No. 2 (Cell 2) Inlet Gate Open Status	ZIO-445	1				Indicate gate open	PLC-4
Calcite Filter No. 2 (Cell 2) Inlet Gate Closed Status	ZIC-445	1				Indicate gate closed	PLC-4
Calcite Filter No. 2 (Cell 3) Inlet Gate Remote Status	YI-446	1				Indicate remote status	PLC-4
Calcite Filter No. 2 (Cell 3) Inlet Gate Open/Close	ZC-446		1			Control gate open/close	PLC-4

Calcite Filter No. 2 (Cell 3) Inlet Gate Open Status	ZIO-446	1				Indicate gate open	PLC-4
Calcite Filter No. 2 (Cell 3) Inlet Gate Closed Status	ZIC-446	1				Indicate gate closed	PLC-4
Calcite Filter No. 1 (Cell 1) Media Level	LI-447			1		Indicate calcite media level	PLC-4
Calcite Filter No. 1 (Cell 2) Media Level	LI-448			1		Indicate calcite media level	PLC-4
Calcite Filter No. 1 (Cell 3) Media Level	LI-449			1		Indicate calcite media level	PLC-4
Calcite Filter No. 2 (Cell 1) Media Level	LI-450			1		Indicate calcite media level	PLC-4
Calcite Filter No. 2 (Cell 2) Media Level	LI-451			1		Indicate calcite media level	PLC-4
Calcite Filter No. 2 (Cell 3) Media Level	LI-452			1		Indicate calcite media level	PLC-4

SECTION 13602

FIBERGLASS REINFORCED PLASTIC BUILDING

PART 1 GENERAL

1.01 SCOPE

A. The work under this specification consists of furnishing all labor, material, and equipment for the provision of fiberglass reinforced plastic buildings as shown on the plans.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 11243 Hydrofluorosilicic Acid Feed System
   2. Section 13420 Instrumentation
   3. Section 13445 Supervisory Control & Data Acquisition (SCADA) System

1.03 DESCRIPTION

A. The building shall be of the prefabricated type fitted with all electrical components, doors, ventilation, and mounting hardware suitable for storing and pumping hydrofluorosilicic acid.

B. The building shall have the interior dimensions as follows:
   1. Hydrofluorosilicic Acid Building: The building shall be 12'-0" wide x 24'-0" long with a side wall height of 8'-0".

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330 Submittals:
   1. Shop Drawings: Submit project specific shop drawings for the following:
      a. Fiberglass Reinforced Plastic Building and accessories.
      b. Detailed utility connection and configuration diagrams and dimensioned drawings.

1.05 QUALITY CONTROL

A. Manufacturer shall have at least five (5) similar installations that have been in service for a minimum of five (5) years.

B. Building with all interior components shall be listed and bear a label as an assembly from U.L. or other North Carolina approved third party testing agency.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

A. The building wall shall be of ribbed construction for superior structural stability and each wall section shall be molded in one piece with a minimum thickness of 1" polyurethane foam encapsulated between 1/8" fiberglass reinforced skins. Minimum thickness at the rib sections shall be 2 inches. There shall be no embedded wood, treated or otherwise.

B. Wall and roof panels shall be structurally reinforced with steel and aluminum extrusions fully encapsulated to meet loading conditions. Encapsulated aluminum

extrusion 3 inches wide by 1 ½ inches high by 0.125 inch thick with a 1 inch wide side flange shall be encapsulated into each corner of end panels (full height) and 4 inches wide by 2 ½ inches high by 0.125 inch thick with a 1 inch wide side flange around the entire roof perimeter to maintain flatness, straightness, and structural integrity. Integral internal flanges on mating panels shall be provided for bolting the sides, ends and roof to the encapsulated aluminum extrusions. Aluminum extrusions: incorporate threaded inserts on 12-inch centers for internal bolting to mating panel flange during assembly. Steel reinforcement shall be encapsulated in walls at end and roof perimeter, to form a continuous, one-piece molded composite wall or roof panel. A 4-inch perimeter FRP bottom flange shall be on each wall panel and shall be anchored to the concrete floor with 316 stainless steel wedge anchors. Protruding stainless steel bolts/nuts shall be epoxy coated after wall installation.

C. Assemble panels with 3/8 inch diameter Hastelloy C-276 bolts on 12-inch centers and a ¼ inch thick by 3 inches wide foam gasket for a weather tight seal at all joints. Assembly bolts shall not penetrate the exterior wall of the structure.

D. FRP mounting channel reinforcement: 0.078 inch thick by 1 5/8 inch high by 1 5/8 inches wide. Mechanically attach to the interior surface with stainless steel pop rivets on 12-inch centers, on all walls. Rivets shall be covered with FRP gel coat or epoxy coating.

E. The building shall have a gabled roof with 2 ½" high offset overhang all around. The roof shall be made of laminated fiberglass skins of not less than 1/8" thickness bonded on the inside and out to a core of polyurethane closed cell foam of 2" minimum thickness.

F. Resin for all building surfaces shall have a minimum 15 mil gelcoat containing UV inhibitor. All resin material for surfaces shall be Ashland Derakane 411-350 or Engineer approved equal. The laminate shall be fiberglass reinforced polyester containing not less than 25% glass content by weight.

G. Molded as an integral part of the walls along the bottom edge shall be a 4" FRP bolted flange of minimum 3/16" thickness to allow permanent mounting on a concrete pad as shown on the drawings. Flange material shall be of the same resistant resin material as the interior surfaces described above. All flange bolts or fasteners for securing the building to the concrete pad shall be Hastelloy C-276.

H. Double Doors
   1. Insulated FRP double door set, one-piece, resin transfer molded (RTM) in matched metal molds to produce an industrial quality door, which exhibits a smooth finished, seamless, monolithic, warp-free composite consisting of a gel-coat, fiberglass reinforcement, polyester resin, insulating core, and internal reinforcements with all mortises, openings, recesses, and pockets molded in place and shall be mounted in a recess for increased tamper resistance.
   2. There shall be a clear opening of not less than 6'-0" wide a 6'-8" high with a raised 3/8" all weather removable/replacable bottom sill. The door opening shall be raised above the bottom of the wall sill to facilitate a weathertight closure. The door shall have a resilient, closed cell foam seal per ASTM-D 1056 and SCE 41-42 to provide a tight closure on all four edges. Seal material shall be resistant to attack by hydrofluorosilicic acid and be approved by the Engineer. Provide bottom door sweeps for each door.
   3. Door hardware shall include a stainless steel lever operated keyed entrance

lockset with epoxy coated interior door handle on the primary door with top bolt and foot bolt on the secondary door, heavy duty stainless steel hinges, and a spring loaded door holder to help prevent door from closing during windy conditions. Hinges shall be of the long strap design have ½" diameter stainless steel hinge pins with nylon liners. Hinges shall be bolted to the door and shelter; rivets or other fasteners that do not permit door adjustment shall not be used.

4. There shall be a rain visor installed over the door. Mounting channel strut shall be laminated to the inside rear wall for supporting instruments or equipment.

I. The building shall be capable of withstanding a 125 mph (200 km per hr.) wind load and a 40 psf (195 kg per sq. meter) snow and ice load. The exterior of the building shall be finished with a smooth gelcoat surface of minimum 19 mil thickness. Color to be selected by the owner.

J. The building shall be equipped with a corrosion resistant 3,000 watt, 208 volt Underwriters Listed heater with an integral thermostat/on-off switch.

K. The building shall be equipped with a thermostatically controlled intake FRP fan having a free air capacity of 900 cfm. Fan shall be mounted high on one side or the back and shall exhaust air from the shelter. Fan shall be provided with OSHA approved guards. A gravity FRP exhaust louver with bug screen shall be supplied and shall be sized for the specified fan capacity. Fan motor shall be mounted outside the building and have a weather shield over the motor.

L. Stainless steel lifting eyes shall be securely mounted at the four corners of the roof in such a manner to allow the enclosure to be raised by over-head crane.

M. An electrical package for Hydrofluorosilicic Acid building shall be included and consist of the following:
   1. Circuit Breaker Panel: 208/120V, 60A panel shall conform to requirements of Section 16441 shall be all FRP construction (4X enclosure).
      a. In addition to the loads listed below, the panel shall also provide power to the Hydrofluorosilicic Acid Chemical Feed System Control Panel, the Chemical Transfer Pump control panel, and the chemical day tank electronic scale:
         1) Chemical Feed System Control Panel (Pump Skid) Power
            i) 120VAC, 1 phase, 60 Hz power;
            ii) Main circuit breaker, rated to 20A for duplex skid
            iii) Circuit breaker for each of two metering pumps, rated to 20A
         2) Chemical Transfer Pump
            i) Pump motor: 3/4HP, 3-phase, 208V, 60Hz, IP55, 3600 rpm, TEFC
            ii) Circuit breaker for one chemical transfer pump, rated to 40A.
         3) Electronic Scale.
            i) Scale control panel and scale: 120 VAC
            ii) Circuit breaker for electronic scale, rated to 20A.
   2. Interior Lighting: One enclosed and gasketed, 4 ft., LED fixture with impact resistant, UV resistant, reinforced polyester fiberglass housing and PVC latches.
   3. Exterior Lighting: One vapor proof compact LED fixture with photoelectric control; Lithonia # W4GLED 10C1000 40K T3S MVOLT SPD PE GYSDP, or equal.
   4. Alarm Light: Weatherproof flashing red light, 120 VAC.

5. Wiring Devices: Two light switches, four duplex receptacles and one manual fan starter switch. Devices shall be weatherproof (PVC construction) and be chemical resistant to hydrofluorosilicic acid.
6. Exhaust fan and electrical unit as herein specified.
7. Wiring method shall be building wire in PVC conduit. Wire, Conduit, and boxes shall conform to requirements of Sections 16120, 16130, and 16136. Wire and conduit sizes are included in the panel schedule on the electrical drawings.
8. Provide 120V, 20A circuit breaker for heat trace wire connection.
9. Panel shall be a UL listed panel.

N. FRP strut shall be laminated to the interior wall for supporting instruments and chemical lines.

PART 3 EXECUTION

3.01 INSTALLATION

A. The building shall be installed on the concrete foundation as indicated and/or recommended by the manufacturer. The building shall not be installed on the concrete foundation until the foundation has been coated with a special coating by the Contractor. After the building is secured to the coated base, a bead of caulk shall be applied along the entire inner FRP flange. Caulk shall be polysulfide flexible caulking, Thiokol 2235 M or equal.

B. Building supplier shall coordinate configurations and locations of utility connections with contractors prior to assembly. Utility connections shall be clearly detailed on shop drawing submittals.

3.02 FINISH

A. Building color shall be as selected by the Owner.

END OF SECTION

SECTION 14301

HOIST

PART 1 GENERAL

1.01 SCOPE

A. Provide the hoisting equipment complete as specified herein and indicated on the Drawings.

1.02 DESCRIPTION

A. Single girder top running dual motor driven bridge crane with rotating axle end trucks for smooth operation on ASCE rail. System to include adjustable frequency drive for smooth acceleration and deceleration of load in bridge transverse motion up to a maximum speed of 80 fpm, rubber bumpers, hardened wheels, rail sweeps, NEMA 12 enclosure with through door fused disconnect switch, magnetic mainline contactor, C-track flat cable festoon and 8-button pendant station from hoist.

B. Electric chain hoist rated 2-ton capacity with 30'-0" available lift at a speed of 10-12 fpm, motorized driven trolley at a speed of 30-35 fpm. Hoist will have an upper limit switch, machined grooved steel drum, disc magnet motor brake, AC squirrel cage induction motor with thermistors for overheat protection and H4 duty rated. Motors shall be rated 480V, 3 phase, 60 Hz.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. Clearly indicate equipment to be furnished for the Project including options to be provided.
      a. Individual components of the system.
   2. Shop Drawings: Submit Project specific shop drawings for the following:
      a. Equipment dimensions and weight.
      b. Mounting details indicating position of equipment.
   3. Manufacturer's Installation Procedures.

PART 2 PRODUCTS

2.01 ELECTRIC HOIST

A. Chain hoist rated 2-ton capacity with 30'-0" available lift at a speed of 10-12 fpm, motorized driven trolley at a speed of 30-35 fpm with latch type safety hook

B. The hoist shall be equipped with a five pocket load sheave that increases chain and sheave engagement, provides smoother lifting, and reduces wear. The lower hook block shall be of the swivel type. All hooks shall have a spring operated latch kit which is notched, in order to allow positive engagement with the hook tip. The hook tip shall have a factory predrilled hole which allows the latch to be secured in the closed position when required.

C. Hoist shall be provided with two (2) lift chains and an appropriately size chain container.

D. All hoist gearing shall be helical and spur type, precision machined of ally steel and operating in an oil bath for longer, quieter performance. The first stage minimum must be helical gearing.

E. All bearings shall be heavy duty, anti-friction type. All gears shall operate in an oil bath in sealed housings providing positive splash lubrication for gears and bearings.

F. The hoist motor brake shall be of the heavy duty, three post type, magnetically operated, multiple disc, direct acting, AC type. Brake shall be spring activated and equally effective in both directions of motor rotation. It shall be of sufficient size to stop and hold the rated capacity of the hoist. The brake shall automatically set when current is not flowing to the motor.

G. A mechanical load brake shall be provided in addition to the hoist motor brake. The mechanical load brake shall be of the Weston type and multiple disc, to control load lowering and prevent drift.

H. The hoist shall be equipped with a factory calibrated, non-adjustable, friction type, overload clutch that protects the hoist, overhead support structure and hoist operator from damaging overloads.

I. Adjustable upper and lower limit switches shall be included as standard equipment with the hoist. The limit switch traveling nuts shall be of brass and the shaft shall be of stainless steel to prevent corrosion and to insure long life.

J. For added safety, an upper paddle type limit switch shall be included as standard equipment in addition to the adjustable upper and lower limit switches on all cross mounted models.

K. Motors shall be NEMA Standard design for hoist duty service. High torque, H3/H4 duty class with class B insulation, rated on the basis of 40 deg. C ambient temperature.

L. Motors shall be rated 480V, 3 ph, 60 Hz, provided with starter.

M. Push button controls for all electrified portions of the hoisting system shall be contained in one common push button control pendant. The push button pendant shall be manufactured of double insulated thermoplastic material or equal rated NEMA 4X.

N. Hoist shall be totally weatherproof and suitable for the intended service.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install hoist as indicated on the drawings and in accordance with manufacturer's recommendations.

3.02 PAINTING

A. The unit shall be painted in accordance with Section 09000, PAINTING, of these specifications.

3.03 FIELD QUALITY CONTROL

A. Acceptance Test
   1. Conduct testing for final acceptance after the erection has advanced to the point that inspection and testing can proceed without interruption.

2. Allow inspection of all parts of the crane containing electrical parts or moving mechanical parts by the Engineer.
3. Test the crane for capacity, speed and deflections in the presence of the Engineer and Owner with 125 percent of the hoist capacity load on the hook. Test weights shall be supplied by the crane supplier.
4. Submit to the Owner a certificate of load test and compliance with OSHA requirements.

END OF SECTION

SECTION 15005

GENERAL PROVISIONS RELATED TO PLUMBING WORK

PART 1 GENERAL

1.01 SCOPE

A. The plumbing work will include the furnishing of all plant, labor, materials, accessories, and equipment required to install a complete and fully operational plumbing system as shown, specified and/or reasonably implied for a complete project.

B. The project includes all plumbing work indicated, specified and reasonably implied for the construction of the building, such as:

1. Provision of complete new interior domestic water system to within 5 ft. outside the building or as otherwise shown on drawings.

2. Provision of complete new soil, waste and vent system to within 5 ft. outside the building or as otherwise shown on drawings.

3. Provision of plumbing fixtures and equipment.

4. Site utilities are provided under the General Contract.

C. Refer to Division 1, Division 2, and General Conditions for Project Requirements.

1.02 DETAIL SPECIFICATION SECTIONS

A. The following specification sections cover the various work items, materials and equipment as may be applicable to the Plumbing Contract.

1. Section Title
   a. 15100 Electrical Requirements for Plumbing Equipment
   b. 15135 Gages and Meters
   c. 15140 Plumbing Supports and Anchors
   d. 15190 Plumbing Identification
   e. 15260 Plumbing Pipe Insulation
   f. 15410 Plumbing Pipe
   g. 15430 Plumbing Specialties
   h. 15440 Plumbing Fixtures
   i. 15450 Plumbing Equipment
   j. 15460 Tests and Cleaning

1.03 COORDINATION OF WORK

A. The General Contractor shall be responsible for coordination between various Subcontractors. Whenever interference might occur between the Plumbing Work and the work of other trades, the Plumbing Contractor shall consult with the General Contractor before installing any of the work in question. When it appears that a departure from the Plans is necessary due to actual field conditions or other causes, detailed drawings shall be prepared for submittal to the Architect for approval. The Architect shall make final decision as to any conditions which require changing the work.

1.04 FEES, PERMITS AND INSPECTIONS

A. Plumbing Contractor shall obtain permits and arrange all inspections necessary for the installation of his work, paying all fees in connection therewith, and furnishing the Architect with certificates of inspection from all authorities having jurisdiction.

B. Inspections and tests shall be made upon formal notice to the Architect and the Owner from the Contractor sufficiently in advance to allow a representative of the Architect and the Owner to be present for each test.

C. No piping or other construction shall be covered up or concealed until it has been inspected or approved. The Contractor shall furnish all material, labor, fuel, equipment and apparatus, and bear all expenses of such tests as are hereinafter specified for the work.

1.05 CODES AND STANDARDS

A. The applicable provisions of the following codes and standards, each of the latest issues, and all addenda thereto shall form a part of these specifications.

1. North Carolina Building Codes (which includes the National Electrical Code).
2. North Carolina Boiler Inspection Law, Rules, and Regulations, latest issue.
3. National Fire Protection Association Standards No's. 13 & 54.
4. Underwriters' Laboratories, ASTM, ASME, NEMA, ANSI, and other Standards as specifically referred to in these specifications.
5. County of Martin and local utility standards.

1.06 TEMPORARY UTILITY SERVICES

A. Temporary utilities shall be provided in accordance with General Conditions.

1.07 POST INSPECTIONS

A. Two post construction inspections shall be held by the Architect/Engineer with the Contractors and Owner to assure that the building is continuing to operate in accordance with the plans and specifications and that no unusual problems are occurring in the building systems. The first post construction inspection will be held approximately six months after substantial completion. This inspection will address Plumbing, HVAC and Electrical work. The second post construction inspection shall be held prior to expiration of the 1 year warranty period.

B. It shall address General Construction as well as Plumbing, HVAC and Electrical work. All problems discovered during these inspections that relate to defective materials or defective workmanship shall be corrected by the responsible Contractor at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. Equipment and materials entering into the permanent work shall be new and shall bear the manufacturer's name or trade name. All water consuming devices shall be the water saving type. In every case where a standard has been established by the Underwriters' Laboratories for a particular material, such material shall bear UL label. Equipment and material of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.

1. Piping, fittings and valves in connection with semi-permanent plumbing fixtures and temporary water outlets shall be as specified for similar items in the permanent work under Section titled "Plumbing Pipe" when fixtures are set in the permanent structure. Should the Contractor elect to construct a temporary structure to contain toilets for the use of workmen, the piping, valves and fittings may be of materials of the Contractor's selection provided they are completely removed from the project when no longer in use.

2. Plumbing fixtures for use in semi-permanent toilets may be approved second-hand items which will meet the requirements of the North Carolina State Plumbing Code. Such fixtures shall be completely removed from the project when no longer in use.

2.02 DIMENSIONS

A. The Plumbing Contractor shall be responsible for insuring that items of equipment furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those of connections, and shall furnish and install such sizes and shapes of equipment that the final installation shall suit the true intent and meaning of the drawings and specifications.

2.03 MANUFACTURER'S DIRECTIONS

A. Manufacturer's directions shall be followed completely in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the Contract Documents and the manufacturer's directions, and shall obtain the Architect's written instructions before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or such written instructions from the Architect, he shall bear all costs arising in correcting the deficiencies.

2.04 EQUIPMENT ACCESSORIES

A. The Plumbing Contractor shall provide all equipment, accessories, connections and incidental items necessary to fully complete the work, ready for use, occupancy and operation by the Owner.

2.05 SUBCONTRACTORS AND MATERIALS LIST

A. The Plumbing Contractor shall, within the requirements of the General Conditions, submit to the Architect, in triplicate, a complete list of Sub-Contractors and materials he proposes to use in the work. Materials list shall include manufacturer's name of specific items of material proposed.

2.06 SHOP DRAWINGS AND CATALOG DATA

A. The Plumbing Contractor shall submit shop drawings and catalog cuts of all pieces of equipment to the Architect for approval. The Plumbing Contractor shall submit the number of copies as required by the General Conditions. Approval of the Architect of shop drawings for any materials, apparatus, devices, and layouts shall not relieve this Contractor from the responsibility of furnishing same of proper dimensions, size, quantity, quality, and all performance characteristics to efficiently

perform the requirements and intent of the Contract Documents. Such approval shall not relieve this Contractor from responsibility for errors of any sort on the shop drawings. If the shop drawings deviate from the Contract Documents, this Contractor shall advise the Architect of the deviations in writing accompanying the shop drawings, including the reason for deviations.

B. Any items found on the job either installed or not installed which do not meet the above criteria shall be replaced by the Contractor at the discretion of the Engineer and the Owner. Review and stamp all shop drawings submittals before submitting them to the Engineer for approval. Any submittals not stamped and signed by the Contractor prior to submittal to the Engineer will be returned to the Contractor for his stamp and resubmittal. A copy of the approved shop drawings shall be maintained on the project site at all times.

2.07 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions in accordance with Division 1 of this specification.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that the Contractor:

1. Has investigated proposed product and determined that it meets or exceeds that quality level of the specified product.

2. Will provide the same warranty for the Substitution as for the specified product.

3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.

4. Waives claims for additional costs or time extension which may subsequently become apparent.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitutions Submittal Procedure:

1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.

2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.

3. The Engineer will notify Contractor, in writing, of decision to accept or reject the request.

PART 3 EXECUTION

3.01 SUPERVISION

A. The Contractor shall have a thoroughly competent superintendent in charge of the construction work at all times. The superintendent shall have extensive experience in the work to be performed.

3.02 MATERIALS AND WORKMANSHIP

A. All materials and workmanship shall comply with all applicable codes, specifications, state and local ordinances, industry standards and utility company regulations.

3.03 LOCATION OF PIPES, FIXTURES, EQUIPMENT AND APPURTENANCES

A. Location of pipes, fixtures, equipment and appurtenances shall be adjusted to accommodate the work to interferences anticipated and encountered.

B. Install all equipment to provide minimum clearances per manufacturer's instructions around each piece of equipment.

C. The Contractor shall furnish and install as shown on the drawings, or as necessary to complete the working systems in accordance with the intent of the drawings and specifications, complete systems of piping, all valves as indicated or as necessary to completely control the entire apparatus and all appurtenances. The piping drawings are diagrammatic and indicate the general location and connections. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from providing the necessary valves, fittings, and accessories to meet the conditions and the responsibility for the proper erection of systems of piping in every respect suitable for the work as described in the specification and approved by the Architect.

3.04 BUILDING AND FINISHES

A. Building and finishes shall be protected. The Contractor will be held responsible for damage incurred, and shall repair all damage done.

3.05 INSTALLATION OF SEMI-PERMANENT TOILET FACILITIES

A. Piping, valves, fittings and appurtenances shall be in accordance with Sections titled "Plumbing Pipe".

B. Plumbing fixtures shall be installed in accordance with Section titled "Plumbing Fixtures".

3.06 SUPPORTS

A. The Contractor shall support plumb, rigid and true to line all work and equipment installed under this Contract. The Contractor shall thoroughly study all general, structural, heating, cooling and ventilating, and electrical drawings, shop drawings and catalog data to determine how equipment, accessories, piping, fixtures, and related items are to be supported, mounted, or suspended. He shall provide all

bolts, inserts, pipe stands, brackets, structural supports and accessories for proper support whether or not shown on the drawings.

3.07 RECORD DRAWINGS

A. Record Drawings shall be provided in accordance with Division 1.

B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings. Mark the set in red to show the actual installation where the installation varies substantially from the work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the work.

2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

3. Note related Change Order numbers where applicable.

4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

5. Upon completion of mark-up, submit complete set of record documents to Designer for the Owner's records.

3.08 TEST REPORTS

A. The Contractor shall provide, in addition to notice to the authorities having jurisdiction, a minimum of 24 hours notice, prior to such testing, to the Engineer and Owner. All systems are required to be tested and shall be documented as follows:

1. Documented in writing listing date, item tested, section tested, witnesses to the test (signed) and specification section which requires testing.

2. Reports to testing shall be provided to the Architect within seven (7) days of completion of each test.

3. All backflow preventers shall be tested, with copies of test reports to be included in O & M manuals.

3.09 PAINTING

A. All field painting of plumbing work, with exception of touch-up paint on factory finished equipment, shall be in accordance with the "Painting" section of these specifications. Any equipment which has its factory paint coat scratched or otherwise damaged shall be retouched with paint to match the finish coat, and shall be repainted if necessary.

3.10 FIRESTOPPING

A. Firestopping shall be installed by Plumbing Contractor under provisions of Section 07270 and as detailed on drawings.

B. The Plumbing Contractor shall be responsible for firestopping all partitions, walls and floor penetration resulting from his work. Penetrations shall be firestopped to meet or exceed rating of wall or floor systems as required by code.

3.11 FREEZE PROTECTION

A. Provide capability to drain systems, or provide electric heat, as freeze protection on all water lines subject to freezing conditions.

3.12 DEMONSTRATION OF PROPER INSTALLATION BY PLUMBING CONTRACTOR

A. Upon substantial completion and before Owner acceptance, rod and clean out each sanitary and storm system.

B. The Plumbing Contractor shall demonstrate at final inspection that all floor drains work and adequately drain the area they serve.

END OF SECTION

SECTION 15072

VIBRATION ISOLATION

PART 1 GENERAL

1.01 SCOPE

A. Inertia bases

B. Vibration Isolation

1.02 REFERENCES

A. Section 03100 - Cast-in-Place Concrete

B. Section 15500 – Basic HVAC Requirements

C. Section 15072 - Supports and Anchors

1.03 PERFORMANCE REQUIREMENTS

A. Provide vibration isolation on motor driven equipment over 0.5 HP, and isolation for connected piping and ductwork.

B. Provide minimum static deflection of isolators for equipment as indicated.

1. Under 20 HP

a. 400 - 600 rpm: 1 inch

b. 600 - 800 rpm: 0.5 inch

c. 800 - 900 rpm: 0.2 inch

d. 1100 - 1500 rpm: 0.14 inch

e. Over 1500 rpm: 0.1 inch

2. Over 20 HP

a. 400 - 600 rpm: 2 inch

b. 600 - 800 rpm: 1 inch

c. 800 - 900 rpm: 0.5 inch

d. 1100 - 1500 rpm: 0.2 inch

e. Over 1500 rpm: 0.15 inch

3. Normal

a. 400 - 600 rpm: 3.5 inch

b. 600 - 800 rpm: 2 inch

c. 800 - 900 rpm: 1 inch

d. 1100 - 1500 rpm: 0.5 inch

e. Over 1500 rpm: 0.2 inch

4. Critical

a. 600 - 800 rpm: 3.5 inch

b. 800 - 900 rpm: 2 inch

c. 1100 - 1500 rpm: 1 inch

d. Over 1500 rpm: 0.5 inch

C. Use concrete inertia bases for fans having static pressure in excess of 3.5 inch WC or motors in excess of 40 HP, and on base mounted pumps over 10 HP.

1.04 SUBMITTALS

A. Submit under provisions of Division 1 and Section 15500

B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

C. Product Data: Provide schedule of vibration isolator type with location and load on each.

D. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

E. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 and Section 15500

B. Record actual locations of hangers including attachment points

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mason Industries, Inc.

B. Kinetics Industries, Inc.

C. Vibration Mountings & Controls, Inc.

D. Substitutions: Under provisions of Section 15500

2.02 VIBRATION ISOLATORS

A. Open Spring Isolators:

1. Spring Isolators:

a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

3. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromed plated hardware.

4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

B. Restrained Spring Isolators:

1. Spring Isolators:

a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

3. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromed plated hardware.

Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

4. Restraint: Provide heavy mounting frame and limit stops.

C. Closed Spring Isolators:

1. Spring Isolators:

a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

b. Code: Color code springs for load carrying capacity.

2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

D. Restrained Closed Spring Isolators:

1. Spring Isolators:

a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

b. Code: Color code springs for load carrying capacity.

2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.

E. Spring Hanger:

1. Spring Isolators:

a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators or rubber hanger with threaded insert.

4. Misalignment: Capable of 20 degree hanger rod misalignment.

F. Neoprene Pad Isolators:

1. Rubber or neoprene waffle pads

a. 30 durometer.

b. Minimum 1/2 inch thick.

c. Maximum loading 40 psi.

d. Height of ribs shall not exceed 0.7 times width.

2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

G. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instruction.

B. Install isolation as indicated on the plans and for motor driven equipment without factory-installed vibration isolation.

C. Inertia Bases:

1. Provide inertia bases under all base mounted pumps.

2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

3. Adjust equipment level.

D. Install spring hangers without binding.

E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

G. Provide pairs of horizontal limit springs on fans with more than 6.0 inches static pressure, and on hanger supported, horizontal mounted axial fans.

H. Support piping connections with spring hangers as follows:

1. Up to 4 Inch Diameter: First three points of support from isolated equipment.

2. 5 to 8 Inch Diameter: First four points of support from isolated equipment.

3. 10 Inch Diameter and Over: First six points of support from isolated equipment.

4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

I. Connect flexible conduit and electrical wiring to isolated equipment with flexible hanging loop.

J. All vibration isolators shall be selected to have a minimum static deflection as scheduled below and a reserve load capacity of at least 50% of the design load. All spring isolators shall have a loaded height/diameter ratio of 0.8 or less. All frame and base members shall have a height that is at least 1/10th of the spacing between adjacent isolators. All spring hangers shall function properly with a hanger rod misalignment of up to 15 degrees in any direction.

3.02 MANUFACTURER'S FIELD SERVICES

A. Inspect isolated equipment after installation and submit report indicating compliance with specifications and manufacturer's recommendations. Include static deflections.

END OF SECTION 15072

SECTION 15085

PIPING INSULATION

PART 1 GENERAL

1.01 SCOPE

A. Piping insulation

B. Jackets and accessories

1.02 RELATED SECTIONS

A. Section 15185 – Refrigerant Piping and Specialties

B. Section 15503 – Supports and Anchors

1.03 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate

B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

D. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

E. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

F. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

G. ASTM C547 - Mineral Fiber Preformed Pipe Insulation

H. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation

I. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation

J. ASTM E84 - Surface Burning Characteristics of Building Materials

K. ASTM E96 - Water Vapor Transmission of Materials

L. NFPA 255 - Surface Burning Characteristics of Building Materials

M. UL 723 - Surface Burning Characteristics of Building Materials

1.04 SUBMITTALS

A. Submit under provisions of Division 1 and Section 23 05 00

B. Product Data: Provide product description, list of materials and thickness for each service, and locations

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved

1.05 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, and UL 723

1.06 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum five years' experience

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Division 1 and Section 23 05 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 ENVIRONMENTAL REQUIREMENTS.

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 POLYISOCYNAURATE THERMAL INSULATION MANUFACTURERS:

A. CertainTeed Corporation

B. Knauf Fiber Glass GmbH

C. Owens-Corning Fiberglas

D. Schuller/Manville

E. Substitutions: Under provisions of Section 15500

2.02 INSULATION: ASTM C547; RIGID MOLDED, NONCOMBUSTIBLE.

A. 'K' value: ASTM C335, 0.18 at 75 degrees F.

B. Maximum service temperature: 300 degrees F.

C. Maximum moisture absorption: 2 percent by volume.

D. Water vapor permeance: 3 perm-in or less.

E. Density: 2.0 lb/cu ft density.

2.03 VAPOR BARRIER JACKET

A. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.

B. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.

C. Secure with self sealing longitudinal laps and butt strips.

D. Secure with outward clinch expanding staples and vapor barrier mastic.

2.04 VAPOR BARRIER LAP ADHESIVE

A. Manufacturers:

1. Halstead Industries

2. H. B. Fuller Company

3. 3M

4. Substitutions: Under provisions of Section 15500

B. Compatible with insulation

2.05 FIBROUS GLASS FABRIC

A. Manufacturers:

1. CertainTeed Corp

2. Knauf Fiber Glass GmbH

3. Owens-Corning Fiberglas

4. Schuller/Manville

5. Substitutions: Under provisions of Section 15500

B. Cloth: Untreated; 9 oz. /sq .yd. weight.

C. Blanket: 1.0 lb. /cu. ft. density.

2.06 INDOOR VAPOR BARRIER FINISH

A. Manufacturers:

1. Manville

2. PABCO

3. Fibrex, Inc.

4. Substitutions: Under provisions of Section 15500

B. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.07 OUTDOOR VAPOR BARRIER MASTIC

A. Manufacturers:

1. Manville

2. PABCO

3. Fibrex, Inc.

4. Substitutions: Under provisions of Section 15500

B. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.08 INSULATING CEMENT

A. Manufacturers:

1. Manville

2. PABCO

3. Fibrex, Inc.

4. Substitutions: Under provisions of Section 15500

B. ASTM C449.

2.09 CELLULAR FOAM

A. Manufacturers:

1. K-FLEX USA.

2. Rubatex Corp.

3. Foam Enterprises

4. Substitutions: Under provisions of Section 15500

B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'K' Value: ASTM C177 or C518; 0.27, 0.28 at 75 degrees F.

2. Minimum Service Temperature: -40 degrees F.

3. Maximum Service Temperature: 220 degrees F.

4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.

5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.

6. Maximum Flame Spread: ASTM E84; 25.

7. Maximum Smoke Developed: ASTM E84; 50.

8. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive

1. Air dried, contact adhesive, compatible with insulation.

2.10 JACKETS

A. PVC Plastic

1. Manufacturers:

a. CertainTeed Corporation

b. Knauf Fiberglass GmbH

c. Owens-Corning Fiberglas

d. Schuller/Manville

e. Substitutions: Under provisions of Section 15500

2. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, off white color.

   a. Minimum Service Temperature: -40 degrees F

   b. Maximum Service Temperature: 150 degrees F

   c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches

   d. Maximum Flame Spread: ASTM E84; 25

   e. Maximum Smoke Developed: ASTM E84; 50

   f. Thickness: 30 mil

   g. Connections: Brush on welding adhesive; pressure sensitive color matching vinyl tape.

   h. Shall be field applied jackets as specified above.

3. Covering Adhesive Mastic

   a. Compatible with insulation

B. Canvas Jacket: UL listed

1. Fabric: ASTM C921, 6 oz. /sq. yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

2. Lagging Adhesive

   a. Compatible with insulation

C. Aluminum Jacket: ASTM B209.

1. Thickness: 0.016 inch sheet.

2. Finish: Smooth.

3. Joining: Longitudinal slip joints and 2 inch laps.

4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.

5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Provide glass fiber insulation on hydronic piping systems in accordance with glass fiber insulation schedule attached at the end of this Section. Cellular foam may be substituted on metal pipe used for condensate drains.

C. On exposed piping, locate insulation and cover seams in least visible locations.

D. For insulated pipes or cold pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.

3. Finish with glass cloth and vapor barrier adhesive for field applied jackets.

4. Provide PVC fitting covers on all elbows and tees.

5. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

6. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies and expansion joints.

E. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

3. Finish with glass cloth and adhesive for field applied jackets.

4. Provide PVC fitting covers on all elbows and tees.

5. For hot piping conveying fluids 140 degrees F. or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

6. For hot piping conveying fluids over 140 degrees F., insulate flanges and unions at equipment.

F. Inserts and Shields:

1. Application: Piping 1/2 inch diameter or larger.

2. Shields: 18 gauge minimum galvanized steel between pipe hangers or pipe hanger rolls and inserts.

3. Insert Location: Between support shield and piping and under the finish jacket.

4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

G. Finish insulation at supports, protrusions, and interruptions.

H. For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

I. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

J. Provide canvas jacketing on all piping exposed on mezzanines, in Mechanical Equipment Rooms and in occupied finished spaces.

3.03 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.04 POLYISOCYNAURATE THERMAL INSULATION SCHEDULE

PIPING SYSTEMS	PIPE SIZE (Inch)	THICKNESS (Inch)
COOLING SYSTEMS		
Condensate Drains	1″-4″	1″
Condensate Drains from		

Cooling Coils		

3.05 CELLULAR FOAM INSULATION

PIPING SYSTEMS	PIPE SIZE (Inch)	THICKNESS (Inch)
VARIABLE VOLUME REFRIGERATION SYSTEM		
Hot Gas, Liquid Line and Suction	Up to and including 1-1/4"	1-1/2"

END OF SECTION 15085

SECTION 15100

ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 16.

1.02 SUMMARY

A. This section specifies the basic requirements for electrical components which may or may not be an integral part of the Plumbing equipment. These components include, but are not limited to motors, motor starters, and disconnect switches.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for Plumbing equipment are specified within the individual equipment specification sections, and/or are scheduled on the drawings.

C. All electrical work shall be done by licensed electricians in accordance with the N.C. State Building Code which includes the National Electrical Code, latest edition and the Electrical Division of this specification. Furnish a certificate to the appropriate Electrical Inspector.

D. Work Included:

1. The Plumbing Contractor shall furnish and install all motor starters, disconnect switches, and combination starters for equipment furnished under their contract. All power wiring on the line side shall be provided by the Electrical Contractor up to a termination point consisting of a junction box, trough, starter or disconnect switch. The Electrical Contractor is responsible for the line side termination. Refer to plumbing detail sheets, of the Contract Drawings for division responsibility regarding electrical requirements.

2. Provide all 120 v and 24 v control wiring, in conduit, required to satisfactorily control all equipment included in this section. Furnish and wire all control devices such as transformers, thermostats, switches, relays and any other devices necessary to control the equipment furnished in this section.

1.03 REFERENCES

A. NEMA Standards MG 1.

B. NEMA Standards ICS 2.

C. NEMA Standard 250.

D. NEMA Standard KS 1.

E. National Electrical Code (NFPA 70).

F. N.C. State Building Code.

1.04 SUBMITTALS

A. Provide a separate electrical submittal for all field mounted starters and disconnects not included as integral pieces of Plumbing equipment. Submittal shall conform to requirements of Division 1 and Sections 16441 and 16481.

B. For Plumbing equipment with integral starters and/or disconnects no separate electrical submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

C. Before any electrical work is performed submit wiring diagrams and methods of powering and controlling all electrically connected or operating equipment to the Architect for approval. Controls subcontractor shall check and approve all diagrams before submittal to the Engineer. The diagrams shall show points of connection of equipment to system provided by the Electrical Contractor and shall show conduit and wire sizes.

1.05 QUALITY ASSURANCE

A. All electrical equipment and materials shall be UL labeled.

PART 2 PRODUCTS

2.01 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements shall be specified by the Engineer in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

3. Temperature Rating: Rated for 40 deg. C. environment with maximum 50 deg. C. temperature rise for continuous duty at full load (Class A Insulation).

4. Starting capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.

5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.

6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
   a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
   b. Bearings:
      1) ball or roller bearings with inner and outer shaft seals;
      2) re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance;
      3) designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor;
      4) for fractional horsepower (1/20 hp and below), light duty motors, sleeve type bearings are permitted.
   c. Enclosure Type:
      1) open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation;
      2) guarded drip-proof motors where exposed to contact by employees or building occupants;
      3) weather protected Type I for outdoor use, Type II where not housed;
   d. Overload protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
   e. Noise rating: "Quiet" rating on motors located in occupied spaces of building.
   f. Efficiency: All motors shall be "Energy Efficient". Motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, test method B.
   g. Nameplate: indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

7. All motors shall be of the quiet operating type, guaranteed to fulfill the specified requirements without producing objectionable sound in occupied areas of the building. All belt connected motors shall have adjustable bases and set screws to maintain proper belt tension. All fan motors shall have adjustable sheaves for speed adjustment, and one belt more than computed.

8. No shaded pole motors will be acceptable on any equipment above 1/20 horsepower.

2.02 DISCONNECT SWITCHES

A. Shall conform to all requirements specified in Section 16441 - "Enclosed Switches".

B. Disconnect switches shall be fused.

C. Nema 4X disconnect switches shall be provided in wet areas, refer to drawings.

2.03 MOTOR STARTERS AND COMBINATION STARTERS

A. Shall conform to all requirements specified in Section 16481 - "Enclosed Motor Controllers".

PART 3 EXECUTION

3.01 CONDUCTOR SIZES SHALL BE AS SPECIFIED IN THE NATIONAL ELECTRICAL CODE.

3.02 Control circuits shall be 120 volts or 24 volts. Electrical Contractor shall provide in-line toggle switch, labeled and identified, at each control panel and starter to disconnect control power. All control power shall be provided from the load side of toggle switches, such that the switches will turn off power to their respective control panel and associated control power.

3.03 Ground all equipment per requirements of the National Electrical Code.

3.04 Equipment overcurrent protection and conductors in the electrical contract shall be sized to accommodate most major brands of Plumbing equipment. If the Plumbing Contractor chooses to use an item of equipment that exceeds the capacity of the electrical overcurrent protection and conductors, or requires multiple circuits, the Plumbing Contractor shall be responsible for any additional cost required to increase the size of the overcurrent protection and conductors or provide the additional circuits and disconnects at no additional cost to the Owner or Electrical Contractor. He shall also coordinate this work with the Electrical Contractor to assure proper electrical service to the equipment.

END OF SECTION

SECTION 15135

GAUGES AND METERS

PART 1 GENERAL

1.01 SCOPE

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

1.02 RELATED SECTIONS

A. Section 15410 - Plumbing Pipe.

1.03 REFERENCES

A. ASME - B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.

B. ASTM E1 - Specification for ASTM Thermometers.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Manufacturers:

1. Palmer Instruments.

2. Weiss Instruments Model UG-2.

3. Ametek, U.S. Gauge Div.

B. Gauge: ASME B40.1, drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Steel with brass bourdon tube.

2. Size: 3-1/2 inch diameter.

3. Mid-Scale Accuracy: One percent.

4. Scale: Psi 0-100.

2.02 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psig.

B. Needle Valve: Stainless Steel, 1/4 inch NPT for minimum 150 psig.

C. Siphon: Bronze, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

A. Manufacturer:

1. Palmer Instruments.

2. Weiss Instruments Model 3 VBM.

3. Substitutions: Permitted with prior approval.

B. Thermometer: ASTM E1, adjustable angle, round dial-type, with type 304 stainless steel case and positive locking device.

1. Size: 9 inch

2. Window: Clear glass.

3. Stem: ½ inch NPT brass; length as required per pipe diameter.

4. Scale: 0° F. – 200° F.

5. Calibration: Degrees F.

6. Accuracy: 1 percent.

2.04 THERMOMETER SUPPORTS

A. Socket: Brass separate sockets for thermometer stems with or without extensions as required, and with cap and chain.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide instruments with scale ranges selected according to service with largest appropriate scale.

C. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

D. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

END OF SECTION

SECTION 15140

PLUMBING SUPPORTS AND ANCHORS

PART 1 GENERAL

1.01 SCOPE

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.02 RELATED SECTIONS

A. 03300 Cast-In Place Concrete: Equipment Bases

B. 09900 Painting

C. 15410 Plumbing Piping

D. 15430 Plumbing Specialties

E. 15440 Plumbing Fixtures

F. 15450 Plumbing Equipment

1.03 REFERENCES

A. ASME B31.1

B. ASME B31.2

C. ASME B31.5

D. ASME B31.9

E. ASTM F708

F. MSS SP58

G. MSS SP69

H. MSS SP89

I. UL 203

1.04 SUBMITTALS

A. Submit under provisions of Division 1

B. Product Data: Provide manufacturer's catalog data including load capacity.

C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.05 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of specified piping systems.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

A. Pipe hangers and supports shall be a size to support piping filled with water with a safety factor of 5 based on ultimate tensile strength, without sagging or excessive vibration or movements. Pipe hangers shall be sized to permit insulation to pass through. Use one hanger manufacturer throughout this project. Supports for vertical piping passing through floors shall be heavy steel riser clamps, bolted each side.

B. Manufacturers:

1. Grinnell Corporation
2. Elcen Metal Products
3. Mason Industries, Inc.
4. Vibration Mountings & Controls
5. B-Line Systems, Inc.

C. Piping:

1. Plumbing Piping – DWV.
   a. Conform to ASME B31, 9.
   b. Hangers for pipe sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
2. Hangers for pipe sizes 2 inches and over: Carbon steel, adjustable, clevis.
3. Multiple or trapeze hangers: Steel channels with welded spacers and hanger rods.
4. Wall support for pipe sizes to 3 inches: Cast iron hook.
5. Wall support for pipe sizes 4 inches and over: Welded steel bracket and wrought steel clamp.
6. Vertical support: Steel riser clamp.
7. Floor support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

D. Plumbing Piping - Water:

1. Conform to ASME B31.9.

2. Hangers for pipe sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.

3. Hangers for cold pipe sizes 2 inches and over: Carbon steel, adjustable, clevis.

4. Multiple or trapeze hangers: Steel channels with welded spacers and hanger rods.

5. Wall support for pipe sizes to 3 inches: Cast iron hook.

6. Vertical support: Steel riser clamp.

7. Floor support for cold pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

8. Floor support for hot pipe sizes to 4 inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

9. Copper pipe support: Carbon steel ring, adjustable, copper plated.

2.02 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded, with washers on both sides of hangers. Double nut connection.

B. Roof Top Supports: Non-penetrating roof support of 100% UV resistant recycled rubber, or polycarbonate resin pipe supports.

1. B-Line, C Port

2. Miro pillow block pipe supports

3. MAPA

2.03 INSERTS

A. Manufacturers:

1. Hilti Corp.

2. The Rawlplug Co., Inc.

3. Heckman Building Products, Inc.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING

A. Metal Flashing: 26 gauge galvanized steel

B. Metal Counterflashing: 22 gauge galvanized steel

C. Lead Flashing:

1. Waterproofing: 5 lb/sq ft sheet lead

2. Soundproofing: 1 lb/sq ft sheet lead

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing

E. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements

2.05 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: 18 gauge galvanized steel.

B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe, Schedule 40 or 18 gauge of galvanized steel.

C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed. Refer to details on drawings.

D. Firestopping Insulation: In lieu of prefabricated sleeves Contractor may provide penetration seal materials in accordance with printed instructions of the U.L. Fire Resistance Directory and in accordance with manufacturer's instruction, and as required by local code officials.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. All firestopping of Plumbing penetrations shall be provided by the Plumbing Contractor. Install all firestopping penetration seal materials in accordance with printed instructions of the U.L. Fire Resistance Directory and in accordance with manufacturer's instruction, and as required by local code officials.

3.02 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, core drill through concrete slab and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. Obtain Architect's approval of locations prior to drilling.

3.03 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support vertical piping at every floor.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Support riser piping independently of connected horizontal piping.

H. Provide copper plated hangers and supports for copper piping.

I. Design hangers for pipe movement without disengagement of supported pipe.

J. Prime coat exposed steel hangers and supports. Refer to Section 09900. Hangers and supports located in crawl spaces, pipe shafts and suspended ceiling spaces are not considered exposed.

3.04 FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather- or water-proofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with commercial grade pre-fabricated flashing collars. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal shower and mop sink drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.05 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors one inch above finished floor level. Caulk sleeves.

D. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide penetration seal materials in accordance with printed instructions of the U.L. Fire Resistance Directory and in accordance with manufacturer's instruction, and as required by local code officials. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

E. Prefabricated fire rated sleeves shall be installed in accordance with manufacturer's instruction. Install stainless steel escutcheons at finished surfaces.

F. Install chrome plated steel escutcheons at finished surfaces.

3.06 EQUIPMENT BASES AND SUPPORTS

A. Pads will be provided by Plumbing Contractor. Housekeeping pads shall be concrete, minimum 4 inches thick with ¾" chamfer edges and extending 6 inches beyond supported equipment on all sides. Plumbing Contractor shall provide all anchoring devices, inserts, etc. as required.

B. Contractor shall paint all equipment pads yellow in accordance with OSHA requirements.

3.07 SCHEDULES

Pipe Size	**Max. Hanger Spacing**	**Hanger Rod Diameter**
Inches	Feet	Inches
1/2 to 1-1/4	6	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
C.I. Bell and Spigot for No-Hub and at Joints	5	7/8

END OF SECTION

SECTION 15185

REFRIGERANT PIPING AND SPECIALTIES

PART 1 GENERAL

1.01 SCOPE

A. Piping

B. Refrigerant

C. Moisture and liquid indicators

D. Valves

E. Filter-driers

F. Expansion valves

1.02 RELATED SECTIONS

A. Section 15503 – Supports and Anchors

B. Section 15830 – Variable Refrigerant Volume HVAC System

C. Section 15085 - Piping Insulation

1.03 REFERENCES

A. ARI 495 - Refrigerant Liquid Receivers.

B. ARI 710 - Liquid Line Dryers.

C. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers

D. ARI 750 - Thermostatic Refrigerant Expansion Valves.

E. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

F. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

G. ASHRAE 34 - Number Designation of Refrigerants.

H. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

I. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

J. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.

K. ASME B31.5 - Refrigeration Piping.

L. ASME B31.9 - Building Services Piping.

M. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

N. ASTM F708 - Design and Installation of Rigid Pipe Hangers.

O. AWS A5.8 - Brazing Filler Metal.

P. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.

Q. MSS SP69 - Pipe Hangers and Supports - Selection and Application.

R. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

S. UL 429 - Electrically Operated Valves.

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASTM B31.5, MSS SP69 unless indicated otherwise.

C. Liquid Indicators:

1. Use line size liquid indicators in main liquid line leaving condenser.

2. If receiver is provided, install in liquid line leaving receiver.

3. Use line size on leaving side of liquid solenoid valves.

D. Valves:

1. Use service valves on suction and discharge of compressors.

2. Use gauge taps at compressor inlet and outlet.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Replaceable Cartridge Filter-Driers:

1. Use vertically in liquid line adjacent to receivers.

2. Use filter-driers for each solenoid valve.

G. Solenoid Valves:

1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.

2. Use in liquid line of single or multiple evaporator systems.

1.05 SUBMITTALS

A. Submit under provisions of Division 1

B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

C. Product Data: Provide general assembly of specialties, including manufacturer's catalog information. Provide manufacturers catalog data including load capacity.

D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports: Indicate results of leak test, acid test.

F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

G. Submit welders certification of compliance with ASME SEC 9.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1

B. Record exact locations of equipment and refrigeration accessories on record drawings.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1

B. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.08 QUALIFICATIONS

A. Installer: Company specializing in performing the work of this section with minimum 5 years documented experience.

1.09 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

C. Welders Certification: In accordance with ASME SEC 9.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1 and Section 23 05 00.

B. Deliver and store piping and specialties in shipping containers with labeling in place.

C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.11 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Division 1 and Section 23 05 00.

B. Provide two filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.01 PIPING

A. Copper Tubing: ASTM B280, Type ACR hard drawn.

1. Fittings: ASME B16.22 wrought copper.

2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

B. Copper Tubing to 7/8 inch OD: ASTM B88, Type K, annealed.

1. Fittings: ASME B16.26 cast copper.

2. Joints: Flared.

C. Pipe Supports and Anchors:

1. Conform to ASME B31.5, ASTM F708, MSS SP58, MSS SP69, MSS SP89.

2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron or Carbon steel, adjustable swivel, split ring.

3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

5. Wall Support for Pipe Sizes to 3 Inches Cast iron hook.

6. Vertical Support: Steel riser clamp.

7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

9. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

10. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.02 REFRIGERANT

A. Refrigerant: Refer to equipment schedules

2.03 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure of 500 psig, and maximum temperature of 200 degrees F.

2.04 VALVES

A. Diaphragm Packless Valves:

1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psig and maximum temperature of 275 degrees F.

B. Packed Angle Valves:

1. Forged brass, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psig and maximum temperature of 275 degrees F.

C. Ball Valves:

1. Two piece forged brass body with Teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig and maximum temperature of 300 degrees F.

D. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig.

2.05 FILTER-DRIERS

A. Replaceable Cartridge Angle Type:

1. Shell: ARI 710, UL listed, brass, removable cap, for maximum working pressure of 500 psig.

2. Filter Cartridge: Pleated media with integral end rings, stainless steel support.

3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina.

2.06 SOLENOID VALVES

A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends, for maximum working pressure of 500 psig. Stem shall permit manual operation in case of coil failure.

B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture, and fungus proof, with surge protector and color-coded lead wires, integral junction box with pilot light.

C. Electrical Characteristics: 120 volts, single phase, 60 Hz.

2.07 EXPANSION VALVES

A. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, mechanical pressure limit (maximum operating pressure MOP feature), adjustable non-adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:

1. Install in accordance with ASTM B31.5, ASTM F708, and MSS SP89.

2. Support horizontal piping as scheduled.

3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

4. Place hangers within 12 inches of each horizontal elbow.

5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

7. Provide copper plated hangers and supports for copper piping.

G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access to concealed valves and fittings.

J. Flood piping system with nitrogen when brazing.

K. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

L. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09900.

M. Insulate piping and equipment; refer to Section 15085.

N. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

O. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

P. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

Q. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

R. Fully charge completed system with refrigerant after testing.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psig. Test to no leakage.

3.04 SCHEDULES

A. Pipe Hanger Spacing

PIPE SIZE Inches	MAX. HANGER SPACING Feet	HANGER ROD DIAMETER Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8

END OF SECTION 15185

SECTION 15190

PLUMBING IDENTIFICATION

PART 1 GENERAL

1.01 SCOPE

A. Nameplates

B. Tags

C. Pipe Markers

1.02 RELATED SECTIONS

A. Section 09900 - Painting

1.03 REFERENCES

A. ASME A13.1

1.04 SUBMITTALS

A. Submit under provisions of Division 1

B. Submit list of wording, symbols, letter size, and color coding for plumbing identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturer's catalog literature for each product required.

E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Manufacturers:

1. Seton Name Plate Co.

2. W. H. Brady Co.

3. Preferred Utilities Mfg. Corp.

B. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.02 TAGS

A. Install label on valve or device body. Indicate type of device and associated service on label. (e.g. "Shutoff Valve – DCW")

B. Provide custom printed Indoor / outdoor vinyl or polypropylene markers for each valve. Utilize portable printer equal to Brady HandiMark Portable Industrial Labeling System.

C. Chart: Provide letter size list of valves and locations in anodized aluminum frame with plexi-glass cover.

2.03 PIPE MARKERS

A. Manufacturers:

1. Seton Name Plate Co.

2. W. H. Brady Co.

3. Carlton Industries. Inc.

B. Color: ASME A131 standards. Refer to schedule at end of this section.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mils thick, and solid aluminum foil core between 2 layers of plastic tape, manufactured for direct burial service.

2.04 CEILING MARKERS

A. Install label on ceiling grid in proximity to device above ceiling. Indicate type of device and associated service on label. (e.g. "Shutoff Valve – DCW", "Shock Absorber – DCW")

B. Provide custom printed labels, either of vinyl suitable for indoor / outdoor applications or of polypropylene for each device. Utilize portable printer equal to Brady HandiMark Portable Industrial Labeling System.

C. Maximum height of label is one inch. Maximum width of label is one inch. Black lettering on white tape.

D. Provide pipe markers and flow arrows at 10 foot intervals at all turns and at each floor level or all partitions.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09900 for stencil painting.

3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Apply stencil painting in accordance with Section 09900.

C. Identify valves in main and branch piping with labels.

D. Identify piping, concealed or exposed, with plastic pipe markers. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet apart on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

E. Provide ceiling grid labels to locate valves and shock absorbers above T-bar panel ceilings. Locate on grid in proximity to valve.

3.03 SCHEDULES FOR PIPE LABELS

Piping Fluid	Color	Background Letter and Abbreviation	Arrow Color
Domestic Cold Water	Green	CW	White
Domestic Hot Water	Red	HW	White
Tepid Water	Purple	TW	White

3.04 SCHEDULES FOR PIPE

SYSTEM	COLOR
COLD WATER	DARK BLUE
HOT WATER	DARK RED
FIRE PROTECTION	BRIGHT RED

END OF SECTION

SECTION 15410

PLUMBING PIPING

PART 1 GENERAL

1.01 SCOPE

A. Pipe and pipe fittings

B. Valves

C. Sanitary sewer piping system

D. Domestic water piping system

1.02 RELATED SECTIONS

A. Section 02222 - Excavating

B. Section 02223 - Backfilling

C. Section 02225 - Trenching

D. Section 09900 - Painting

E. Section 15121 - Expansion Compensation

F. Section 15140 - Supports and Anchors

G. Section 15190 - Plumbing Identification

H. Section 15260 - Plumbing Piping Insulation

I. Section 15430 – Plumbing Specialties

J. Section 15440 – Plumbing Fixtures

K. Section 15450 – Plumbing Equipment

1.03 REFERENCES

A. ASME B16.3 - Malleable Iron Threaded Fittings

B. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250

C. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings

D. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings

E. ASTM A47 - Ferritic Malleable Iron Castings

F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless

G. ASTM A74 - Cast Iron Soil Pipe and Fitting

H. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses

I. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

J. ASTM B32 - Solder Metal

K. ASTM B42 - Seamless Copper Pipe

L. ASTM B43 - Seamless Red Brass Pipe

M. ASTM B75 - Seamless Copper Tube

N. ASTM B88 - Seamless Copper Water Tube

O. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube

P. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings

Q. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems

R. CISPI 310 - Joints for Hubless Cast Iron Sanitary System

S. AWS A5.8 - Brazing Filler Metal

1.04 SUBMITTALS

A. Submit under provisions of Division 1

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturer's catalog information. Indicate valve data and ratings

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1

B. Record actual locations of valves and underground piping

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views

1.07 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welder's Certification: In accordance with ASME Sec 9.

1.08 QUALIFICATIONS

A. Installer: Company specializing in performing the work of this section with minimum 10 years' experience.

1.09 REGULATORY REQUIREMENTS

A. Perform Work in accordance with Martin County requirements and N.C. Plumbing code.

B. Conform with Martin County and N.C. Plumbing code for installation of backflow prevention devices.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01600.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. Rags, wool, cotton waste or similar materials may not be used in plugging.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF THE BUILDING

A. Plastic Pipe: ASTM D2665, PVC Schedule 40 material; bell and spigot style solvent sealed joint end.

1. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, clean-outs, reducers, traps and other configurations required.

2. Joints: ASTM D2855 solvent weld with ASTM D2564 solvent cement.

B. Bedding Materials

1. Bedding: As recommended by pipe manufacturer

C. Trenching:

1. See Section 02200

2.02 SANITARY SEWER PIPING, ABOVE GRADE

A. Plastic pipe ASTM D2665, PVC Schedule 40 material, bell and spigot style, solvent sealed joint ends. (Not permitted in kitchen areas).

1. Fittings: Same as 2.01, B.1.

2. Joints: Same as 2.01, B.2.

3. Installed per manufacturer's recommendations.

2.03 WATER PIPING, BURIED - PIPE 3 INCHES AND LESS

A. Copper Tubing: ASTM B88, Type K, annealed.

1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.

2. Joints: AWS A5.8, BCuP silver braze.

2.04 WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.

2. Joints: ASTM B32, solder, Grade 95TA for piping 1 1/4" and smaller; AWS A5.8, BCuP silver braze for piping 1 1/2" and larger.

2.05 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under:

1. Ferrous pipe: 150 psig malleable iron threaded unions.

2. Copper tube and pipe: 150 psig bronze unions with soldered joints.

B. Pipe Size Over 2 Inches:

1. Ferrous pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.

2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16 inch thick preformed neoprene gaskets.

C. Grooved and Shouldered Pipe End Couplings:

1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.

2. Sealing gasket: "C" shape composition sealing gasket.

D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.06 GATE VALVES (BELOW GRADE INSTALLATIONS ONLY)

A. Manufacturers:

1. Hammond
2. Milwaukee
3. Nibco

B. Up to and including 2 Inches: Bronze body, bronze trim, non-rising stem, handwheel, inside screw, single wedge or disc, solder ends 125 WSP-200 WOG rating.

C. Over 2 Inches: Bronze body, bronze trim, rising stem, handwheel, single wedge, solder ends, 125 WSP-200 WOG rating.

D. Install valves in meter box. Box to be flush with finished grade.

2.07 BALL VALVES (INTERIOR ABOVE GROUND INSTALLATION)

A. Manufacturers:

1. Apollo
2. Nibco
3. Hammond

B. Up to and including 2 Inches: Bronze, two piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle, solder ends, Class 150, 200 WOG.

C. Over 2 Inches: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged Class 150.

2.08 SWING CHECK VALVES

A. Manufacturers:

1. Milwaukee
2. Jenkins
3. Stockham
4. Nibco
5. Hammond

B. Up to and including 2 Inches: Bronze swing disc, threaded ends, Class 125.

C. Over 2 Inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends, Class 125.

2.09 RELIEF VALVES

A. Manufacturers:

1. Watts
2. B & G

B. Bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.10 STRAINERS

A. Manufacturers:

1. Watts
2. B&G
3. Wilkins

B. 2 inch and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify excavations under provisions of Division 1.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide clearance for installation of insulation and access to valves and fittings.

H. Provide access where valves and fittings are not exposed.

I. Establish elevations of buried piping outside the building to ensure not less than 2 ft of cover. If job conditions do not permit this depth Contractor shall request approval from Architect for a shallower depth.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

K. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09900.

L. Excavate in accordance with Section 02225 for work of this Section.

M. Backfill in accordance with Section 02225 for work of this Section.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

P. Provide one plug valve wrench for every ten plug valves sized 2 inches and smaller, minimum of one.

Q. All exposed ceiling and wall pipe penetrations shall be provided with chrome escutcheons.

3.04 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

C. Install gate or ball valves for shut-off and to isolate equipment, part of systems or vertical risers.

D. Install globe or ball valves for throttling, bypass, or manual flow control services.

E. Provide plug valves in gas systems for shut-off service.

3.05 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/4 inch per foot for pipes less than 4 inches in diameter and 1/8 inch per foot for pipes 4 inches and larger. Maintain gradients.

B. Slope water piping and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 parts per million of chlorine.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 5 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION

SECTION 15430

PLUMBING SPECIALTIES

PART 1 GENERAL

1.01 SCOPE

A. Hose Bibbs

B. Ice Maker Box

C. Floor Drains

D. Cleanouts

E. Water Hammer Arrestors

F. Backflow Preventers

G. Heat Tracing Cable

1.02 RELATED SECTIONS

A. Section 15410 - Plumbing Piping

B. Section 15440 - Plumbing Fixtures

C. Section 15450 - Plumbing Equipment

1.03 REFERENCES

A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers

B. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent

C. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle

D. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types

E. ANSI A112.21.1 - Floor Drains

F. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types

G. PDI WH-201 Water Hammer Arresters

1.04 SUBMITTALS

A. Submit under provisions of Division 1

B. Product Data: Provide component sizes, rough-in requirements, service sizes and finishes

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1

B. Locate clean outs with two dimensions to permanent structure

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1

B. Maintenance Data: Include installation instructions, spare parts lists, and exploded assembly views.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 HOSE BIBBS

A. Manufacturers:

1. Woodford, Model No. B24
2. Mifab, Model No., MHY-95
3. Prier Model No. C355-C156 BX-1

B. Interior: Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed, with removable loose key handle and integral vacuum breaker in conformance with ANSI/ASST 1011.

2.02 ICE MAKER BOX

A. Manufacturers:

1. Guy Gray Model No. M1B1HA or approved equal
2. Metal preformed rough-in box with brass valve and shock arrestor
3. Substitutions permitted with prior approval

2.03 FLOOR DRAINS

A. Manufacturers:

1. Zurn Model No. ZN-415
2. J. R. Smith Model No. 2005
3. Josam Model No. 3000.
4. Wade Model No. W-1100-STD5-1-6.

B. ANSI A112.21.2; lacquered cast iron two piece body with double drainage flange, weep holes, reversible flashing collar, and round adjustable nickel-bronze strainer. Provide 1072 ASSE approved trap guard equal to Sure Seal.

2.04 CLEANOUTS

A. Manufacturers:

1. Zurn.
2. J. R. Smith.
3. Josam.
4. Wade.

B. Interior Finished Floor Areas: Lacquered cast iron, round adjustable with taper thread bronze plug, scoriated nickel bronze cover, Model Z-1400 manufactured by Zurn, Model No. 4023 manufactured by Smith, Model No.5600-22-Y manufactured by Josam, or Model No. W-6000-1 manufactured by Wade.

C. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw; Model Z-1468 manufactured by Zurn, Model No. 4472 manufactured by Smith, Model No.58890 manufactured by Josam, or Model No. W-8480R manufactured by Wade.

D. Exterior Surfaced Areas: Round cast brass plug with recessed slot; Model Z-1470-BP manufactured by Zurn, Model No.4470-BP manufactured by Smith, Model No. 584540 manufactured by Josam, or Model No. W-8590 manufactured by Wade. Provide in 24" x 24" x 8" concrete pad.

2.05 WATER HAMMER ARRESTORS

A. Manufacturers:

1. Precision Plumbing Products, Inc.
2. Other acceptable manufacturers offering equivalent products.
   a. J. R. Smith.
   b. Zurn.
   c. Mifab.
   d. Wade

B. ANSI A112.26.1; sized in accordance with PDI WH-201, suitable for operation in temperature range -40 to 450 degrees F. (-73 to 149 degrees C.) and maximum 250 psig working pressure; copper water hammer arrestor, piston type, Model #SC Series.

2.06 BACKFLOW PREVENTERS

A. Manufacturers:

1. Watts.

2. Febco.

3. Conbraco.

4. Wilkins.

B. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013, AWWA C506; bronze body with bronze and plastic internal parts and stainless steel springs; two independently operating, spring loaded check valves, epoxy coated; diaphragm type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

C. Provide RPZ device with manufacturer's air gap drain assembly complete with copper piping piped to exterior of building.

2.07 HEATING CABLE

A. Furnish and Install a UL Listed, CSA Certified and FM Approved system of electric self-regulating heating cable, connection kits and electronic controller for maintaining the hot water as indicated on the drawings. The cable shall utilize a radiation-crosslinked conductive polymer as the heating element, and the cable shall be specifically designed, manufactured and UL Listed, CSA Certified and FM Approved for hot water temperature maintenance.

1. Construction: The self-regulating heating cable shall consist of two (2) 16 AWG (1.2 mm2) nickel-coated copper bus wires embedded in a radiation-crosslinked conductive polymer core. It shall be covered by a radiation-crosslinked, polyolefin, dielectric jacket surrounded by a polymer-coated aluminum wrap, and enclosed in a tinned copper braid of 14 AWG (2.5 mm2) equivalent wire size. The braid shall be covered with a (nominal) 40 mil (1 mm) polyolefin outer jacket, color coded for easy identification.
2. Mechanical: The cable shall have a minimum cut-through resistance of 100 lb (445 N) per the IEEE 515.1 (4.3.3) and CSA 130-03 (6.28) Resistance to Cutting Tests. The cable shall have a minimum impact resistance of l0 ft-lbs per the IEEE 515.1 (4.2.9) and CSA 130-03 (6.2.10.2) Impact Tests. The cable shall have a minimum abrasion resistance of 2500 cycles per the IEEE 515.1 (4.3.4) Abrasion Test. The cable shall withstand a crush resistance of 225 lbs per the IEEE 515.1(4.2.8) Deformation Test, and withstand a crush resistance of 345 lbs (1500 N) per the CSA 130-03 (6.2.7) Crush Resistance Test.
3. Connection Kits: All heating cable connection kits shall be UL Listed, CSA Certified and FM Approved for use as part of the system to maintain hot water temperature. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating cable core to expose the bus wires. Connection systems requiring the installing contractor strip the bus wires, or which use crimps or terminal blocks, shall not be acceptable. All connection kits except for the power connection shall be installed under the thermal insulation. The end seal shall use silicone gel.
4. Controller: Installed system shall include at least one agency-approved

electronic controller. The controller shall not be of line sensing over-limit design. The controller shall be capable of setting different pipe temperatures based on ambient and voltage with 24 hour, 7 day/week programmable options. The controller shall have the energy savings feature of lowering pipe temperature during low use periods and the ability to raise the temperature of the pipes for a programmed interval. The controller shall have BMS interface capabilities to set pipe temperatures and provide alarm relays in loss of power, incorrect water heater temperature and communication failure. The controller shall have flexible wiring configurations to operate individually or control up to eight additional controllers.

5. Maintain Temperatures: The system shall maintain temperatures between 105°F (40°C) and 140°F (60°C) at 208 V or single phase, 15 amp service. Temperature shall be maintained by utilizing an electronic controller with straight runs of heating cable on the pipe.
6. Insulation schedule shall be as follows: (This schedule is for heat traced pipe only.)

Insulation Thickness

Copper pipe size (in)	IPS insulation size (in)	Insulation thickness (in)
½	%	1/2
¾	1	1
1	1%	1
1%	1%	1%
11/2	1%	1%
2	2	2
2%	2%	21/2
3	3	3

Note: For pipe 1 1/4 inches and smaller, use insulation that is oversized by 1/4 inch to allow room for installing over the heating cables. For pipes three inches and larger, the thickness of insulation can be equal to the pipe diameter with one heating cable or 1/3 the pipe diameter with two runs of heating cable.

7. Power control (self-regulating index): The slope of the power/temperature shall be such that the power of the heating cable shall increase with decreasing temperature at a rate of at least 0.028 W/ft-°F (0.16W/m-°C) from 50°F (10°C) to 100°F (38°C).
8. Long-term thermal stability (as determined by accelerated testing): The power retention of the heating cable shall be at least 90% after 300 cycles between 50°F (10°C) and 212° (1 00°C).
9. High temperature withstand: The heater shall not decrease in resistance, overheat, or burn when powered at 208 V or 240 V and exposed to 400°F (205°C) in an oven for 30 minutes.
10. Installation and testing shall be per manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with finished grade (24" x 24" x 8").

D. Pipe relief from backflow preventer to nearest drain.

END OF SECTION

SECTION 15440

PLUMBING FIXTURES

PART 1 GENERAL

1.01 SCOPE

A. Water closets

B. Lavatories

C. 2-Compartment Lab and Kitchen Sinks

D. Shower (ADA)

E. Emergency Shower/Eyewash Station

F. Electric Water Cooler

G. Mop Receptor

1.02 RELATED SECTIONS

A. Section 06402 - Interior Architectural Woodwork

B. Section 07901 - Joint Sealers: Seal fixtures to walls and floors

C. Section 15141 - Plumbing Supports and Anchors

D. Section 15410 - Plumbing Piping

E. Section 15430 - Plumbing Specialties

1.03 REFERENCES

A. ANSI/ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use

B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings

C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures

D. ANSI/ASME A112.19.2 - Vitreous China Plumbing Fixtures

E. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use)

F. ANSI/ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards)

G. ANSI/ARI 1010 - Drinking-Fountains and Self-Contained Mechanically-Refrigerated Drinking Water Coolers

H. ANSI/ISEA Z358.1 – Emergency Eyewash and Shower Equipment

1.04 SUBMITTALS

A. Submit under provisions of Division 1

B. Product Data: Provide color catalog illustrations of fixtures, sizes, utility sizes, trim and finishes.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1

B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1

B. Accept fixtures on site in factory packaging. Inspect for damage

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use

1.07 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks

PART 2 PRODUCTS

2.01 WATER CLOSET (ADA)

A. Bowl:

1. Manufacturers:
   a. Kohler Model No. K-4350
   b. American Standard Model No. 2234.015
   c. Gerber Model No. Model No. 25-730

2. ANSI/ASME A112.19.2; floor mounted, siphon jet, vitreous china, elongated rim, bolt caps, 1 ½ inch spud, white, 1.6 gallon flush. Rim 17 inches above floor.

B. Flush Valve:

1. Manufacturers:
   a. Sloan Model No. Optima Plus 8111-62
   b. Zurn Model No. ZER-6000-CP-WS1-YB-YC
   c. Delany Model No. PL1402-1.6

2. ASME A112.18.1; exposed "water saving" chrome plated battery powered sensor operated flush valve, I.P.S. screw driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, vacuum

breaker flush connection and spud coupling for top spud, wall and spud flanges, solid ring pipe support, 1.6 gal/flush.

C. Seat:

1. Manufacturers:
   a. Church Model No. 9500 NSSC
   b. Bemis Model No. 1655SSC
   c. Olsonite Model No. 95CCSS
   d. Beneke Model No. 527SS

2. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

2.02 LAVATORY (ADA)

A. Basin:

1. Manufacturers:
   a. Kohler Model No. K-2849 Hudson
   b. American Standard Model No. 4869.020 Regalyn
   c. TOTO Model No. LT307.4

2. ANSI/ASME A112.19.1; enameled cast iron, wall-hung, 20" x 18", faucet ledge, front overflow, 4 inch centers, 4 inch high back, soap depression, wall hanger, white. Mount 34" inches to rim.

B. Trim:

1. Faucet: ASME A112.18.1; single post, battery powered, sensor operated, electric hand washing faucet with integral above deck temperature mixer, chrome plated finish, solid brass construction, ADA compliant and 0.5 GPM vandal resistant aerator.
   a. Sloan Model No. EAF-150-ISM
   b. Chicago Model No. 116.121.AB.1
   c. Symmons Model No. S-6080

2. Cast brass grid drain (17 gauge) with 6" x 1¼" tailpiece
   a. McGuire Model No. 155A
   b. Kohler Model No. K-7715
   c. Brasscraft Model No. 0701
   d. T&S Model No. B-0899
   e. Zurn Model No. Z-8743

3. Trap: Cast brass 17 gauge swivel joint 1¼" x 1½" trap with clean out plug and nipple and, escutcheon, cast brass slip nuts, polished chrome plated finish.
   a. McGuire Model No. 8902
   b. Kohler Model No. K8999
   c. Brasscraft Model No. 0120
   d. Zurn Model No. Z-8701-9-B

4. Supplies: 1/2" I.P.S. brass chrome plated angle supply with flexible riser, loose key stop and escutcheons.
   a. McGuire Model No. 2165LK
   b. Brasscraft Model No. SR1712AC
   c. T&S Brass Model No. B1305
   d. Zurn Model No. Z-8802-LR-LK

5. White pre-molded antimicrobial vinyl insulation kit on tailpiece, p-trap and supplies.
   a. Truebro Model No. 102K
   b. McGuire Prowrap Model No. PW2000
   c. Zurn Model Z-8946-1
   d. Plumberex Model No. X4333

6. Wall mounted carrier:
   a. Manufacturers:
      1) Zurn Z-1224
      2) Smith 0700
      3) Josam 17100
   b. Top support plate, rectangular steel uprights with welded feet, adjustable support plate and mounting fasteners.

2.03 TWO COMPARTMENT SINK

A. Bowl (Break Room):

1. Manufacturers:
   a. Elkay Model LRAD-3319-5-DS
   b. Just Model No. DL-ADA-1933-A-GR

2. ANSI/ASME A112.19.3; Double compartment, 18 gauge thick Type 302 stainless steel, self-rimming with undercoating, LK-35 basket strainer with chrome brass drain, located in rear center of each bowl, and 5" deep bowl.

B. Bowl (Lab):

Epoxy resin sink molded from thermosetting epoxy resin, molded interior corners to radius, slope sink base to drain outlet, 1-1/2" outlet, with overflow. Color to match adjacent work surfaces.

1. Manufacturers:
   a. Durcon
   b. LOC Scientific
   c. Chem Tops
   d. Kewanee

C. Trim:

1. Faucet: single handle with swing spout, 2.0 GPM aerator, polished chrome finish, hose spray.
   a. Elkay Model No. LK-4102
   b. Chicago Model No. 2200-4CP
   c. T&S Model No. B2731-LH.

2. Strainers: Stainless steel strainer basket with flex stem and rubber stopper, fits 3½" opening, chrome-plated brass, 1-½" off-set tailpiece, one for each compartment.
   a. Elkay Model No. LKAD-35 & LK-53
   b. McGuire Model No. 1151WC & 111C21G17
   c. Just Model No. J-ADA-35
   d. Zurn Model No. Z-8702-9-B

3. Trap: Cast brass 17 gauge swivel joint 1½" x 1½" trap with clean out plug and nipple and escutcheon, cast brass slip nuts, polished chrome plated finish, 1½ chrome plated brass center outlet continuous waste.
   a. McGuire Model No. 8912 & 111C21G17 Cont. Waste.
   b. Kohler Model No. K8999
   c. Brasscraft Model No. 0030
   d. Zurn Model No. Z-8702-9-B & A-8754

4. Supplies: ½" I.P.S. brass chrome plated angle supply with flexible riser, loose key stop with escutcheon.
   a. McGuire Model No. 2167LK
   b. Brasscraft Model No. SR3712AC
   c. T&S Brass Model No. B1305
   d. Zurn Model No. Z-8803-LR-LK

5. White pre-molded antimicrobial vinyl insulation kit on tailpiece, p-trap, continuous waste from second bowl and supplies.
   a. Truebro
   b. McGuire Prowrap
   c. Plumberex

6. Mount in cabinet top as shown and specified under Architectural work.

2.04 SHOWER (ADA)

A. Pressure-balancing shower valve, hand spray with 5 feet of chrome-plated hose with inline vacuum breaker, 24 inch chrome bar with adjustable slide, diverter valve, and fixed shower head.

   1. Manufacturers:
      a. Symmons Model No. 1-117VT-FS-XB24
      b. Delta Model No. 11T5-0-3

B. Drain shall be brass with stainless steel top and to equal Lasco Model No. 03-1223.

C. Shower compartment shall be fiberglass with grab bar, folding seat, curtain, and curtain rod. Unit shall be equal to Clarion Model No. 3837BF24, 38" X 38" x 78".

2.05 EMERGENCY SHOWER (P-12)

A. Barrier free, combination eye/face wash and shower safety station with stainless steel shower head, stainless steel bowl, powder coated cast aluminum flag handle and floor flange, 1 ¼" IPS schedule 40 galvanized pipe and fittings, 1" IPS and ½" IPS U.S. made chrome plated brass stay open ball valves, and polished stainless steel pull rod. Shower unit shall have a 20 gpm flow controlled orifice. Unit shall

have spray heads with integral flip-top dust covers, filters, and 3.0 gpm flow control orifices mounted on a chrome plated brass eyewash assembly. Unit shall include ANSI sign and inspection tag.

B. Fixture shall be equal to Guardian Model No. GBF1909SSH

C. Performance: Unit shall comply with ADA requirements for accessibility by handicapped persons. Unit shall meet or exceed current ANSI Z358.1.

2.06 PLASTIC EMERGENCY SHOWER (P-16)

A. Barrier free, plastic combination eye/face wash and shower safety station with plastic shower head and bowl, 1 ¼" IPS schedule 40 galvanized pipe and fittings, 1" IPS and ½" IPS U.S. made chrome plated brass stay open ball valves, and polished stainless steel pull rod. Shower unit shall have a 20 gpm flow controlled orifice. Unit shall have spray heads with integral flip-top dust covers, filters, and 3.0 gpm flow control orifices mounted on a eyewash assembly. Unit shall include ANSI sign and inspection tag.

B. Fixture shall be equal to ULINE Model No. H5101

C. Safety Shower Water Heater: P-16, Self-contained safety shower water heater 54 Kw, 480 volts @ 65 amps, tank less water heater with temperature controller, solid state relays, ASME rated heat exchanger, NEMA 4X enclosure, with scald protection and adjustable temperature control and freeze protection. Unit shall be suited for outdoor installation.

1. Manufacturers:
   a. Keltech SNA Series
   b. Bradley Corporation
   c. Hubbell Model ETX

D. Performance: Unit shall comply with ADA requirements for accessibility by handicapped persons. Unit shall meet or exceed current ANSI Z358.1.

2.07 ELECTRIC WATER COOLER

A. Fountain:

1. Manufacturers:
   a. Haws Model No. HWUACP8LSS
   b. Elkay Model No. EZTL8-SS
   c. Oasis Model No. P8ACSL-SS

2. ANSI/ARI 1010; two-level wheelchair accessible electric water cooler with stainless steel top, steel body, elevated anti-squirt flexi-guard bubbler with stream guard, automatic stream regulator, mounting bracket, refrigerated with integral air cooled condenser. Unit shall deliver 8.0 GPH of 50 degrees F water at 90 degrees F ambient and 80 degrees F inlet water. Unit shall be equipped with self-closing front and side push bars. Color shall be stainless steel.
   a. Mount lowest unit 34 inches above finished floor. Provide trap, cast brass swivel joint 1-1/4" x 1-1/4" trap with cleanout plug and nipple and

escutcheon - McGuire 8872; Brasscraft 0210; Kohler K8998. Supplies, 3/8" I.P.S. brass chrome plated angle supply with flexible riser, loose key stop and escutcheon - McGuire 165 LK; Brasscraft SR 1512 AC; T&S Brass.

3. Maintenance Data: Include adjustment instructions.

2.08 MOP RECEPTOR

A. Receptor shall be 24" x 24"x 12" type with drop front, molded stone, brass drain, removable stainless steel strainer. Color selection: white.

1. Fiat Model No. MSB2424
2. Florestone Model No. MSR 2424
3. Acorn Model No. TDF-24

B. Trim:

1. (Mop Receptor) ASME A112.18.1 exposed wall type supply with cross handles, spout wall brace, vacuum breaker, hose and spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges; 3 feet of 1/2 inch diameter plain and reinforced rubber hose, hose clamp, (2) 12 x 24 inch stainless steel wall guards and mop hanger. Mop hanger shall be mounted above basin opposite of faucet.
   a. Faucet
      1) T&S Model No. B-0665-BSTP
      2) Chicago Model No. 8124
      3) Zurn Model No. Z-842M2

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

C. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install each fixture with trap, easily removable for servicing and cleaning.

C. Provide chrome plated rigid supplies to fixtures with loose key stops, reducers and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with wall supports, wall carriers and bolts.

F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07901; color to match fixture.

G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.03 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.04 ADJUSTING

A. Adjust work under provisions of Division 1.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.05 CLEANING

A. Clean work under provisions of Division 1

B. At completion, clean plumbing fixtures and equipment.

3.06 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Division 1

B. Do not permit use of fixtures until final acceptance of building

3.07 FIXTURE HEIGHTS

A. Install fixtures to heights above finished floor as indicated in Architectural specifications and on Engineer/Architectural drawings.

END OF SECTION

SECTION 15450

PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

A. Water Heaters

B. Thermostatic Mixing Valves

C. In-line Circulator Pumps

1.02 RELATED SECTIONS

A. Section 15140 - Supports and Anchors

B. Section 15100 – Electrical Requirements for Plumbing Equipment

1.03 REFERENCES

A. ANSI/ASHRAE 90A - Energy Conservation in New Building Design

B. ASME Section VIIID - Pressure Vessels; Boiler and Pressure Vessel Codes

C. ANSI/NFPA 30 - Flammable and Combustible Liquids Code

D. ANSI/NFPA 70 - National Electrical Code

E. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters

F. ANSI/UL 174 - Household Electric Storage Tank Water Heaters

G. ANSI/NEMA 250 - Enclosure for Electrical Equipment (1000 Volts Maximum)

1.04 SUBMITTALS

A. Submit under provisions of Division 1

B. Product Data:

C. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.

D. Provide electrical characteristics and connection requirements

E. Manufacturer's Installation Instructions.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1

B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.06 WARRANTY

A. For electric water heater provide 5 year warranty under provisions of Division 1

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with State of N.C. Building Code

B. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:

1. National Sanitation Foundation (NSF)
2. American Society of Mechanical Engineers (ASME)
3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI)
4. National Electrical Manufacturers' Association (NEMA)
5. Underwriters Laboratories (UL)

1.08 REGULATORY REQUIREMENTS

A. ANSI/NFPA 70, ANSI/UL 174 requirements for water heaters.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 ELECTRIC WATER HEATER

A. Commercial Manufacturers:

1. A.O. Smith
2. Bradford White
3. Lochinvar

B. Type: Automatic, electric, vertical storage.

C. Performance:

1. Storage: 120 gallons
2. Input: 2 elements @ 6 kw for a 12 kw total (simultaneous operation)
3. Minimum Recovery rate: 135 gph with 100° F temperature rise
4. Maximum working pressure: 150 psig

D. Electrical Characteristics:

1. 480 volts, three phase, 60 Hz

E. Tank: Glass lined welded steel thermally insulated with 2 inch glass fiber, encased in corrosion-resistant steel jacket, baked-on enamel finish.

F. Controls: Automatic water thermostat with temperature range from 120 to 170 degrees F, screw-in nichrome elements

G. Accessories: Brass water connections and dip tube, isolation valves, drain valve, high density magnesium anode, ASME temperature and pressure relief valve and heat trap nipples

2.02 THERMOSTATIC MIXING VALVES

A. Manufacturers:

1. Leonard
2. Lawler
3. Powers

B. Master Mixing Valve Capacity: 1 GPM minimum, and 15 GPM maximum at 20 psi drop, initial setpoint 115°F (adjustable)

C. Emergency Shower Mixing Valve Capacity: 20 GPM minimum bypass, and 43 GPM at 35 psi drop

D. Accessories:

1. Check valves on inlets
2. Volume control shut-off valve on outlet
3. Stem thermometer on outlet
4. Strainer stop checks on inlets
5. Color coded dials
6. Pressure gauges

E. Surface mounted on wall at water heater

2.03 IN-LINE CIRCULATOR PUMPS

A. Manufacturers:

1. Bell & Gossett
2. Grundfos
3. Taco

B. Performance:

1. Flow: 46 gpm at 16 feet of head.

2. Electrical Characteristics:
   a. 1-1/2 hp.
   b. 115 volts, single phase, 60 Hz.

C. Casing: Bronze, rated for 125 psig (860kPa) working pressure.

D. Impeller: Bronze.

E. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

F. Seal: Carbon rotating against a stationary ceramic seat.

G. Drive: Flexible coupling

H. Motor: ECM variable speed

PART 3 EXECUTION

3.01 WATER HEATER INSTALLATION

A. Install water heater in accordance with manufacturer's instructions.

B. Coordinate with plumbing piping and electrical work to achieve operating system.

C. Provide label on water heaters to show warranty and substantial completion date

END OF SECTION

SECTION 15460

TESTS AND CLEANING

PART 1 GENERAL

1.01 SCOPE

A. This work consists of providing all plant, labor, materials, apparatus, services, and equipment required to test all plumbing systems, and the cleaning of all equipment and fixtures furnished and/or installed under the Plumbing Specifications.

B. Items of equipment and fixtures installed by others and connected to roughing provided by the Plumbing Contractor shall be the responsibility of the installer. The Plumbing Contractor shall be responsible only to the termination of the roughing.

C. The Plumbing Contractor shall be responsible for the results of testing all work provided by his forces. Equipment and fixtures furnished by others for connection by the Plumbing Contractor shall be tested and approved for operation before connection by the Plumbing Contractor. Rough-in work by the Plumbing Contractor shall be tested and approved before connection to equipment furnished by others. Should internal workings of such items prove faulty the Plumbing Contractor shall notify the Architect.

D. Final cleaning of fixture and equipment shall be the responsibility of the Contractor responsible for the provision of the item.

1.02 GENERAL

A. All work must remain uncovered until required tests have been completed, but in the event the project construction schedule requires it, the Contractor shall make arrangements for prior tests on portions of the work involved. Any damage caused as a result of tests shall be repaired at the expense of the Contractor responsible for the provision of the work under test.

B. It is desirable that each system be tested in its entirety, but the various systems may be tested in sections as may be required to expedite the work of other trades.

C. The Contractor responsible for the work shall pay all costs and shall furnish all instruments, test equipment and personnel required for the tests. He shall obtain certificates of approval, acceptance and compliance with regulations of agencies and/or authorities having jurisdiction.

D. All tests shall be conducted in the presence of the Architect's representative.

1.03 WORK INCLUDED

A. Pressure testing of water piping systems

B. Pressure testing of drainage and vent systems

C. Placing into proper operation all electric and/or mechanical equipment provided by the Plumbing Contractor and such items as have been installed by him.

D. Cleaning

E. Sterilizing

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 WATER PIPING SYSTEM PRESSURE TEST

A. The following systems shall be hydrostatically tested at a pressure of 1-1/2 times the normal working pressure of 150 psig, whichever is greater.

1. Cold water system

2. Hot water supply system

B. Test pressures shall be maintained without plumbing for a minimum of four (4) hours without loss of pressure other than may be attributable to changes in atmospheric conditions. During the test period, each joint shall be examined for leaks. Sweats or drips will not be accepted.

C. After satisfactory completion of tests and before permanent connection of equipment and fixtures, flush entire pipe systems for a sufficient length of time to free interiors completely of foreign matter.

3.02 SOIL, WASTE, AND VENT DRAINAGE SYSTEMS

A. Water Test: The entire drainage and venting system shall be tested as a single unit or in sections provided that a vertical stack of ten feet (10') above the highest horizontal line of the section is tested integrally with that part or section. Pressure may be maintained by using a pressure pump. A pressure of ten feet (10') head (4.3 pounds) shall be maintained throughout the section being tested for a fifteen (15) minute time period without evidence of leakage at any joint connection.

B. Air Test: If tests are made with air, a pressure of not less than five (5) psig shall be applied with a force pump and maintained at least fifteen (15) minute without leakage. A mercury column gauge shall be used in making the air test.

3.03 STERILIZING

A. The interior piping both hot and cold water shall have been completed and all fixtures set and operating, then the entire system shall be sterilized by thoroughly flushing the system to the satisfaction of the Owner.

3.04 WORK

A. If inspection and tests show defects, such defective work or material shall be replaced and inspection and tests repeated. Repairs to piping shall be made with new material. No caulking of screwed joints or holes will be acceptable.

3.05 CLEANING

A. After satisfactory completion of tests and inspection, all parts of the work shall be thoroughly cleaned. All equipment pipe, valves, and fittings shall be cleaned of grease, metal cuttings, and sludge which may have accumulated by operation of the system for testing.

B. Any stoppage or discoloration or damage to parts of the building, its finish or furnishings, due to the Contractor's failure to properly clean the piping system, shall be repaired by the Contractor without cost to the Owner.

3.06 BALANCING

A. At the completion of the work, flush valves and other parts of the work shall be adjusted for quiet operation. Automatic control device shall be adjusted for proper operation.

B. Hot water return systems shall be balanced to assure that hot water is readily available at all outlets.

3.07 DEMONSTRATION OF OPERATION

A. When the installation is complete and cleaned, and adjustments specified herein have been made, the system shall be operated by the Plumbing Contractor for a period of one (1) week during which time it shall be demonstrated to the Architect as being completed and operating in conformance with the Plans and Specifications. During this week of operation the Contractor shall instruct the Owner's operating personnel in the manner of operation of all systems.

3.08 OWNER'S RIGHT TO TEST SYSTEMS

A. Should, in the opinion of the Architect, and during the guarantee period, reasonable doubt exists as to the proper functioning of any equipment installed under this Contract, the right is reserved for the Owner and Architect to perform any test deemed practical to determine whether such equipment is functioning properly and performing at required capacity. If such tests show proper functioning, the cost of the test will be paid by the Owner. If the test shows improper functioning of any equipment the Plumbing Contractor shall pay the cost of the test and shall also make good any deficiencies shown by the test to the full satisfaction of the Owner and the Architect.

3.09 OPERATING AND MAINTENANCE MANUALS

A. Three (3) complete sets of operating and maintenance manuals shall be submitted to the Owner through the Architect/Engineer two (2) weeks prior to the pre-final inspection date.

B. The O&M manuals shall be installed in a 3-ring heavy back notebook with the name of the building and the words "Operation and Maintenance Manuals" on the cover and spine. The manuals shall contain the following items as a minimum:

1. Index, page numbers and tabs
2. Certificate of substantial completion
3. All warranties
4. List of all subcontractors and suppliers with names, addresses and phone numbers.
5. Complete start-up, operation and shut-down procedures for each piece of equipment, locations of switches, emergency procedures and any other critical items.
6. Lubrication schedules and types of lubricants.
7. Complete set of current shop drawings and equipment description showing all capacities and other operation conditions.
8. Equipment summary showing all capacities and ratings. (HP, KW)
9. All submittal data and shop drawings.
10. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
11. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instruction.
12. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair and reassembly; aligning and adjusting instructions.
13. Wiring and control diagrams
14. Manufacturer's cuts, part numbers, and serial numbers.

3.10 RECORD DRAWINGS

A. Record drawings showing the work as actually installed shall be prepared, signed and dated by the Contractor and turned over to the Architect for approval and submitted to the Owner.

END OF SECTION 15460

SECTION 15500

BASIC HVAC REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide and coordinate all plant, labor, materials, apparatus, services, and equipment required for the installation of a fully operational HVAC system as shown on the project drawings and specified in the contract documents.

B. All work shall be planned and coordinated to minimize disturbance of finishes and construction. Contractors shall prepare routing schemes for approval by Architect.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 15.

B. Applicable Codes, Regulations and Specifications:

1. Product Data: Provide manufacturer's catalog data for fastening systems. Latest Edition of the North Carolina State Building Code

2. Applicable National Fire Protection Association (NFPA) Codes

3. Applicable Underwriters Laboratory (UL) Standards, All electrical materials and equipment shall be UL listed and labeled in every case where such listing has been established

4. Latest Edition of the National Electrical Code (NEC, NFPA 70)

5. Latest Edition of the National Electrical Manufacturer's Association (NEMA) Standards

1.03 SUMMARY

A. This Section includes general administrative and procedural requirements for HVAC installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in the general conditions.

1. Submittals

2. Coordination drawings

3. Record documents

4. Maintenance manuals

5. Rough-ins

6. HVAC installations

B. Related Sections

1. Specification Section 15501 "Electrical Requirements for HVAC Equipment", for factory-installed motors, disconnects, motor starters, controllers, accessories and connections.

C. The drawings accompanying this specification are generally diagrammatic and do not show all details required for the complete system. They should however be followed as closely as possible in the general arrangement and location of equipment. Do not scale the drawings. Check all dimensions at the building and investigate all structural and finish conditions. Arrange all work to meet these conditions and provide such offsets, brackets and other necessary accessories as may be required.

D. Immediately upon discovery of any discrepancy in the drawings or the specifications, or points of conflict therein, notify the Engineer who will clarify such discrepancy in writing prior to the progress of the work beyond the point concerned.

E. Do not cover up construction until it has been inspected and approved by the Engineer.

1.04 SUBMITTALS

A. General: Follow the procedures specified in Division 1.

B. Increase, by the quantity listed below, the number of HVAC related shop drawings, product data, and samples submitted, to allow for required distribution plus one copy of each submittal required, which will be retained by the Engineer.

1. Shop Drawings - 1 additional blue - or black-line print

2. Product Data - 1 additional copy of each item

C. Additional copies may be required by individual sections of these specifications. Upon completion of the project, provide the Owner with a complete set of all shop drawings and submittals as outlined in Paragraph VI of this Section.

D. Shop Drawings and Catalog Data: Approval of submittals for any material, apparatus, devices and layouts shall not relieve the Contractor from the responsibility of furnishing same as specified of proper dimensions, size, and quantity. If the submittals deviate from the contract documents in these three areas, advise the Engineer of the deviations in writing accompanying the shop drawings, including the reason for deviations. Any items found on the job either installed or not installed which do not meet the above criteria shall be replaced by the Contractor at the discretion of the Engineer. Review and stamp all shop drawings and submittals before submitting them to the Engineer for approval. Any

submittals not stamped and signed by the Contractor prior to submittal to the Engineer will be returned to the Contractor for his stamp and resubmittal. A copy of all shop drawings and submittals shall be kept at the job site at all times.

E. Required Submittals:

1. Variable Refrigerant Volume (VRV) HVAC Systems
2. Split System Dehumidification units
3. Ventilation Fans
4. Exhaust Fans
5. Electric Infrared Heaters
6. Refrigerant Piping and Accessories
7. Piping Hangers and Supports
8. Ductwork
9. Diffusers, Registers and Grilles
10. Ductwork Hangers and Supports
11. Piping Insulation and Jacketing
12. Mechanical Identification
13. Vibration Isolation
14. Test and Balance Report

1.05 RECORD DOCUMENTS

A. Indicate the following installed conditions:

1. Ductwork mains and branches, size and location, control devices, filters, boxes, and fan coil units requiring periodic maintenance or repair.
2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 15 Section "HVAC Identification."
3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
4. Approved substitutions, Contract Modifications, Alternates and actual equipment and materials installed.

B. During construction operations this Contractor shall faithfully and accurately record all changes from the contract drawings, including dimensions where applicable including invert elevations for all below-grade outside utilities with reference to permanent above-grade objects.

C. At project close-out, this Contractor shall neatly record with red ink all construction changes on an unused set of contract drawing prints supplied by the Engineer. This set of prints shall be submitted to the Engineer for review and approval. Should the Engineer find these record documents to be incomplete they will be returned to the Contractor and corrected accordingly by the Contractor with no additional cost to the Owner.

1.06 OPERATING AND MAINTENANCE MANUALS

A. Four (4) complete sets of operating and maintenance manuals shall be submitted to the Owner through the Architect/Engineer two (2) weeks prior to the pre-final inspection date.

B. The O&M manuals shall be installed in a 3-ring heavy back note book with the name of the building and the words "Operations and Maintenance Manuals" on the cover and spine. The manuals shall contain the following items as a minimum:

1. Index and page numbers

2. Certificate of substantial completion

3. All warranties

4. List of all subcontractors and suppliers with names, addresses and phone numbers

5. Certified testing and balancing report

6. Complete start-up operation, and shut-down procedures for each system including sequence of events, locations of switches, emergency procedures and any other critical items.

7. Lubrication schedules and types of lubricants

8. Complete set of current shop drawings and equipment description showing all capacities and other operation conditions.

9. Equipment summary showing all capacities and ratings. (HP, Tons, KW, Filter size, etc.)

10. All submittal data and shop drawings

11. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts

12. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; summer and winter operating instructions

13. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair and reassembly; aligning and adjusting instructions

14. Wiring and control diagrams.

15. Manufacturer's cuts, part numbers, and serial numbers

16. A print of the main electrical control diagrams on non-fading paper shall be wall mounted under glass in each mechanical room. Show control sequence on the diagrams

1.07 FINAL INSPECTIONS

A. Each project shall have both a pre-final and final inspection made before it is finally accepted by the Owner. A complete thorough training session shall be conducted by this Contractor and all applicable Subcontractors for the Owner's personnel after the pre-final inspection.

B. The pre-final inspection shall be held after all systems are in place and in operation. The HVAC Contractor shall demonstrate to the Engineer and Owner that all systems in the building are properly installed, balanced, and performing as designed and specified. All Contractors and Subcontractors shall attend this inspection including HVAC and air and water balance Subcontractor.

C. The final inspection shall be held with the Owner, Architect/Engineer, all Contractors and Subcontractors to demonstrate to the Owner that all systems in the building are operating as designed and to their satisfaction.

1.08 POST INSPECTIONS

A. Two post construction inspections shall be held by the Architect/Engineer with the Contractors and Owner to assure that the building is continuing to operate in accordance with the plans and specifications and that no unusual problems are occurring in the building systems. The first post construction inspection will be held approximately six months after substantial completion. This inspection will address Plumbing, HVAC and Electrical work. The second post construction inspection shall be held prior to expiration of the 1 year warranty period. It shall address General Construction as well as Plumbing, HVAC and Electrical work. All problems discovered during these inspections that relate to defective materials or defective workmanship shall be corrected by the responsible Contractor at no additional cost to the Owner.

1.09 WARRANTIES

A. All work shall be fully warranted for one year from the date of substantial completion by the Contractor who shall replace any defective materials and repair any defective workmanship. In addition, written warranties shall be provided for the following products and time periods. These warranties shall include any material cost to repair defective materials.

1. 5 Year Warranty

a. HVAC Compressors including Refrigeration

1.10 TEST REPORTS

A. All systems are required to be tested and shall be documented in writing, listing date, item tests, section tested, witnesses to the test (signed), and specification section which requires testing. Reports on testing shall be submitted within seven (7) days of completion of each test. In addition all test reports shall be compiled in a spiral bound 8 1/2" x 11" document and submitted at the same time and in the same quantity as required for Operation and Maintenance manuals.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver the products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. All equipment and materials shall be fully protected and covered with protective materials to prevent any damage.

1.12 GENERAL PRODUCT INFORMATION

A. Where three or more manufacturers are listed for an item of equipment without an "or approved equivalent" clause, the Contractor may, at his option, provide any one of those specified. Equipment by manufacturers other than those listed will not be considered.

B. Where one or more manufacturers and a substitutions clause are listed for an item of equipment the Contractor may, at his option, provide the specified item or propose a substitute item of equal quality and performance. Submit a request for substitution for any manufacturer not named. Refer to Section II below regarding substitutions. The Engineer shall determine whether a substitute item is equivalent to the product specified and reserves the right to reject that substitute item.

C. All materials and equipment specified and shown on the plans shall be new and free from any defects. Each item of equipment shall bear the manufacturer's name or trade mark.

D. Dimensions: Insure that all items of equipment furnished fit the space available. Make necessary field measurements to ascertain space requirement.

E. Subcontractors and materials list: Provide within 5 days after execution of the contract a complete list of proposed subcontractors and materials including manufacturer's name.

1.13 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions in accordance with Division 1 of this specification.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that the Contractor:

1. Has investigated proposed product and determined that it meets or exceeds that quality level of the specified product.

2. Will provide the same warranty for the Substitution as for the specified product.

3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.

4. Waives claims for additional costs or time extension which may subsequently become apparent.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitutions Submittal Procedure:

1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.

2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.

3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

1.14 SUPERVISION

A. The Contractor shall have a thoroughly competent foreman in charge of the construction work at all times. The foreman shall have extensive experience in the work to be performed.

1.15 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

1.16 HVAC INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of HVAC systems, materials, and equipment with work of all other Contractors on the project. Comply with the following requirements:

1. Coordinate HVAC systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction to allow for HVAC installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

7. Coordinate connection of HVAC systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

9. Install HVAC equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

10. Duct and pipe penetrations: Duct and pipe penetrations shall be provided by the Mechanical Contractor. Mechanical shop drawings shall be provided to the Architect/Engineer and General Contractor with ALL duct and pipe penetrations sized and located. These shop drawings shall be submitted during early phases of construction so not to delay the General Construction Schedule. Any additional costs, associated with the

construction delays, that result from a failure to coordinate this work will be paid by the Mechanical Contractor.

11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

12. Properly support all work and equipment installed under this contract. Study all drawings, shop drawings, and catalog data to determine how equipment, accessories, piping, and related items are to be supported, mounted, or suspended. Provide all bolts, inserts, pipe stands, brackets, structural supports, and accessories for proper support of equipment furnished under this contract.

13. Provide suitable vibration isolating bases or suspension systems as indicated and/or required for all rotating, reciprocating, and vibrating equipment. Design all isolation for maximum absorption efficiency so that no transmission of vibration or structurally borne noise shall occur. The selection of isolators for proper loading to obtain the desired efficiency shall be the responsibility of the manufacturer of the isolating units and shall be fully guaranteed by the manufacturer.

14. Fire Barrier Penetrations: Where HVAC work passes through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Provide penetration seal materials in accordance with printed instructions of the U.L. Fire Resistance Directory and in accordance with manufacturer's instruction.

15. Under no circumstances shall any air handling system be used as a source of temporary heat or cooling until the building has progressed to the point where not dust, or debris are on the premises served by the air handling system. The building at this point should be free of debris, broom cleaned and closed off by the General Contractor to any other portion of the building in which work is in progress.

16. The HVAC Contractor shall contact the Architect/Engineer seven (7) days in advance of using any permanent HVAC system for temporary cooling or heating. 1" wide 30% efficient filters shall be installed in all air handling equipment while supplying temporary heat or cooling. Filters shall be maintained and changed as needed to prevent unloading of dust and dirt into the air distribution system. Filters shall be removed upon completion of the work and new operating filters installed.

17. All field painting of HVAC work, including touch-up paint on factory finished equipment shall be by HVAC Contractor. Any equipment which has its factory paint coat scratched or otherwise damaged shall be retouched with paint to match the finish coat, and shall be repainted if necessary.

PART 2 PRODUCTS – NOT USED

PART 3 INSTALLATION – NOT USED

END OF SECTION 15500

SECTION 15501

ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 16.

1.02 SUMMARY

A. This section specifies the basic requirements for electrical components which may or may not be an integral part of the HVAC equipment. These components include, but are not limited to motors, motor starters and disconnect switches.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for HVAC equipment are specified within the individual equipment specification sections, and/or are scheduled on the drawings.

C. All electrical work shall be done by licensed electricians in accordance with the N.C. State Building Code which includes the National Electrical Code, latest edition, and the Electrical Division of this specification. Furnish a certificate to the appropriate Electrical Inspector.

D. Work Included:

1. All power wiring and associated conduit shall be provided to HVAC equipment by the Electrical Contractor. The HVAC Contractor shall furnish all motor starters, disconnect switches and combination starters for HVAC equipment and turn them over to the Electrical Contractor for installation. All final power wiring connections to HVAC equipment shall be made by the HVAC Contractor from slack wire left by the Electrical Contractor. Refer to the Contract Drawings for division responsibility regarding electrical requirements.

2. Provide all control wiring, in conduit, required to satisfactorily control all equipment included in this section. Furnish and wire all control devices such as thermostats, switches, relays and any other devices necessary to control the equipment furnished in this section.

3. HVAC Contractor shall provide power wiring and conduit to all damper and valve actuators.

1.03 REFERENCES

A. NEMA Standards MG 1

B. NEMA Standards ICS 2

C. NEMA Standard 250

D. NEMA Standard KS 1

E. National Electrical Code (NFPA 70)

F. N.C. State Building Code

1.04 SUBMITTALS

A. Provide a separate electrical submittal for all field mounted starters and disconnects not included as integral pieces of HVAC equipment. Submittal shall conform to requirements of Division 1 and Sections 16441 and 16481.

B. For HVAC equipment with integral starters and/or disconnects no separate electrical submittal is required. Submit product data for motors, starters and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

C. Before any electrical work is performed submit wiring diagrams and methods of powering and controlling all electrically connected or operating equipment to the Architect for approval. Controls Subcontractor shall check and approve all diagrams before submittal to the Engineer. The diagrams shall show points of connection of equipment to system provided by the Electrical Contractor and shall show conduit and wire sizes.

1.05 QUALITY ASSURANCE

A. All electrical equipment and materials shall be UL labeled.

PART 2 PRODUCTS

2.01 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements shall be specified by the Engineer in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

3. Temperature Rating: Rated for 40 deg. C. environment with maximum 50 deg. C. temperature rise for continuous duty at full load (Class A Insulation).

4. Starting capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.

5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.

6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.

   a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.

   b. Bearings:

      1) ball or roller bearings with inner and outer shaft seals;
      2) re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance;
      3) designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor;
      4) for fractional horsepower (1/20 hp and below) light duty motors, sleeve type bearings are permitted.

   c. Enclosure Type:

      1) open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation;
      2) guarded drip-proof motors where exposed to contact by employees or building occupants;
      3) weather protected Type I for outdoor use, Type II where not housed;

   d. Overload protection: built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.

   e. Noise rating: "Quiet" rating on motors located in occupied spaces of building.

   f. Efficiency: All motors shall be "Energy Efficient". Motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, test method B.

   g. Nameplate: indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

7. All motors shall be of the quiet operating type, guaranteed to fulfill the specified requirements without producing objectionable sound in occupied areas of the building. All belt connected motors shall have adjustable bases and set screws to maintain proper belt tension. All fan motors shall have adjustable sheaves for speed adjustment, and one belt more than computed.

8. No shaded pole motors will be acceptable on any equipment above 1/20 horsepower.

2.02 DISCONNECT SWITCHES

A. Shall conform to all requirements specified in Section 16441 - "Enclosed Switches".

2.03 MOTOR STARTERS AND COMBINATION STARTERS

A. Shall conform to all requirements specified in Section 16481 - "Enclosed Motor Controllers".

2.04 VARIABLE FREQUENCY DRIVES

A. Shall conform to all requirements specified in Section 15542 "Variable Frequency Drives".

PART 3 EXECUTION

A. Conductor sizes shall be as specified in the National Electrical Code.

B. Control circuits shall be 120 volts or 24 volts. Electrical Contractor shall provide in-line toggle switch, labeled and identified, at each control panel and starter, to disconnect control power.

C. Ground all equipment per requirements of the National Electrical Code.

D. Equipment overcurrent protection and conductors in the electrical contract shall be sized to accommodate most major brands of HVAC equipment. If the HVAC Contractor chooses to use an item of equipment that exceeds the capacity of the electrical overcurrent protection and conductors, or requires multiple circuits, the HVAC Contractor shall be responsible for any additional cost required to increase the size of the overcurrent protection and conductors or provide the additional circuits and disconnects, at no additional cost to the Owner or Electrical Contractor. He shall also coordinate this work with the Electrical Contractor to assure proper electrical service to the equipment.

END OF SECTION 15501

SECTION 15503

SUPPORTS AND ANCHORS

PART 1 GENERAL

1.01 SCOPE

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.02 RELATED SECTIONS

A. Section 03300 - Cast-In-Place Concrete: Equipment bases

B. Section 07270 - Firestopping: Joint seals for piping and duct penetration of fire rated assemblies

1.03 REFERENCES

A. ASME B31.9 - Building Services Piping

B. ASTM F708 - Design and Installation of Rigid Pipe Hangers

C. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer

D. MSS SP69 - Pipe Hangers and Supports - Selection and Application

E. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.04 SUBMITTALS

A. Submit under provisions of Division 1 and Section 15500

B. Product Data: Provide manufacturer's catalog data including load capacity

C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe and riser support hangers

D. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components

1.05 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of specified piping systems

PART 2 PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Grinnell Corporation

2. Fee & Mason Manufacturing Co.

3. B-Line Systems, Inc.

4. C & S Manufacturing Co.

5. Superstrut/Thomas & Betts

6. Substitutions: Under provisions of Section 15500

2.02 HANGER RODS

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded; with washers on both sides of hangers. Double nut connection

2.03 INSERTS, UPPER ATTACHMENTS, AND BEAM CLAMPS

A. Manufacturers:

1. Grinnell Corporation

2. Fee & Mason Manufacturing Co.

3. B-Line Systems, Inc.

4. C & S Manufacturing Co.

5. Superstrut/Thomas & Betts

6. Substitutions: Under provisions of Section 15500

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

C. Upper Attachments: Malleable iron or steel, plain finish

D. Beam Clamps: Malleable iron c-clamps with locknuts, adjustable beam clamps in malleable iron or steel, all clamps with plain finish

2.04 FLASHING

A. Metal Flashing: 26 gauge galvanized steel

B. Metal Counterflashing: 22 gauge galvanized steel

C. Lead Flashing:

1. Waterproofing: 5 lb/sq ft sheet lead

2. Soundproofing: 1 lb/sq ft sheet lead

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing

E. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements

2.05 EQUIPMENT CURBS

A. Manufacturers:

1. Mason Industries, Inc.

2. Thycurb

3. The Pate Company

4. Substitutions: Under provisions of Section 15500

B. Fabrication: Welded 18 gauge galvanized steel shell and base, 14 inches minimum height, mitered 3 inch cant, variable step to match roof insulation, minimum 1-1/2 inch thick insulation, factory installed wood nailer.

2.06 EQUIPMENT CURBS WITH ACOUSTICAL TREATMENT:

A. Provide with all roof mounted air handling equipment with duct penetrations through roof deck above occupied spaces.

2.07 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: 18 gauge galvanized steel

B. Sleeves for Pipes through Non-fire Rated Walls and Footings, Schedule 40 galvanized steel pipe or 18 gauge galvanized steel

C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls; Prefabricated fire rated sleeves including seals, UL listed, where indicated

D. Sleeves for Round Ductwork: Galvanized steel.

E. Sleeves for Rectangular Ductwork: Galvanized steel.

F. Firestopping Insulation and sealants: Provide penetration seal materials in accordance with printed instructions of the U.L. Fire Resistance Directory, in accordance with manufacturer's instruction, and as required by local codes and plan details.

G. Sealant for non-fire penetrations: Acrylic caulk.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. All firestopping of HVAC penetrations shall be provided by the HVAC Contractor. Provide penetration seal materials in accordance with printed instructions of the U.L. Fire Resistance Directory and in accordance with manufacturer's instruction, as required by local code officials, and as indicated on plan details.

3.02 INSERTS UPPER ATTACHMENTS, AND BEAM CLAMPS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams or walls

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface

E. Provide upper attachments and beam clamps to support work from steel beams and bar joists

F. Direct attachment to metal roof decks is prohibited

3.03 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support vertical piping at every floor.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Support riser piping independently of connected horizontal piping.

H. Provide copper plated hangers and supports for copper piping.

I. Design hangers for pipe movement without disengagement of supported pipe.

J. Provide a prime coat and two (2) finish coats of paint on exposed steel hangers and supports. Finish coat shall match paint color of adjacent pipe or

insulation. Hangers and supports located in crawl spaces, pipe shafts and suspended ceiling spaces are not considered exposed.

K. Provide shields and blocking for all piping at hangers and supports in accordance with Section 15507 - Piping Insulation

L. Do not support piping or ductwork from bar joist bridging

3.04 EQUIPMENT BASES AND SUPPORTS

A. All HVAC Equipment sitting on Mechanical Room Floor shall have housekeeping pads provided by Mechanical Contractor. Housekeeping pads shall be concrete, minimum 4 inches thick with 3/4" chamfer edges, and extending 6 inches beyond supported equipment on all sides. The Mechanical Contractor shall provide all anchoring devices, inserts, etc. as required. The Mechanical Contractor shall paint the pads yellow in compliance with OSHA requirements and guidelines.

B. Provide templates, anchor bolts and accessories for mounting and anchoring equipment. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

C. Provide rigid anchors for pipes after vibration isolation components are installed.

3.05 FLASHING (COORDINATE WITH ROOFING REQUIREMENTS)

A. General Contractor shall provide flexible flashing and metal counterflashing where indicated for piping and ductwork penetrating weather or waterproofed walls, floors and roofs.

B. Furnish curbs for mechanical roof mounted equipment a minimum of 14 inches high above roofing surface. Curbs shall be furnished by the Mechanical Contractor and installed by the General Contractor. Curb blocking, flashing and counterflashing shall be provided by the General Contractor. Refer to plan details.

C. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.06 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for insulation continuous through the sleeve.

C. Extend sleeves through floors one inch above finished floor level. Caulk sleeves.

D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide penetration seal materials in accordance with printed instructions of the U.L. Fire Resistance Directory and in accordance with manufacturer's instruction, and as required by local code officials and plan details.

Provide close fitting sheet metal collar or escutcheon covers at both sides of penetration. See plan details.

E. Install chrome or stainless steel escutcheons at all pipe penetrations in exposed areas.

END OF SECTION 15503

SECTION 15509

DUCTWORK INSULATION

PART 1 GENERAL

1.01 SCOPE

A. Ductwork insulation

B. Insulation jackets

1.02 RELATED SECTIONS

A. Section 09900 - Painting: Painting insulation jackets

B. Section 15505 - Mechanical Identification

1.03 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate

B. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation

D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation

E. ASTM E84 - Surface Burning Characteristics of Building Materials

F. ASTM E96 - Water Vapor Transmission of Materials

G. NFPA 255 - Surface Burning Characteristics of Building Materials

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

I. UL 723 - Surface Burning Characteristics of Building Materials

1.04 SUBMITTALS

A. Submit under provisions of Division 1 and Section 15500

B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, U.L. 723.

1.06 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum five years experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1 and Section 15500.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 GLASS FIBER, FLEXIBLE

A. Manufacturers:

1. CertainTeed Corporation

2. Knauf Fiber Glass GmbH

3. Owens-Corning Fiberglas

4. Schuller/Manville

5. Substitutions: Under provisions of Section 15500

B. Insulation: ASTM C553, C612; flexible, noncombustible blanket

1. 'K' value: ASTM C518, 0.29 at 75 degrees F

2. Maximum service temperature: 250 degrees F

3. Maximum moisture absorption: 0.20 percent by volume

4. Density: 0.75 lb/cu ft.

C. Vapor Barrier Jacket

a. Indicate assembly dimensions, locations of support posts, and general construction details.

b. Indicate welded connections.

c. Provide a Bill of Materials to include all components of the assembly.

d. Indicate location and type of insulating materials.

2. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film

3. Moisture vapor transmission: ASTM E96

4. Secure with pressure sensitive tape

a. Vapor Barrier Tape

5. Manufacturers:

a. Halstead

b. 3M

c. United McGill

d. Substitutions: Under provisions of Section 15500

6. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that all joints in ductwork have been sealed and that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Insulated ductwork conveying air below and above ambient temperature:

1. Provide insulation with vapor barrier jackets.

2. Finish with tape and vapor barrier jacket.

3. Continue insulation through walls, sleeves, hangers and other duct penetrations.

4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections and expansion joints. Where service access is required, bevel and seal ends of insulation.

3.03 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.04 DUCT INSULATION SCHEDULE

A. Provide insulation on exterior of all supply, return and outside air ductwork. Exterior insulation is not required on exhaust ductwork and double-wall pre-insulated ductwork.

B. Ductwork is defined to include housings, mixing boxes, in-line fan housing, and similar components of the duct system. All exposed ends of all coils, including reheat coils shall be insulated the same as for ducts. All supply diffusers and outlets shall have the neck, back of diffuser and bare duct insulated the same as supply ducts, unless otherwise noted.

C. Externally Insulated in Concealed Ceiling Spaces: Two-inch (2") thickness of 3/4 lb.density glass fiber blanket faced with vapor barrier jacket.

D. Externally Insulated in Exposed Spaces (i.e. Mechanical Rooms): Two-inch (2") thickness of rigid vapor seal fiberglass duct insulation of three (3) lb. density with factory-applied embossed aluminum foil facing. Breaks and joints shall be filled with vapor barrier cement on all corners. Finish shall be eight (8) ounce canvas adhered with lagging cement.

END OF SECTION 15509

SECTION 15760

TERMINAL HEAT TRANSFER UNITS

PART 1 GENERAL

1.01 SCOPE

A. Electric Infrared Heaters

B. Radiant Heating Panels

1.02 RELATED SECTIONS

A. Section 15501 Electrical Requirements for HVAC Equipment

1.03 REFERENCES

A. ANSI/NFPA 70

1.04 SUBMITTALS

A. Submit shop drawings under provisions of Division 1 and Section 15500

B. Submit product data under provisions of Division 1 and Section 15500

C. Submit product data indicating typical catalog of information including arrangements.

D. Indicate mechanical and electrical service locations and requirements, specifically indicating deviations from indicated products.

E. Submit manufacturer's installation instructions under provisions of Division 1 and Section 15500

1.05 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 1 and Section 15500

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Division 1 and Section 15500

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum ten years documented experience.

1.08 REGULATORY REQUIREMENTS

A. Conform to applicable ANSI/NFPA 70 code for internal wiring of factory wired equipment.

1.09 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 1 and Section 15500

B. Store and protect products under provisions of Division 1 and Section 15500

C. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

PART 2 PRODUCTS

2.01 MANUFACTURERS - ELECTRIC UNIT HEATERS

A. Electromode

B. Chromalox

C. Markel

D. Modine

E. Raywall

F. Berko

G. Q-Mark

H. Substitutions: Under provisions of Section 15500

2.02 RADIANT CEILING PANELS

A. UL listed and labeled with built-in 36" flexible cable pre-wired.

B. Construction: Electric resistance graphite element embedded between two layers of insulation. Outer shell shall be formed steel with baked enamel finish.

C. Ceiling Panels: 24 x 48 inch pans with white finish. Provide with layin ceiling mounting kit.

D. Provide with wall mounted line voltage thermostat

2.03 ELECTRIC INFRARED HEATERS

A. Assembly: Stainless steel with non-corrosive housing, hardware and brackets, no ferrous metals, UL listed and labeled with terminal box and cover and controls.

B. Heating Element: Clear quartz lamps

C. Enclosure: Stainless steel body with gold anodized aluminum reflector.

D. Accessories: Wire guard to protect heating element and line voltage thermostat capable of controlling multiple heaters

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work and opening dimensions are as indicated on shop drawings and instructed by the manufacturer.

B. Verify that required utilities are available, in proper location, and ready for use.

C. Beginning of installation means installer accepts existing surfaces.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Hang unit heaters from building structure, with hangers anchored to building, not from piping or ductwork. Mount at height indicated. Submit proposed mounting method with equipment shop drawings.

C. Protect units with protective covers during balance of construction.

3.03 CLEANING

A. Clean work under provisions of Division 1 and Section 15500

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean the coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION

SECTION 15830

VARIABLE REFRIGERANT VOLUME (VRV) HVAC SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable refrigerant volume HVAC system includes:

1. Outdoor/Condensing unit(s)

2. Indoor/Evaporator units

3. Heat Recovery Units

4. Refrigerant piping

5. Control panels

6. Control wiring

1.02 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.

B. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2011

C. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2009

D. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc ; 2007, Including All Addenda (ANSI/ASHRAE/

E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings shown in the contract documents:

1. Outdoor/Central Units:

a. Refrigerant Type and Size of Charge

b. Cooling Capacity: Btu/h (W)

c. Heating Capacity: Btu/h (W)

d. Cooling Input Power: Btu/h (kW)

e. Heating Input Power: Btu/h (kW)

f. Operating Temperature Range, Cooling and Heating

g. Air Flow: Cubic feet per minute (Cubic meters per second)

h. Fan Curves

i. External Static Pressure (ESP): Inches WG (Pa)

j. Sound Pressure Level: dB(A)

k. Electrical Data:

i) Maximum Circuit Amps (MCA)

ii) Maximum Fuse Amps (MFA)

iii) Maximum Starting Current (MSC)

iv) Full Load Amps (FLA)

v) Total Over Current Amps (TOCA)

vi) Fan Motor: HP (W)

2. Weight and Dimensions.

a. Maximum number of indoor units that can be served

b. Maximum refrigerant piping run from outdoor/condenser unit to indoor/evaporator unit

c. Maximum height difference between outdoor/condenser unit to indoor/evaporator unit, both above and below

d. Control Options

3. Indoor/Evaporator Units:

a. Cooling Capacity: Btu/h (W)

b. Heating Capacity: Btu/h (W)

c. Cooling Input Power: Btu/h (kW)

d. Heating Input Power: Btu/h (kW)

e. Air Flow: Cubic feet per minute (Cubic meters per second)

f. Fan Curves

g. External Static Pressure (ESP): Inches WG (Pa)

h. Sound Pressure level: dB(A)

i. Electrical Data:

vii) Maximum Circuit Amps (MCA)

viii) Maximum Fuse Amps (MFA)

ix) Maximum Starting Current (MSC)

x) Full Load Amps (FLA)

xi) Total Over Current Amps (TOCA)

xii) Fan Motor: HP (W)

j. Maximum Lift of Built-in Condensate Pump

k. Weight and Dimensions

l. Control Options.

4. Control Panels: Complete description of options, control points, zones/groups

B. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:

1. Detailed piping diagrams, with branch balancing devices

2. Condensate piping routing, size, and pump connections

3. Detailed power wiring diagrams

4. Detailed control wiring diagrams

5. Locations of required access through fixed construction

6. Drawings required by manufacturer

C. Operating and Maintenance Data:

1. Manufacturer's complete standard instructions for each unit of equipment and control panel.

2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.

3. Identification of replaceable parts and local source of supply.

D. Project Record Documents: Record the following:

1. As-installed routing of refrigerant piping and condensate piping

2. Locations of access panels

3. Locations of control panels

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.

B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.06 WARRANTY

A. VRF equipment shall be warranted by the manufacturer's limited warranty for a period of two years from date of installation or 30 months from date of delivery whichever is shorter. System shall be commissioned by the manufacturer or certified manufacturer's agent with a report submitted to the VRF manufacturer. Labor is not included.

B. Compressors: Provide manufacturer's warranty for six (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of the manufacturer. All warranty service work shall be preformed by a factory trained service professional. Labor is not included.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: The system design shown in the contract documents is based on equipment and system designed by Daikin.

B. Systems designed and manufactured by other manufacturers will be considered by Owner under the terms described for substitutions with the following exceptions:

1. Substitution requests will be considered only if required submittal data is complete; see article SUBMITTALS above.

2. Contractor (not equipment supplier) shall certify that the use of the substitute system and equipment will not require changes to other work or redesign by Architect.

3. Do not assume substitution has been accepted until formal written notice has been issued by Architect.

2.02 HVAC SYSTEM DESIGN

A. System Operation: Heating and cooling, simultaneously.

1. Zoning: Provide capability for temperature control for each individual indoor/evaporator unit independently of all other units.

2. Zoning Provide heating/cooling selection for each individual indoor/evaporator unit independently of all other units.

3. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.

4. Conditioned spaces are shown on the drawings

5. Heat Recovery Unit locations are not shown on the drawings

6. Required equipment unit capacities are shown on the drawings

7. Refrigerant piping sizes are not shown on the drawings

8. Connect equipment to condensate piping provided by others; condensate piping is shown on the drawings.

B. Cooling Mode Interior Performance:

1. Daytime Setpoint: 68 degrees F, plus or minus 2 degrees F

2. Setpoint Range: 57 degrees F to 77 degrees F

3. Night Setback: 78 degrees F

4. Interior Relative Humidity: 20 percent, maximum.

C. Heating Mode Interior Performance:

1. Daytime Setpoint: 68 degrees F, plus or minus 2 degrees F

2. Setpoint Range: 59 degrees F to 80 degrees F

3. Night Setback: 60 degrees F

4. Interior Relative Humidity: 10 percent, minimum.

D. Outside Air Design Conditions:

1. Summer Outside Air Design Temperature: 0.4 percent cooling design condition listed in ASHRAE Fundamentals Handbook.

2. Summer Outside Air Design Temperature on the Building Roof: 98 degrees F dry-bulb.

3. Winter Outside Air Design Temperature: 99.6 percent heating design condition listed in ASHRAE Fundamentals Handbook.

E. Energy Design Wind Speed: 25 mph

F. Operating Temperature Ranges:

1. Simultaneous Heating Operating Range: 14 degrees F to 60 degrees F wet bulb.

2. Simultaneous Cooling Operating Range: 14 degrees F to 81 degrees F dry bulb.

3. Cooling Mode Operating Range: 23 degrees F to 115 degrees F dry bulb.

4. Heating Mode Operating Range: minus 4 degrees F to 60 degrees F wet bulb; without low ambient controls or auxiliary heat source.

G. Refrigerant Piping Lengths: Provide equipment capable of serving system with following piping lengths without any oil traps:

1. Minimum Piping Length from Outdoor/Central Unit(s) to Furthest Terminal Unit: 738 feet

2. Total Combined Liquid Line Length: 3280 feet, maximum

3. Maximum indoor unit elevation separation: 49 feet

4. Maximum elevation difference of outdoor unit and indoor unit, outdoor unit either above or below indoor unit, is 360 ft.

5. Maximum equivalent pipe length from first branch to farthest indoor unit is 295 ft.

6. Maximum elevation change between series piped Heat Recovery units is 16 ft.

H. Control Wiring:

1. Provide a minimum 18 AWG, 2 conductors stranded shielded copper cable only. Maintain polarity throughout the communications network.

2. Connect the communications cable between indoor units using a daisy chain configuration only. "Star" or "Home Run" control wiring connections involving soldering or wire caps are not permitted.

3. Provide separate conduits/paths for control wiring and power wiring.

I. Controls: Provide the following control interfaces:

1. For Each Indoor/Evaporator Unit: One wall-mounted wired "local" controller, with temperature sensor; locate where indicated.

2. One central remote control panel for entire system; locate where indicated.

J. Local Controllers: Wall-mounted, wired, containing temperature sensor.

2.03 EQUIPMENT

A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.

1. Refrigerant: R-410A.

2. Performance Certification: Provide systems AHRI 1230 Certified; (www.ahridirectory.org.)

3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL and bearing the certification label.

4. Provide outdoor/condensing units capable of serving indoor unit capacity up to 100 percent of the capacity of the indoor units.

5. Provide units capable of serving the zones indicated.

6. Energy Efficiency: Report EER and COP based on tests conducted at "full load" in accordance with AHRI 1230

B. Electrical Characteristics:

1. Power - Condensing Units: 208-230 or 460-480 Volts, 3-phase, 60 Hz.

2. Power - Branch Selector Units: 208 to 230 Volts, single phase, 60 Hz.

3. Power - Indoor Units: 208 to 230 Volts, single phase, 60 Hz.

4. 208-230 Voltage Tolerance is plus or minus 10%

5. Control: 24 volts DC

C. Refrigerant Piping:

1. Provide three-pipe refrigerant system, including high/low pressure dedicated hot gas, liquid and suction lines; two-pipe systems utilizing lower tem-

perature mixed liquid/gas refrigerant to perform heat recovery are not permitted due to reduced heating capabilities.

2. Refrigerant Flow Balancing: Provide refrigerant piping joints and headers specifically designed to ensure proper refrigerant balance and flow for optimum system capacity and performance; T-style joints are prohibited.

3. Insulate each refrigerant line individually between the condensing and indoor units.

2.04 OUTDOOR/CONDENSING UNITS

A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.

1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.

2. Refrigerant: Factory charged.

3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.

4. Capable of being installed with wiring and piping to the left, right, rear or bottom.

5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source.

6. Outdoor unit shall have a tested sound rating no higher than 58 dB (A) per outdoor frame tested per ISO1996.

7. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.

8. Provide refrigerant auto-charging feature and refrigerant charge check function.

9. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

10. Provide double spiral tube refrigerant sub-cooling heat exchanger to ensure the liquid refrigerant does not flash when supplying to us indoor units.

11. Oil Management: The outdoor unit shall have a centrifugal oil separator for each compressor and controls to insure sufficient oil supply is maintained for the compressor.

B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed galvanized steel panels coated with powder coat baked enamel finish.

1. Designed to allow side-by-side installation with minimum 3 inch spacing.

C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.

1. External Static Pressure: Factory set at 0.12 in WG (30 Pa), minimum.

2. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG (80 Pa), minimum; provide for mounting of field-installed ducts.

3. Fan Airflow: As indicated for specific equipment.

4. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment. Maximum speed of fan shall not exceed 1050 rpm.

D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance. The coil fins shall have factory applied corrosion resistant with hydrophilic coating. Coil shall be protected with an integral metal guard.

E. Compressors: Scroll type, hermetically sealed, digitally controlled inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit;

1. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.

2. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.

3. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.

4. Provide oil separators and intelligent oil management system.

5. Provide spring mounted vibration isolators.

2.05 HEAT RECOVERY UNITS

A. Heat Recovery Units: Concealed boxes designed specifically for this type of system to control heating/cooling mode selection of downstream units; consisting of electronic expansion valves, subcooling heat exchanger, refrigerant control piping and electronics to facilitate communications between outdoor unit, heat recovery unit, and indoor/evaporator units.

1. Control direction of refrigerant flow using electronic expansion or solenoid valves.

2. When branch unit is simultaneously heating and cooling, energize double spiral sub-cooling heat exchanger per port as needed.

3. Casing: Galvanized steel sheet; with flame and heat resistant foamed polyethylene sound and thermal insulation.

4. Condensate Drainage: Provide unit that does not require condensate drainage.

5. Heat Recovery Units shall be run tested at the factory.

6. Heat Recovery Units shall have 2, 3, or 4 ports for connections to indoor units. Each port shall be capable of connecting from one to eight indoor units up to a maximum nominal capacity of 54 MBH.

7. Heat Recovery Units shall be permitted to be piped in series or parallel to minimize material cost and labor.

8. The Heat Recovery Unit shall be controlled by integral microprocessors and communicate with the main control in the outdoor unit. The control circuit between the indoor units, heat recovery box, and outdoor unit shall be 24VDC completed using a 2-conductor, stranded and shielded cable for the RS485 daisy chain communication.

2.06 INDOOR/EVAPORATOR UNITS

A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.

2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.

3. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.

4. Provide thermistor on liquid and gas lines.

5. Fans: Direct-drive, with statically and dynamically balanced impellers; high and low speeds unless otherwise indicated; motor thermally protected.

6. Return Air Filter: Washable long-life net filter with mildew proof resin, unless otherwise indicated.

7. Condensate Drainage: Built-in condensate drain pan with PVC drain connection.

8. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.

9. The indoor unit shall communicate with the outdoor unit

10. Indoor unit refrigerant circuit shall be filled with a dry nitrogen gas charge from the factory.

B. High Static Ceiling Concealed Units: Ducted horizontal discharge and return; galvanized steel cabinet.

1. Return Air Filter: Factory supplied removable, washable filter

2. Sound Pressure: Measured at low speed at 5 feet (1.5 m) below unit.

3. Provide external static pressure switch adjustable for high efficiency filter operation

4. Fan: The indoor unit fan shall be no more than one assembly with two Sirocco fans direct driven by a single motor. Fan shall be statically and dynamically balanced with permanently lubricated bearings.

5. Condensate Pump: Factory installed, with lift of 27 inches minimum above the bottom of the indoor unit.

C. Vertical/Horizontal Air Handler: Ducted vertical/horizontal discharge and return; 22-gauge coated baked enamel finish steel cabinet. The return air opening will be on the bottom in the vertical position or right end in the horizontal position. Return air plenum subbase to be field provided.

1. Return Air Filter: Field provided for 16" x 20" x 1" filter rack. Filter access is from the front of the unit for easy serviceability.

2. Sound Pressure: Measured at low speed at 5 feet (1.5 m) below unit.

3. Provide external static pressure switch adjustable for high efficiency filter operation

4. Fan: The indoor unit fan shall be no more than one assembly with Sirocco fan direct driven by a single brushless digitally controlled design (BLDC)

motor. Fan shall be statically and dynamically balanced with permanently lubricated bearings.

5. All access panels to be provided with gasket seals to minimize air leakage within the unit.

6. Condensate drain connection for gravity condensate system.

D. Building Controls

1. Provide a central control panel with color touch screen for user interface. The AC Smart shall have the following features and capabilities:

a. Group Control: Group up to 64 devices by refrigerant circuit, floor, tenant, department, area, or any other breakdown. AC Smart panel controls and monitors device operating schedules, room temperatures, and other operating parameters.

b. Scheduling: Panel may be programmed to start and stop each device based on a customizable 365 day schedule.

c. System Backup: Provide an onboard battery that enables continued operation during power outages.

d. USB port: USB port required to provide a backup to AC Smart setup parameters and to update software

e. Provide expansion capability of up to 128 devices if required

f. Provide Digital Output expansion kit for control of additional binary outputs to control specified ancillary devices, such as lighting, exhaust fans, or ventilation dampers.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.

B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install refrigerant piping in accordance with equipment manufacturer's instructions.

C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).

D. Coordinate with installers of systems and equipment connecting to this system.

3.03 FIELD QUALITY CONTROL

A. Provide manufacturer's field representative to inspect installation prior to startup.

3.04 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform system startup.

B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.

C. Adjust equipment for proper operation within manufacturer's published tolerances.

3.05 CLEANING

A. Clean exposed components of dirt, finger marks, and other disfigurements.

3.06 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

B. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.

2. Briefly describe function, operation, and maintenance of each component.

C. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of two hours of training.

END OF SECTION

SECTION 15838

HVAC FANS

PART 1 GENERAL

1.01 SCOPE

A. Inline Fans

B. Shutter Mount Exhaust Fans

C. Fiberglass Wall Ventilator

1.02 RELATED SECTIONS

A. Section 15072 – Vibration Isolation

B. Section 15500 – Basic HVAC Requirements

C. Section 15072 - Supports and Anchors

D. Section 15890 - Ductwork

1.03 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. AMCA 99 - Standards Handbook.

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices.

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.

G. NEMA MG1 - Motors and Generators.

H. NFPA 70 - National Electrical Code.

I. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.04 SUBMITTALS

A. Submit under provisions of Division 1 and Section 15500

B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

C. Product Data: Provide schedule of vibration isolator type with location and load on each.

D. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

E. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.05 OPERATION AND MAINTENANCE

A. Submit under provisions of Section 01 78 23.

B. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list and wiring diagrams.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01 31 00.

B. Protect motors, shafts and bearings from weather and construction dust.

1.07 EXTRA MATERIALS

A. Furnish under provisions of Section 01 60 00.

B. Provide two sets of belts for each fan.

1.08 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 and Section 15500

B. Record actual locations of hangers including attachment points.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mason Industries, Inc.

B. Kinetics Industries, Inc.

C. Dayton

D. Greenheck

E. Twin City

F. Substitutions: Under provisions of Section 15500

2.02 INLINE FANS

A. Impeller: Centrifugal fans in cabinet with direct drive motors.

B. Electrical Characteristics:

1. Refer to Section 15501

2. Motor: Self-aligning pre-lubricated ball or sleeve bearings.

3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

4. Frame: One piece, square steel with die formed venturi orifice, mounting flanges and supports, with baked enamel finish.

5. Backdraft Damper: Multiple blade with offset hinge pin, blades linked. Backdraft dampers not required on units not connected to outdoor louvers or gravity ventilators.

6. Safety Screens: One inch galvanized wire cover inlet, motor, and drive

2.03 CORROSION RESISTANT SHUTTER MOUNT EXHAUST FANS

A. Propeller: Fiberglass reinforced polypropylene

B. Electrical Characteristics:

1. Refer to Section 15501

2. Motor: 115 volt totally enclosed motor

3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

C. Frame: Fiberglass with an automatic shutter with stainless steel hardware

D. Gaurd: OSHA compliant epoxy coated wire guard

E. UL and C-UL Listed

2.04 FIBERGLASS WALL VENTILATOR

A. Fan: Polypropylene backward inclined

B. Electrical Characteristics:

1. Refer to Section 15501

2. Motor: 115 volt totally enclosed motor.

3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

C. Frame: Molded fiberglass housing

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide sheaves required for final air balance.

C. Provide safety screen where inlet or outlet is exposed.

D. Provide backdraft dampers on discharge of exhaust fans and as indicated.

E. Do not operate fans in normal operation until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 15840

UNITARY AIR CONDITIONING UNITS

PART 1 SECTION INCLUDES

1.01 GENERAL

A. Computer Room Air Condition (CRAC) Unit

B. Split System Dehumidification Unit

1.02 RELATED SECTIONS

A. Section 16140 – Wiring Devices

1.03 REFERENCES

A. ARI 210 - Unitary Air-Conditioning Equipment.

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

C. NFPA 70 - National Electrical Code.

D. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

1.04 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

C. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

D. Division 1 - Submittals: Submittals for information.

E. Submit manufacturer's installation instructions. Indicate assembly, support details, connection requirements, and include start-up instructions.

F. Division 1 - Contract Closeout: Division 1 - Operation and Maintenance Data: Submittals for project closeout.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

B. Unit shall be rated in accordance with ARI Standards 210/240 or 360 and 270. Designed in accordance with UL Standard 1995.

C. Unit shall be designed to conform to ASHRAE 15, latest revision.

D. Unit shall be UL - tested and certified in accordance with ANSI Z21.47 Standards and UL listed and certified under Canadian standards as a total package for safety requirements.

1.06 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE AND PROTECTION

A. Protect units from physical damage by storing off site permanent mounting pads are in place, ready for immediate installation of units.

1.08 WARRANTY

A. Division 1 – Closeout Procedures.

B. Division 1 – Product Requirements.

C. Provide a five year warranty to include coverage for refrigeration compressors.

1.09 EXTRA MATERIALS

A. Install one new set of filters at the time of substantial completion and furnish one additional set of filters for the indoor units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Liebert

B. Stulz

C. Data Aire

D. PoolPak

E. Desert Aire

F. Substitutions as identified through documented Substitution process

2.02 COMPUTER ROOM AIR CONDITIONING UNIT

A. System shall consist of an indoor unit and an outdoor condensing unit. The two components shall be connected by refrigerant piping with integral condensate pump.

B. Unit components shall be tested by a Nationally Recognized Testing Laboratory (NRTL)) and bear the ETL label.

C. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

D. The system shall be rated in accordance with Air-conditioning Refrigeration Institute's (ARI) Standard 210 and bear the ARI Certification label.

E. A pressure charge of R410A refrigerant sufficient for 75 feet of refrigerant tubing shall be provided in the condensing unit.

F. System efficiency shall meet or exceed 12.5 SEER.

G. Provide a unit mounted controller for the indoor unit. This controller shall perform input functions necessary to operate the system. The controller shall consist of a power ON/OFF switch, mode selector, temperature setting, timer control, fan speed and select. The unit shall have an emergency operation mode to allow operation without the controller

H. The units shall have a manufacturer's parts and defects warranty for a period one (1) year from the date of the original installation. The compressor shall have a warranty of 6 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. The warranty shall cover material and labor.

I. The indoor unit Component:

1. The indoor unit shall be factory assembled, wired and run tested. The unit shall be factory wired, have all internal piping and control circuit board, fan motor and condensate pump.

2. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch.

3. Indoor unit and refrigerant pipes shall be charged with dry air before shipment from the factory.

4. Install the unit on equipment pad as shown

5. The indoor unit fan shall be in the upflow arrangement; direct driven by a single fan motor.

6. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.

7. The indoor unit fan motor shall operate in three (3) selectable speeds, High, Medium and Low.

8. The return air stream shall have a means for installing a filter.

9. The indoor unit (evaporator) coil shall be of nonferrous construction with smooth, hydrophilic coated aluminum fins on copper tubing.

10. Tubing shall have inner groves for high efficiency heat exchange.

11. All tube joints shall be brazed with PhosCopper or silver alloy.

12. The coil shall be pressure tested at the factory.

13. A sloped condensate pan and drain with extension hose shall be provided under the coil.

14. The electrical power for the indoor and outdoor units will be supplied individually. Refer to equipment schedule for unit voltage.

15. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wall mounted controller, providing emergency operation and controlling the outdoor unit.

16. The system shall be capable of automatic restart when power is restored after power interruption.

J. The Outdoor Condensing Unit :

1. The outdoor unit shall be designed specifically for use with indoor units. The units shall be equipped with a circuit board that interfaces to the indoor unit circuit board. The outdoor unit shall be completely factory assembled, internally piped and wired. Each unit shall be run tested at the factory.

2. The outdoor unit casing shall be fabricated from zinc coated steel, bonderized with an electrostatically applied, thermally bonded, acrylic or polyester powder coating for corrosion protection.

3. Case and mounting feet shall be as follows:
   a) The MS-A09WA base shall be of Aluminum-Zinc-Magnesium alloy coated steel, with welded mounting feet.
   b) The base for the MS-A12WA shall have a galvanized steel base with welded mounting feet.

4. The outdoor unit shall have a direct drive propeller type fan, statically and dynamically balanced for smooth and quiet operation.

5. The fan motor shall have inherent protection, be equipped with permanently lubricated bearings. The fan motor shall be mounted and isolated for quiet operation.

6. The fan shall be provided with a raised guard to prevent contact with moving parts.

7. The condenser coil shall be of nonferrous construction with pre-coated with E-Coat Epoxy paint or equivalent sea coast coating.

8. The coil shall be protected with an integral metal guard.

9. Refrigerant flow from the condenser shall be controlled by means of a metering orifice.

10. The compressor shall be a high performance, hermetic, rolling piston, rotary type.

11. Compressor shall be mounted using rubber isolating bushings to avoid the transmission of vibration.

12. Compressor shall be protected by an automatic over current relay and a thermal overload switch

13. The outdoor unit shall have an accumulator.

14. The outdoor unit must have the ability to operate with a maximum height difference of 35 feet between indoor and outdoor units.

15. The unit shall have a maximum refrigerant tubing length of 75 feet between in door and outdoor units without the need for line size changes, traps or additional oil.

16. The unit shall be pre-charged for a maximum of 75 feet of refrigerant tubing.

17. Provide an integral condensate pump with the unit. Provide separate power connection for the pump from the unit controller. Install condensate piping from the pump up through the ceiling space to discharge at the location indicated on the drawings.

18. The unit shall be capable of low ambient operation.

2.03 SPLIT SYSTEM DEHUMIDIFICATION UNITS

A. System shall consist of an indoor unit and an outdoor condensing unit. The two components shall be connected by refrigerant piping. The unit shall be capable of hot gas reheat.

B. Unit components shall be tested by a Nationally Recognized Testing Laboratory (NRTL)) and bear the ETL label.

C. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

D. The system shall be rated in accordance with Air-conditioning Refrigeration Institute's (ARI) Standard 210 and bear the ARI Certification label.

E. System efficiency shall meet or exceed 12.5 SEER.

F. Provide unitary controls to maintain constant discharge air temperature and relative humidity.

G. The units shall have a manufacturer's parts and defects warranty for a period one (1) year from the date of the original installation. The compressor shall have a warranty of 6 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. The warranty shall cover material costs only.

H. The indoor unit Component:

1. The indoor unit shall be factory assembled, wired and run tested. The unit shall be factory wired, have all internal piping and control circuit board and fan motor.

2. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch.

3. Indoor unit and refrigerant pipes shall be charged with dry air before shipment from the factory.

4. The indoor unit casing shall have a factory finish.

5. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.

6. The return inlet air stream shall have a means for installing a filter.

7. The indoor unit coils shall be coated for chemically resistant operations.

8. The indoor unit (evaporator) coil shall be of nonferrous construction with smooth, pre-coated aluminum fins on copper tubing.

9. Tubing shall have inner groves for high efficiency heat exchange.

10. All tube joints shall be brazed with PhosCopper or silver alloy.

11. The coil shall be pressure tested at the factory.

12. A condensate pan and drain with extension hose shall be provided with the unit.

13. The system shall be capable of automatic restart when power is restored after power interruption.

I. The outdoor condensing unit Component:

1. The outdoor unit shall be designed specifically for use with the associated indoor unit. The unit shall be equipped with a circuit board that interfaces to the indoor unit circuit board. The outdoor unit shall be completely factory assembled, internally piped and wired. Each unit shall be run tested at the factory.

2. The outdoor unit casing shall be fabricated from zinc coated steel, bonderized with an electrostatically applied, thermally bonded, acrylic or polyester powder coating for corrosion protection.

3. The outdoor unit shall have a direct drive propeller type fan, statically and dynamically balanced for smooth and quiet operation.

4. The fan motor shall have inherent protection, be equipped with permanently lubricated bearings. The fan motor shall be mounted and isolated for quiet operation.

5. The fan shall be provided with a raised guard to prevent contact with moving parts.

6. The condenser coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing.

7. The coil shall be protected with an integral metal guard.

8. Refrigerant flow from the condenser shall be controlled by means of a metering orifice.

9. The compressor shall be a high performance, hermetic, rolling piston, rotary type.

10. Compressor shall be mounted using rubber isolating bushings to avoid the transmission of vibration.

11. Compressor shall be protected by an automatic over current relay and a thermal overload switch

12. The outdoor unit shall have an accumulator.

13. The outdoor unit must have the ability to operate with a maximum height difference of 35 feet between indoor and outdoor units.

14. The unit shall have a maximum refrigerant tubing length of 75 feet between in door and outdoor units without the need for line size changes, traps or additional oil.

15. The unit shall be pre-charged for a maximum of 75 feet of refrigerant tubing.

16. The unit shall be capable of low ambient operation

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 1 – Project Management and Coordination: Verification of existing conditions prior to beginning work.

1. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and NFPA 90A.

B. Install indoor air conditioning units on wall. Install units level.

C. Install indoor dehumidification units and indoor dedicated outdoor air units on floor with leveling legs.

D. Install condensing units on pads on grade. Install units level.

3.03 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Division 1 – Quality Requirements.

B. Provide initial start-up and shut-down during first year of operation, including routine servicing and check-out.

END OF SECTION 1584

SECTION 15890

DUCTWORK

PART 1 SECTION INCLUDES

1.01 GENERAL

A. Metal ductwork

B. Nonmetal ductwork

C. Casing and plenums

D. Duct cleaning

1.02 RELATED SECTIONS

A. Section 09900 - Painting: Weld priming, weather-resistant paint or coating

B. Section 15503 - Supports and Anchors

C. Section 15509 - Duct Insulation

D. Section 15910 - Ductwork Accessories

E. Section 15940 - Air Distribution

F. Section 15990 - Testing, Adjusting and Balancing

1.03 REFERENCES

A. ASTM A 36 - Structural Steel

B. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles

C. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

D. ASTM A 366 - Steel, Sheet, Carbon, Cold Rolled, Commercial Quantity

E. ASTM A 480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

F. ASTM A 525 - General Requirements for Steel Sheet, Zinc- Coated (Galvanized) by the Hot-Dip Process

G. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality

H. ASTM A 568 - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled

I. ASTM A 569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality

J. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate

K. AWS D9.1 - Welding of Sheet Metal

L. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

M. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems

N. NFPA 91 - Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying

O. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment

P. SMACNA - HVAC Air Duct Leakage Test Manual

Q. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

R. SMACNA - Fibrous Glass Duct Construction Standards

S. UL 181 - Factory-Made Air Ducts and Connectors

1.04 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.05 SUBMITTALS

A. Submit under provisions of Division 1

B. Shop Drawings: Indicate duct fittings and particulars such as gauges, sizes, welds, and configuration prior to start of work. Prepare and submit to the Engineer coordinated composite layouts of all sheet metal ductwork. The drawings shall be drawn at not less than 1/4-inch per foot and shall include dimensions for connections and offsets. Include sectional views, installation details and other items that must be shown to assure a coordinated installation.

C. Product Data: Provide data for duct materials, fittings, duct connectors, etc.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 and Section 15500

B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum five years documented experience.

1.09 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90.

B. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061- T6 or of equivalent strength.

C. Flexible Ducts:

1. Manufacturers:

a. The Flexaust Co.

b. Hart & Cooley

c. The Wagner Group

d. Therma Flex

e. Substitutions: Under provisions of Section 15500

2. UL labeled multiple layers of aluminum laminate supported by helically wound spring steel wire.

3. Pressure Rating: 10 inches WG positive and 1.0 inches negative

4. Maximum Velocity: 4000 fpm

5. Temperature Range: -20 degrees F. to 210 degrees F

D. Insulated Flexible Ducts:

1. Manufacturers:

a. Certain Teed

b. Knauf Fiber Glass

c. Owens Corning

d. Therma Flex

e. Substitutions: Under provisions of Section 15500

2. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire; fiberglass insulation; aluminized vapor barrier film.

3. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.

4. Maximum Velocity: 4000 fpm.

5. Temperature Range: -20 degrees F. to 210 degrees F

E. Stainless Steel Ducts: ASTM A167, Type 304 or 316.

F. Fasteners: Rivets, bolts, or sheet metal screws.

G. Sealant:

1. Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.

H. Hanger Rod: ASTM A36; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

I. Fiberglass Reinforced Plastic Ductwork

1. Manufacturers:

a. Monoxivent

b. Perry Fiberglass Products, Inc.

c. Vari-Tech LLC

d. ATS Inc.

e. Substitutions: Under provisions of Section 15500

2. FRP – Fiberglass Reinforced Plastic ductwork and appurtenances, complete and in place, in accordance with the requirements of the Drawings.

3. All supply and return ductwork from the dehumidification units into the main process area of the Water Treatment Plant shall be FRP as indicated. All ductwork in chemical storage rooms shall be FRP as indicated.

4. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

   a. ASTM C 582 – Standard specification for contact – molded reinforced thermosetting plastic laminates for corrosion resistant equipment.

   b. ASTM D 3982 – Standard specification for contact-molded fiberglass ducts and hoods.

   c. ASTM D 2996 – Standard specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Pipe.

   d. NPS 15-69 - Standards specification for Custom Contact-Molded Reinforced - Polyester Chemical - Resistant Process Equipment.

   e. SMACNA Thermoset FRP Duct Construction Manual

   f. ASTM E 84 - Test for low flame

5. Fittings:

   a. Fittings shall be hand lay-up construction fabricated from the same resin and have the same strength as the FRP duct.

   b. The internal diameter of fittings shall be equal to the adjacent duct.

   c. The centerline radius of all elbows shall be 1.5 times the diameter.

   d. Elbows 24" (610mm) diameter and smaller shall be smooth radius. Elbows larger than 24" (610mm) diameter shall be mitered.

   e. Elbows 45 degrees or less shall be at least two (2) miter/three (3) gore. Elbows greater than 45 degrees shall be at least four (4) miter/five (5) gore.

6. Flanges:

   a. Provide flanged connections as required to flexible connectors, expansion joints, vessels, demisters, fans, silencers and other locations as shown.

b. Flanges shall be hand lay-up construction. Dimensions shall be in accordance with PS 15-69 – Table 2 and the duct dimension schedule.

c. Flange faces shall be perpendicular to the axis of the duct within 0.5 degree.

d. Flange faces shall be flat to within 0.0313" (0.8mm) up to and including 18" (457mm) diameter and within 0.0625" (1.6mm) for 20" (508mm) diameter and larger.

e. Gaskets shall be EPDM/Neoprene, full face and minimum 0.125" (3.2mm) thickness.

f. Bolts, nuts and washers shall be Type 316 stainless steel.

7. Joints:

a. Provide butt and wrap joints in accordance with ASTM D 3982.

b. Field weld materials shall be supplied by the duct manufacturer. Complete written and online video instructions shall be provided along with Material Safety Data Sheets.

c. Resin, catalyst and fiberglass materials shall be supplied in bulk for the total number of joints plus 20% extra.

2.02 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

1. Supply ductwork - 2" W.G.

2. Return, relief, outdoor air and exhaust ductwork (-) 2" W.G.

3. Exhaust ductwork downstream of cabinet fan (-) 4" W.G.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream. No duct taps will be allowed in any diverging or converging transitions.

D. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

E. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

2.03 MANUFACTURED DUCTWORK AND FITTINGS

A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

B. Round Ducts:

1. Manufacturers:

a. Monroe Metal

b. United McGill

c. R. V. Money

d. Dixie Steel

e. Eastern Sheet Metal

f. Spiral Pipe of Texas

g. Substitutions: Under provisions of Section 15500

2. Machine made from round spiral lockseam duct with light reinforcing corrugations; fittings manufactured of at least two gauges heavier metal than duct.

3. Double wall spiral duct, with 2" of insulation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Provide sealant on all duct joints.

C. Provide duct leakage tests on all ductwork in accordance with SMACNA Air Duct Leakage Test Manual. Test pressure shall be 2" w.g. Allowable leakage rate shall not exceed 1%.

D. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage.

Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

G. Use crimp joints with or without bead for joining round duct sizes 8 inches and smaller with crimp in direction of air flow.

H. Use double nuts and lock washers on threaded rod supports.

I. Connect diffusers to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.

J. Connect flexible ducts to metal ducts with draw bands and sheet metal screws.

K. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

L. No ductwork shall be hung or supported from structural bridging or the roof deck material.

M. Support flexible duct maximum 3'-0" O.C. and in any change in direction.

N. FRP ducts shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings and equipment.

O. Supports and anchors: All ducting shall be firmly supported with fabricated or commercial hangers or supports in accordance with SMACNA requirements. Where necessary to avoid stress on equipment or structural members, the ducts shall be anchored or harnessed.

P. Expansion joints and guides as shown on drawings shall compensate for expansion due to temperature differences.

Q. Support duct risers in accordance with ASHRAE and SMACNA as indicated.

3.02 CLEANING

A. Clean work under provisions of Division 1 and Section 15500.

B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

C. Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

END OF SECTION 15890

SECTION 15910

DUCTWORK ACCESSORIES

PART 1 PART 1 - GENERAL

1.01 SCOPE

A. Backdraft dampers

B. Duct access doors

C. Duct test holes

D. Fire dampers

E. Flexible duct connections

F. Volume control dampers

1.02 RELATED SECTIONS

A. Section 15890 - Ductwork

B. Section 16180 - Equipment Wiring Systems: Electrical characteristics and wiring connections

1.03 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

B. NFPA 70 - National Electrical Code

C. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

D. UL 33 - Heat Responsive Links for Fire-Protection Service

E. UL 555 - Fire Dampers and Ceiling Dampers

1.04 SUBMITTALS

A. Submit under provisions of Division 1 and Section 15500

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.

C. Product Data: Provide for shop fabricated assembles including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Indicate for fire dampers and for combination fire dampers.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 and Section 15500

B. Record actual locations of access doors & test holes.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.07 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1 and Section 15500.

B. Protect dampers from damage to operating linkages and blades

1.09 EXTRA MATERIALS

A. Furnish under provisions of Division 1 and Section 15500

B. Provide two of each size and type of fusible link

PART 2 PART 2 - PRODUCTS

2.01 BACKDRAFT DAMPERS

A. Gravity Backdraft Dampers, Size 18 x 18 inches or smaller, furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16 gauge thick galvanized steel, or extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.02 DUCT ACCESS DOORS

A. Manufacturers:

1. United McGill

2. Duro-Dyne

3. Ductmate Ind.

4. Substitutions: Under provisions of Section 15500

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

1. Less Than 12 Inches Square: Secure with sash locks

2. Up to 18 Inches Square: Provide two hinges and two sash locks

3. Up to 24 x 48 Inches: Three hinges and two compression latches with outside and inside handles

4. Larger Sizes: Provide an additional hinge

D. Access doors with sheet metal screw fasteners are not acceptable

2.03 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill-in ducts are required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation

2.04 FIRE DAMPERS

A. Manufacturers:

1. Ruskin Mfg.

2. Air Balance, Inc.

3. Vent Products Co.

4. Greenheck

5. Penn Ventilator

6. Prefco

7. NCA Manufacturing

8. United Air

9. Substitutions: Under provisions of Section 15500

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated

C. Ceiling Radiation Dampers for Round Neck Diffusers: 1-1/2 hour rated, galvanized steel, 20 gauge frame and 20 gauge blade with UL Classified insulation. Provide with thermal insulating blanket for diffuser and UL listed fusible link air volume adjustment. Provide extended neck type where flexible ductwork connects to diffusers.

D. Ceiling Radiation Dampers for Square Neck Diffusers: 1 hour rated, UL classified, square curtain type damper, one-piece 22 gauge roll formed galvanized steel ramp, tightly woven reinforced fiberglass fabric with aluminum impregnated coating, stainless steel negator springs, 165 deg. F. fusible link, fabric riveted to blade.

E. Curtain Type Dampers: 1-1/2 or 3 hour rated as indicated galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations closure under air flow conditions. Configure with blades out of air stream except for ducts up to 12 inches in height.

F. Multiple Blade Dampers: 16 gauge galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles; 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible Links: UL 33, separate at 165 degrees F.

2.05 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

1. Duro-Dyne Corp.

2. United McGill Corp.

3. Vibration Mountings & Controls, Inc.

4. Substitutions: Under provisions of Section 15500

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated

C. Connector: Fabric crimped into metal edging strip

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz. per sq. yd.

2. Net Fabric Width: Approximately 3 inches wide

3. Metal: 3 inches wide, 24 gauge galvanized steel

2.06 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Ruskin Mfg.

2. United McGill Corp.

3. Air Balance Corp.

4. Greenheck

5. Penn Ventilator

6. Duro-Dyne

7. NCA Manufacturing

8. Substitutions: Under provisions of Section 15500

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Single Blade Dampers: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. End Bearings: Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

E. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.

2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.07 BACK PRESSURE DAMPER

A. Back draft damper, end-pivoted counter-balanced blades, airfoil blades, galvanized steel construction equal to American Warming and Ventilating Model BD-52.

B. Provide external linkage for motor operation.

C. Damper shall be motor operated, but shall also open or close in response to air pressure.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install accessories in accordance with manufacture's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, smoke detectors, smoke dampers, and elsewhere as indicated.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Demonstrate re-setting of fire dampers to Owner's representative.

G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

I. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 15940

AIR DISTRIBUTION

PART 1 GENERAL

1.01 SCOPE

A. Diffusers

B. Registers/grilles

C. Gravity Ventilators

D. Louvers

E. FRP Diffusers

F. FRP Louvers

1.02 RELATED SECTIONS

A. Section 15890 - Ductwork: Insulated flexible duct

B. Section 15910 - Ductwork Accessories: Volume dampers and air extractors

1.03 REFERENCES

A. ADC 1062 - Certification, Rating and Test Manual

B. AMCA 500 - Test Method for Louvers, Dampers and Shutters

C. ARI 650 - Air Outlets and Inlets

D. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets

E. SMACNA - HVAC Duct Construction Standard - Metal and Flexible

F. NFPA 70 - National Electrical Code

G. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.04 SUBMITTALS

A. Submit under provisions of Division 1 and Section 15500

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Samples: Submit one sample of a square ceiling diffuser

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 and Section 15500

B. Record actual locations of air outlets and inlets

1.06 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70

B. Test and rate louver performance in accordance with AMCA 500

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Titus

B. Greenheck

C. Loren Cook

D. Carnes

E. Acme

F. Metalaire

G. E. H. Price

H. Krueger

I. Tuttle & Bailey

J. Primary Plastics Inc.

K.

L. Substitutions: Under provisions of Section 15500

2.02 SQUARE CEILING DIFFUSERS (SUPPLY)

A. Type: Square steel diffuser with adjustable discharge on supply and fixed discharge on return. Square inlet integral to diffuser with square to round adaptor. Outer frame assembly of size shown on schedule. Inner core assembly consists of fixed deflection louvers set in a 4-way discharge pattern. Inner core diffusers shall be a minimum of 20" x 20" on all 24" x 24" diffusers. Inner core assembly

shall be removable in the field without the use of tools for easy cleaning, installation and damper adjustment.

B. Frame: Inverted T-bar type. In gypsum board ceilings, provide surface-mount ceiling frame.

C. Fabrication: Steel with baked enamel off-white finish.

D. All diffusers installed in gypsum board ceilings shall be furnished with an opposed blade volume damper adjustable from the face of the diffuser. Refer to reflected ceiling plans and mechanical plans for locations.

2.03 SQUARE CEILING RETURN AND EXHAUST GRILLES

A. Type: Eggcrate aluminum grid with 1/2" x 1/2" x 1/2" cubes with minimum 90% free area.

B. Frame: Outer border shall be constructed of heavy extruded aluminum (thickness of 0.040" - 0.050") and shall have countersunk screw holes for a neat appearance.

C. Damper: Integral, opposed blade volume damper constructed of heavy gauge steel or aluminum operable from face of grille at all locations where grille is installed in non-accessible ceilings.

2.04 GRAVITY VENTILATORS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Fabricate of galvanized steel, minimum 16 gauge base and 20 gauge hood, or aluminum, minimum 16 gauge base and 18 gauge hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory baked enamel finish.

C. Mount unit on minimum 12 inch high curb base with insulation between duct and curb.

D. Make hood outlet area minimum of twice throat area.

2.05 LOUVERS

A. Type: Weather proof louver designed to protect air intakes and exhaust openings. Unit shall have stationary drainable horizontal blades that channels water to the jambs to drain through the sill. AMCA licensed performance required.

B. Frame: Heavy gauge extruded 6063-t5 Aluminum 4" x 0.081" nominal wall thickness

C. Fabrication: Aluminum mechanically fastened, mill finish

D. All louvers shall be provided with birdscreen

2.06 FRP LOUVERS

A. Type: Fiberglass Reinforced Plastic FRP louver. Louvers shyall be flush construction with a 20 mil gelcoated finish; color defined by purchaser.

B. Frame: Jambs, sill, header, slats and vanes shall be fabricated of gelcoated FRP.

C. Fabrication: FRP owner and architect to select color.

D. All louvers designated as FRP construction shall meet flamespread rating per ASTM E-84 and should be self-extinguishing per ASTM D-635.

2.07 SCHEDULE

A. Refer to Air Distribution Schedule for specific requirements and special accessories.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, grille or register assembly.

E. Provide ceiling radiation dampers and thermal blankets on ceiling diffusers in accordance with plans and Section 15910.

END OF SECTION 15904

SECTION 15990

TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.01 SCOPE

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of refrigerating systems.

C. Measurement of final operating condition of HVAC systems.

D. Sound measurement of equipment operating conditions.

E. Vibration measurement of equipment operating conditions.

1.02 RELATED SECTIONS

A. General requirements for testing agencies are specified in the Division 1 Section Quality Control Services.

B. Other Division 15 Sections specify balancing devices and their installation, and materials and installations of HVAC systems.

C. Individual Division 15 system sections specify leak testing requirements and procedures.

1.03 REFERENCES

A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance

B. ADC - Test Code for Grilles, Registers, and Diffusers

C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air conditioning, and Refrigeration Systems

D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems

E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing

1.04 SUBMITTALS

A. Submit under provisions of Division 1

B. Submit name qualifications and references of adjusting and balancing agency for approval within 48 hours after bid opening.

C. Test Reports: Submit under provisions of Division 1

1. All specified tests shall be documented in writing listing date, item tested, section tested, witnesses to the test (signed), and specification section which requires testing. Reports on testing shall be provided to the Architect within seven (7) days of completion of each test. In addition all test reports shall be complied in a spiral bound 8 1/2" x 11" document and submitted at the same time and in the same quantity as required for Operation and Maintenance manuals.

D. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

F. Submit draft copies of report for review prior to final acceptance of Project. Provide final typed copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

G. Provide typed reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

H. Include detailed procedures, agenda, sample report forms, and copy of AABC National Project Performance Guaranty prior to commencing system balance.

I. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, forms prepared following ASHRAE 111 or NEBB forms.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1

B. Record actual locations of flow measuring stations, balancing valves and rough setting.

1.06 QUALITY ASSURANCE

A. A certified testing and balancing agency shall perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance ASHRAE 111 or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. Maintain one copy of each document on site.

1.07 PRE-BALANCING CONFERENCE

A. Convene with Owner and Architect one week prior to commencing work of this section, under provisions of Division 1.

PART 2 PRODUCTS

Not Used

PART 3 PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.

2. Temperature control systems are installed complete and operable.

3. Proper thermal overload protection is in place for electrical equipment.

4. Final filters are clean and in place. If required, install temporary media in addition to final filters.

5. Duct systems are clean of debris.

6. Fans are rotating correctly.

7. Fire and volume dampers are in place and open.

8. Air coil fins are cleaned and combed.

9. Access doors are closed and duct end caps are in place.

10. Air outlets are installed and connected.

11. Duct system leakage is minimized.

B. Submit field reports promptly to Owner and Architect. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.02 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.03 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.04 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark final settings of valves, dampers, and other adjustment devices with paint or engraved devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

F. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. If total air quantities cannot be attained with equipment in place, the Balancing Contractor shall notify the Owner and Architect. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.06 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing

1. Split System Dehumidification Units
2. Variable Refrigerant System
3. Exhaust Fans
4. Air Filters
5. Air Inlets and Outlets

B. Report Forms

1. Title Page:
   a. Project name
   b. Project location
   c. Project Architect
   d. Project Engineer
   e. Project Contractor
   f. Project altitude
   g. Report date
2. Summary Comments:
   a. Design versus final performance
   b. Notable characteristics of system
   c. Description of systems operation sequence

d. Summary of outdoor and exhaust flows to indicate amount of building pressurization

e. Nomenclature used throughout report

f. Test conditions

3. Instrument List:

a. Instrument

b. Manufacturer

c. Model number

d. Serial number

e. Range

f. Calibration date

4. Electric Motors:

a. Manufacturer

b. Model/Frame

c. HP/BHP

d. Phase, voltage, amperage; nameplate, actual, no load

e. RPM

f. Service factor

g. Starter size, rating, heater elements

h. Sheave Make/Size/Bore

5. V-Belt Drive:

a. Identification/location

b. Required driven RPM

c. Driven sheave, diameter and RPM

d. Belt, size and quantity

e. Motor sheave diameter and RPM

f. Center to center distance, maximum, minimum, and actual

6. Air Moving Equipment

a. Location

b. Manufacturer

c. Model number

d. Serial number

e. Arrangement/Class/Discharge

f. Air flow, specified and actual

g. Return air flow, specified and actual

h. Outside air flow, specified and actual

i. Total static pressure (total external), specified and actual

j. Inlet pressure

k. Discharge pressure

l. Sheave Make/Size/Bore

m. Number of Belts/Make/Size

n. Fan RPM

7. Return Air/Outside Air Data:

a. Identification/location

b. Design air flow

c. Actual air flow

d. Design return air flow

e. Actual return air flow

f. Design outside air flow

g. Actual outside air flow

h. Return air temperature

i. Outside air temperature

j. Required mixed air temperature

k. Actual mixed air temperature

l. Design outside/return air ratio

m. Actual outside/return air ratio

8. Exhaust Fan Data:

a. Location

b. Manufacturer

c. Model number

d. Serial number

e. Air flow, specified and actual

f. Total static pressure (total external), specified and actual

g. Inlet pressure

h. Discharge pressure

i. Sheave Make/Size/Bore

j. Number of Belts/Make/Size

k. Fan RPM

9. Duct Traverse:

a. System zone/branch

b. Duct size

c. Area

d. Design velocity

e. Design air flow

f. Test velocity

g. Test air flow

h. Duct static pressure

i. Air temperature

j. Air correction factor

10. Air Distribution Test Sheet:

a. Air terminal number

b. Room number/location

c. Terminal type

d. Terminal size

e. Area factor

f. Design velocity

g. Design air flow

h. Test (final) velocity

i. Test (final) air flow

j. Percent of design air flow

END OF SECTION 15990

SECTION 15995

HVAC SYSTEMS COMMISSIONING

PART 1 GENERAL

1.01 GENERAL PROVISIONS

A. Drawings and general provisions of the Contract, including General Conditions and Supplemental Conditions and Division 1 apply to Work of this section.

B. Provisions of Divisions 15 and 16 of the project specifications which are applicable to Commissioning of the HVAC System are an integral part of this Section.

C. Commissioning is an important and integral part of the Contractor's Quality Control program.

D. In addition to coordination activities with the Owner and the Engineer, the Contractor shall coordinate inspections with the Commissioning Agent.

1.02 WORK INCLUDED

A. "Active participation" in the Commissioning program as generally outlined in this section.

1.03 COMMISSIONING PROGRAM CRITERIA

A. Intent:
   1. The intent of Building System Commissioning is to assure delivery to the Owner of systems which are properly installed and fully functioning in accordance with the contract documents and to assure the Owner's personnel are fully trained and equipped to operate, maintain and troubleshoot the delivered systems.
   2. The HVAC Contractor, in conjunction with the Owner and Design Consultant shall prepare and implement a Commissioning program which achieves these objectives and the scope of work as defined in this Section. The scheduled work of Commissioning must be included in the Detailed Project Construction Schedule.
   3. This Section provides only a general overview of the minimum Commissioning program requirements.
   4. The HVAC Contractor shall exceed those requirements whenever necessary to achieve the stated intent of Building Commissioning.

B. Definitions and Abbreviations:
   1. Maintenance Orientation and Periodic Inspection: At prescribed times during the work the HVAC Contractor shall walk the site with the Engineer's representative and designated Owner's staff, to orient them to equipment types and locations, assist them with access for periodic quality assurance and answer questions concerning the Work. Prescribed training sessions

and submittal of Operation and Maintenance Manuals shall be completed in conjunction with the Commissioning effort.

2. Equipment Placement Completion: Stage of the Work at which the major items of Division 15 equipment have been placed at final locations, but have not received ductwork, piping and electrical connections. Major equipment includes, but is not limited to, heating and cooling plant equipment and air-handlers.
3. Distribution Completion: Stage of Work at which distribution piping and ductwork have been installed and tested, but not insulated or concealed by further Work.
4. O. & M. Manuals: Operation and Maintenance Manuals as specified in Contract Documents.
5. TAB: Testing, Adjusting and flow Balance of Division 15 equipment as specified in Contract Documents.
6. Trade Representative: Person who competently represents the work force engaged by the Contractor for the individual trade named. This person shall be completely familiar with the Work performed for this Contract at all levels of detail of his trade and with coordination to other trades. This person shall be capable of and have authority to execute all commissioning responsibilities of the trade as described in these Contract Documents.
7. Active Participation: Attend Commissioning events, provide technical expertise and knowledge, equipment measurements and observation needed or requested by the Design Consultant or designated Owner's staff. Provide training follow-up analysis, equipment data, design data and other trade or manufacturer's representative service needed in response to Commissioning events or systems operation and testing.
8. Verify: To positively determine that the measured or observed readings, quantities and data gathered satisfies all requirements of the Contract Documents. Simply performing the tests, measurements or observations does not constitute "verification." Tests which fail or data gathered which is not in compliance with the Contract Documents must be repeated and data re-collected at no additional cost to the Owner.

C. Scope:
   1. For coordination purposes, the Commissioning scope is generally outlined below:
      a. Air Systems Balancing:
         1. 100% of air distribution (supply, return, outside and exhaust) will be verified.
         2. Dehumidification Units
         3. Fan coil units
         4. Computer Room Air Conditioning Unit
      b. Owner Training of Mechanical Systems as specified in this section and related sections.
      c. Verify that equipment and systems have been properly installed in accordance with the contract documents and manufacturer's written installation instructions.
      d. Verify that piping systems have been properly cleaned.

e. Verify that equipment has been placed into operation with the appropriate manufacturer's oversight and approval.
f. Verify that adjusting, balancing and system testing has been properly done.
g. Assemble record drawings and other specified project data
h. Assemble operation and maintenance instructions and submittal data on equipment and systems incorporated into the project; review this information in a session with Owner's designated staff.
i. Verify the satisfactory performance of each piece of equipment and key components of each system.
j. Train Owner's designated staff in the proper operation and maintenance of each piece of equipment and key components of each system.
k. Document and review warranty start and end dates.

D. Commissioning Cost:
1. All cost of the Commissioning of Building Systems for this project shall be included in the Bid Breakdown Item included on the Bid Proposal Form.

E. Submittals:
1. All submittals, product data, equipment schedules, etc., relevant to the work included in this section, shall be reviewed by the Owner, in addition to the Design Consultant and Contractor(s), prior to proceeding with the work.

PART 2 PRODUCTS

NOT APPLICABLE TO THIS SPECIFICATION

PART 3 EXECUTION

3.01 COMMISSIONING TEAM

A. The Owner shall assemble the Commissioning Team which shall consist of the following persons:
1. HVAC Contractor and Trade Representative(s)
2. Control System Trade Representative(s)
3. Test, Adjust and Balance (TAB) Trade Representative
4. Electrical Contractor's Representative (limited participation)
5. Owner's Project Manager
6. Owner's Maintenance staff
7. Owner's Commissioning staff
8. Third Party Commissioning Agency (if applicable)
9. Engineer of Record

B. The Commissioning Team shall develop and generally follow a schedule of Commissioning events for the project.

3.02 RESPONSIBILITIES

A. Commissioning Authority (Owner's CxA or Third Party Commissioning Agency)
   1. Assign appropriate staff and schedule them to participate in the various meetings, training sessions and inspections as follows:
      a. Pre-commissioning coordination and schedule of events meeting.
      b. Installation progress inspections
      c. Maintenance orientation and inspection at connection of distribution systems.
      d. Procedures meeting to agree on Testing, Adjusting and Balancing methodology.
      e. Observation of factory start-ups including, but not limited to, dehumidifiers, variable refrigerant system and fan coil units
      f. Validate final Testing and balancing report.
      g. Owner's training and demonstration session(s).
      h. Review of operation and maintenance manuals and submittals for key components of the building systems.
      i. Participate in overhead and substantial completions inspections.
      j. Prepare and maintain a Commissioning Issues Log during the commissioning process of all non-compliance items including submittals, inspections, and systems verification phases of the work. This log shall periodically be distributed to and reviewed by the Commissioning Team for necessary and appropriate action to resolve these items.
      k. Review of submittals from the Contractors; comments to be provide to the design consultant to incorporate into his review and approval process.
      l. Prepare final commissioning report and submit to appropriate owner, architect and engineer.

B. HVAC Contractor
   1. Review all Commissioning requirements and intent of the Contract Documents. Assure all specialty Trade Subcontractors include their active participation in the Commissioning of the building systems.
   2. Coordinate the implementation of the Commissioning program, through organization of all meetings, tests, demonstrations, training events and performance verifications described in the Contract Documents and the Commissioning program.
   3. The plan and specification review by the HVAC Contractor does not include any responsibility for the system evaluation, adequacy of the system to meet design intent, capacity of the system or any of the other elements of the system design which are the strict responsibility of the Engineer of Record.
   4. Schedule a pre-commissioning coordination meeting with the Commissioning Team within 45 days of the award of the contract, at a convenient location. This pre-commissioning meeting will be for the purpose of reviewing the complete Commissioning program and establishing tentative schedules for maintenance orientation and

inspections, O. & M. submittals, training sessions, system flushing and testing, job completion, system start-up and test, adjust and balance work.

5. Schedule, notify and conduct all required Commissioning demonstrations, inspections and sessions which are included in this Commissioning program. These demonstrations will be conducted by the HVAC Contractor and his Trade Representative(s) and witnessed by the Commissioning Team. These shall include but are not limited to the following:
   a. Dehumidification Air Handling Unit pre-installation meeting
   b. Variable Refrigerant System pre-installation meeting
   c. Pre-TAB meeting with TAB Contractor
   d. TAB validation and checkout of final TAB report
   e. Dehumidification Air Handling Unit and associated equipment checkout and performance testing
   f. Variable Refrigerant System and associated equipment checkout and performance testing
   g. Exhaust fan checkout and testing
   h. Radiant Heater checkout and testing
   i. Fire Alarm checkout and testing
   j. Overhead inspections
   k. Substantial completion inspections.
6. Contractor will provide a copy of selected submittals for Commissioning Authority review for equipment that is being commissioned. These submittals will be provided at the same time submittals are provided to the design consultants to allow parallel reviews.
7. Collect and review operation and maintenance manuals and submit to the Engineer of Record for review.
8. Schedule a meeting with the test, adjust and balance (TAB) Trade Representative prior to the start of the test, adjust and balance procedure. This meeting should be attended by the Commissioning Team. The TAB Trade Representative will outline the TAB procedure and get concurrence from the Engineer of Record and HVAC Contractor. Ensure that the TAB Trade Representative has all forms required for the job data-base and understands their importance and use.
9. Schedule and conduct the Owner training sessions. A training outline will be submitted by the Contractor to the Commissioning Authority for approval two weeks prior to conducting the training sessions. These training sessions are to be attended by appropriate members of the Commissioning Team.
10. Prepare and provide to the Commissioning Team a schedule for tracking maintenance (both scheduled and non-scheduled work) for each piece of equipment. This schedule should include preventive maintenance plan. This schedule will be included in the Operational and Maintenance Manuals provided by the HVAC Contractor.
11. Review as-built drawings for accuracy against installed systems. Forward final checked record drawings to the Engineer of Record.
12. Provide written certification that the following work has been completed in accordance with the plans and specifications and that they are functioning as designed. Where the Work has been subcontracted, the Trade

Representative shall be responsible for the initial certification with the HVAC Contractor recertifying that he has inspected the Work and that it has been completed and functioning as designed. These certifications must be submitted to the Commissioning Authority and included in the Final Report.

a. HVAC equipment including all fans, air handling units, dehumidification units, ductwork, dampers, terminals, and all Division 15 equipment.
b. Refrigeration equipment, pumping systems and heat rejection equipment.
c. Fire stopping in the fire rated construction including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
d. Fire detection and smoke detection devices furnished by others as they affect the operation of the smoke control systems.
e. That unitary controlers are functioning properly to monitor, control, and address HVAC equipment, smoke control and lighting control systems.

C. Engineer of Record

1. Provide clarification of any design intent questions raised by the Commissioning Team.
2. Attend and actively participate in initial pre-commissioning coordination meeting to be scheduled by the Commissioning Coordinator within 45 days of the award of the contract.
3. Review and understand the Commissioning program as outlined in this specification.
4. The Engineer of Record shall verify adequate maintenance accessibility for each piece of equipment in shop drawing reviews and actual installation.
5. Receive and review operation and maintenance manuals as submitted by the Contractor.
6. Attend Owner training sessions as appropriate.
7. Review TAB report from HVAC Contractor against design assumptions and system requirements. Issue a report noting deficiencies requiring correction to the Commissioning Team.
8. Prepare record drawings for the project promptly after receipt from the HVAC Contractor.

3.03 TRAINING OF OWNER'S PERSONNEL

A. The Owner's staff shall be given comprehensive training in the operation and maintenance of each major piece of equipment.

B. The HVAC Contractor shall provide to the Commissioning Team, during the submittal phase, a detailed training schedule outlining the proposed timeframes and topics to be included in the training sessions. A training outline will be submitted by the Contractor to the Commissioning Authority for approval two weeks prior to conducting the training sessions.

C. The HVAC Contractor, in cooperation with the Commissioning Team, will be responsible for scheduling and actively participating in the training. Hands on training shall include start-up, operation in all modes possible, shut-down and any emergency procedures.

D. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals and shall include a review of the written operation and maintenance manuals. Training will be included for all major pieces of equipment. Equipment training shall be done by qualified service representatives employed by the manufacturers.

3.04 NOTIFICATION OF SYSTEM COMPLETION AND REQUEST FOR FINAL HVAC SYSTEM COMMISSIONING VERIFICATION

A. When systems are ready for final commissioning verifications, demonstrations, and/or inspections, the HVAC Contractor shall certify to the Commissioning Authority, in writing, that all systems are complete and fully functional. The completion of the Schedules provided in this Specification is one acceptable manner of providing for this written certification. Other means of providing this certification must be approved by the Commissioning Authority. This notification shall be made as soon as possible to allow completion of all verification prior to Substantial Completion. Any inspection, verifications or demonstrations required by this Specification not completed by Substantial Completion shall be added to the Substantial Completion Punch List. In addition, any unsatisfactory items identified during these demonstration or inspections shall be added to the Substantial Completion Punch List.

B. Should the verification test reveal that the equipment is not performing as specified or control operation is not acceptable, the HVAC Contractor will be entitled to one re-inspection of any failed item at no additional cost.

C. Should the verification test determine that the equipment is still not performing as specified or control operation is not acceptable on the second inspection, the time and expenses of the Engineer of Record and Owner to make further verification shall be considered as additional cost to the Owner. The total sum of such costs shall be deducted from the final payment to the HVAC Contractor. Billing rates shall be defined as specified in the Supplemental Conditions. The hourly rate identified in the Supplemental Conditions shall apply to both the Design Consultant and Owner's additional time necessary to perform re-inspections.

3.05 VERIFICATION OF PERFORMANCE

A. Verification of system and component performance will take place after the Contractor and Design Consultant certify that all Work is complete and the building systems are fully operational.

B. Verification will be completed by the Contractor and Commissioning Authority utilizing Schedules contained in these specifications. Any check-out sheets utilized other than those found in this specification shall be approved by the Commissioning Authority.

C. Verification to include demonstration of performance as required by the Contract Documents. The specified Contractor's verifications shall be entered on the attached Commissioning Data Sheets prior to the Commissioning Authority's verification. The witnessed (Commissioned) performance data shall be added to the data sheet at the time of verification.

D. The following demonstrations will be required:
   1. Major duct flow and pressure checks:
      a. The TAB Representative will provide a copy of the TAB report to be used to document testing results. The TAB Trade Representative shall identify all places where temperature, pressure, and/or velocity readings were taken. All locations must be per AABC or NEEB Standards.
   2. Dehumidification Unit Performance:
      a. Coil Performance - Packaged Dehumidification Unit
      b. Both cooling and reheat coils shall be demonstrated with the unit under control and at full air flow. Air temperature data and pressure loss shall be recorded together with air flow.
   3. Fan and motor performance:
      a. Fan and Motor Performance – Dehumidification Unit
      b. Demonstrate performance with the unit under control and at full flow. CFM, Static Pressure and motor volts/amps shall be recorded.
   4. Variable Refrigerant System performance:
      a. Outdoor Unit Performance
      b. Record under operating conditions. Note O.A. ambient condition. Plot on performance chart with part load conditions.
   5. Exhaust fan performance:
      a. Exhaust Fan Schedule – Schedule PC-06.
      b. Demonstrate during normal operation.
   6. HVAC Unitary Controlers: The Mechanicall Contractor is required to provide checkout procedures and checkout data sheets to verify all items noted below. These checkout procedures and data sheets shall be submitted to the Commissioning Authority for approval two weeks prior to start of verification demonstrations.
      a. Verification of all sequences of operation during both heating and cooling seasons.
      b. ON/OFF control of each applicable piece of equipment.
      c. Sequential operation
      d. All control loops:
      e. Demonstrate control to set point without excessive hunting.
      f. Measurement of Building Pressure

3.06 REPORT REQUIREMENTS

A. The HVAC Contractor shall document each Commissioning event by completion date. The schedules shall separately list deficiencies observed or discovered during the event. These documents shall be distributed to the Commissioning Authority as they are completed.

B. The HVAC Contractor shall transmit the following to the Commissioning Authority:
   1. Completed Commissioning Data Sheets
   2. TAB Balancing Report
   3. Confirmation that any system changes resulting from the Commissioning program have been included in the final operations and maintenance manuals or are depicted on the final Record Drawings.

END OF SECTION

SECTION 16050

GENERAL PROVISIONS RELATED TO ELECTRICAL WORK

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental, to the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.

B. Where the word "Contractor" appears in these Technical Specifications it shall be construed to mean the Electrical Contractor.

C. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL INTERCONNECTING DEVICES, CONDUIT, WIRE, AND APPURTENANCES NOT FURNISHED BY OTHERS BUT REQUIRED FOR THE OPERATION OF EQUIPMENT AS DESCRIBED IN THE FUNCTIONAL DESCRIPTIONS WHETHER SPECIFICALLY SHOWN ON THE DRAWINGS OR NOT.

D. The scope of work for this project primarily includes, but is not limited to, the following:
   1. Furnish and installation of new low voltage power distribution equipment.
   2. Furnish and install low voltage motor control equipment including reduced voltage motor starters and variable frequency drives.
   3. Furnish and install power panelboards, lighting panelboards, dry-type transformers, and other low voltage electrical power distribution equipment.
   4. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, and other pertinent components.
   5. Furnish and install all underground raceway systems including conduit, fittings, manholes, handholes and other pertinent components.
   6. Furnish and install all low voltage wire and cable resulting in a complete and operable electrical system.
   7. Furnish and install new lighting systems and wiring devices.
   8. Perform electrical equipment tests and provide equipment operation training as specified herein.
   9. Coordinate the installation of the new utility services with the electric utility.
   10. Other electrical work as specified herein and indicated on the Drawings.

E. All electrical equipment shall conform to the applicable NEMA specifications. All electrical equipment shall be properly identified in accordance with these Specifications and Contract Drawings. All panelboards, starters, control panels, cabinet enclosures, junction boxes, pull boxes, and equipment switches shall be identified per the requirements of Section 16075 – Electrical Identification.

F. All materials, equipment, sizes and capacities of electrical equipment incorporated in the project shall conform to the latest requirements of the current National Electric Code, the National Electrical Manufacturer's Association, the State and local electrical codes, and to applicable rules and regulations of the local electrical utility serving the project.

G. All material and equipment must be the product of an established, reputable, and approved manufacturer; must be new and of first class construction; must be designed and guaranteed to perform the service required; and must bear the label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.

H. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.

I. Where the Contractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.

J. Furnish and install controls for each piece of equipment requiring controls under this Contract. The controls shall be the size and type recommended by the manufacturer for the application and as otherwise specified or indicated on the Drawings. Refer to Divisions 1 and 13 of the Specifications for control, connection and coordination descriptions and requirements.

K. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.

1.02 DEFINITIONS

A. Where the following terms are used in this Division of the specifications and on the Electrical Drawings, meanings are as indicated.
   1. Provide: Furnish and install.
   2. Furnish: Acquire and make available devices or equipment for installation by others.
   3. Install: Install devices or equipment furnished by others.
   4. Wherever the words "Approved" and "Approved Equal" appear, it is intended that items other than the model numbers specified shall be subject to the approval of the Engineer.
   5. Panelboard, switchboard, and motor control center space designations:
      a. Blank: Not intended for use; plate only.
      b. Space: Contains necessary bus and hardware for future addition of circuit breakers or starters within size range.
      c. Spare: Contains a complete circuit breaker or starter installed, size as indicated for future use.
   6. Electrical Contractor: Electrical subcontractor.

1.03 COORDINATION OF WORK

A. Electrical work is included in the General Contract. It is the responsibility of the General Contractor to provide the coordination of electrical work with the electrical sub-contractor.

1.04 FEES, PERMITS, AND INSPECTIONS

A. Electrical Contractor shall obtain permits and arrange for the inspections necessary for the installation of the electrical work and furnish the Engineer with certificates of inspection from authorities having jurisdiction.

B. Inspections and tests shall be made upon formal notice to the Engineer from the Contractor sufficiently in advance to allow a representative of the Engineer to be present for each test.

C. No construction shall be covered up or concealed until it has been inspected or approved. Furnish material, labor, fuel, equipment and apparatus for tests as specified for the work.

D. Make final inspection and tests in the presence of the Engineer and Owner. Make tests under conditions simulating as nearly as practicable, those which will be obtained in operation and which show conclusively that the requirements of the specifications have been fulfilled. Provide instruments required for the tests.

1.05 CODES AND STANDARDS

A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the Insurance Rating Organization having jurisdiction, the serving electrical utility company, the latest edition of the National Electrical Code (NEC), the National Electric Manufacturers Association (NEMA), the Institute of Electrical and Electronic Engineers (IEEE), the Insulated Cable Engineers Association (ICEA), the American Society of Testing Materials (ASTM), the American National Standards Institute (ANSI), the requirements of the Occupational Safety Hazards Act (OSHA), and all other applicable Federal, State and local laws and/or ordinances.
2. All material and equipment shall bear the inspection labels of Underwriters Laboratories, Inc., if the material and equipment is of the class inspected by said laboratories.
3. All work shall be in accordance with local codes.

B. Nonconformance

1. Any paragraph of requirements in these Specifications, or Drawings, deviating from the rules, requirements and Specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules, requirements and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or Specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which

may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

1. Upon completion of the work, the Contractor shall obtain certificate(s) of inspection and approval from the National Board of Fire Underwriters or similar inspection organization having jurisdiction and shall deliver same to the Engineer and the Owner.

1.06 DRAWINGS

A. The Contractor shall furnish, install, and place in satisfactory condition ready for operation, all conduits, cables, and all other material needed for the complete lighting, power, control and other electrical systems shown or indicated in the Contract Drawings. Additional conduits and the required wiring shall be installed by the Contractor wherever needed to complete the installation of the specific equipment furnished.

1.07 EQUIPMENT LOCATION

A. The Drawings show the general location of feeders, transformers, outlets, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly; furnishing such fittings, junction boxes, and accessories as may be required to meet such conditions. The Contractor shall refer to the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Contractor shall verify all equipment dimensions to insure that proposed equipment will fit properly in spaces indicated.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIAL

A. Equipment and material of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.

B. Equipment and material shall be new and shall bear the manufacturer's name or trade name.

C. All materials and equipment shall be labeled or listed by Underwriters' Laboratories or other North Carolina approved testing agency.

D. Where a product is specified by brand name and catalog number, and only one such product is listed, the product shall note the quality standard of product desired. Bidders are not restricted to the specific product listed. The information is used only to set forth and convey the general style, type, character, and quality of product desired. Equivalent products may be submitted to the Engineer for approval. However when three or more products are listed by catalog number, one of the listed products shall be used. Similarly, where three or more manufacturers are listed for a type of product and no catalog number is given, but a descriptive specification is provided, a product of one of the listed manufacturers meeting the specification shall be used.

2.02 DIMENSIONS

A. Ensure that items of equipment furnished fit the space available. Make necessary field measurements to ascertain space requirements, including connections. Provide such sizes and shapes of equipment that the final installation shall suit the true intent and meaning of the drawings and specifications.

2.03 MANUFACTURER'S DIRECTIONS

A. Follow manufacturer's directions for the delivery, storage, protection, and installation of equipment and materials. Notify Engineer in writing of conflicts between the requirements of the contract documents and manufacturer's directions. Obtain the Engineer's written instructions before proceeding with the work. Correct deficiencies in work that does not comply with the manufacturer's directions or written instructions from the Engineer.

2.04 EQUIPMENT ACCESSORIES

A. Provide equipment, accessories, connections, and incidental items necessary to fully complete the work, ready for use, occupancy and operation by the Owner.

2.05 SELECTIVE COORDINATION

A. All overcurrent devices shall be selectively coordinated with all supply-side overcurrent protective devices as required by 2011 National Electric Code, Article 701.27 for legally required systems.

2.06 CONCRETE

A. The Contractor shall furnish all concrete required for the installation of all electrical work, Concrete shall be Class A unless otherwise specified. Concrete and reinforcing steel shall meet the appropriate requirements of Division 3 of the Specifications.

B. The Contractor shall provide concrete equipment pads for all free standing electrical apparatus and equipment located on new or existing floors or slabs. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The exact location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of these pads. Equipment pads shall be 4 inches high unless otherwise indicated on the Drawings and shall conform to standard detail for equipment pads shown on the Contract Drawings. Equipment pads shall not have more than 3" excess concrete beyond the edges of the equipment.

C. The Contractor shall provide concrete foundations for all free standing electrical apparatus and equipment located outdoors or where floors or slabs do not exist and/or are not or provided by others under this Contract. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of the foundations. Equipment foundations shall be constructed as detailed on the Drawings or if not detailed on the Drawings shall be 4 inches thick minimum reinforced with #4 bars at 12-inch centers each way placed mid-depth. Concrete shall extend 6 inches minimum beyond the extreme of the equipment base and be placed on a COMPACTED STONE BED (#57 STONE OR ABC) 6 INCHES THICK MINIMUM.

2.07 CABINETS AND ENCLOSURES

A. Ratings
   1. Unless specified otherwise in these Specifications or shown on the Drawings, cabinets and enclosures shall be:
      a. NEMA 1A (gasketed) when located in environmentally controlled spaces such as control rooms, electric rooms, and similar locations.
      b. NEMA 12 when located in dry, indoor process areas.
      c. NEMA 4X stainless steel when located in damp/wet, indoor, or corrosive process areas.
      d. NEMA 4X stainless steel for all outdoor locations.

B. Construction – Steel
   1. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.
   2. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be stainless steel. Door latches for NEMA 4X cabinets and enclosures shall be all stainless steel, fast operating clamp assemblies that do not require bolts or screws to secure. A hasp and staple shall be provided for padlocking. Interior panels shall be provided. Each enclosure shall have a print pocket.
   3. NEMA 1A and 12 enclosure finish shall be white enamel interior, light grey enamel, ANSI 61 exterior, over phosphatized surfaces. Interior panels shall be white enamel. Special finishes and colors shall be furnished as required.
   4. NEMA 4X enclosures and enclosures suitable for hazardous locations shall be unpainted.

2.08 RUBBER INSULATING MATTING

A. Rubber insulating matting shall be furnished and installed on the floor and in front of each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. The mat shall be long enough to cover the full length of the equipment. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The matting shall meet OSHA requirements and the requirements of ASTM D-178 for Type 2, Class 2 insulating matting. Matting shall be 36 inches wide, minimum. However, matting width shall be no less than the NEC working clearance for the equipment with which it is associated.

B. Matting shall be provided for the following equipment:

- PLC/RTU Enclosures
- Motor Control Centers
- Switchboard Assemblies
- Variable Frequency Drives
- Reduced Voltage Starters
- Panelboards
- Automatic Transfer Switches
- Generator Output Circuit Breakers

PART 3 EXECUTION

3.01 SUPERVISION

A. Provide a competent foreman to be in charge of the construction. Foreman shall have extensive experience in the work to be performed.

3.02 MATERIALS AND WORKMANSHIP

A. Materials and workmanship shall comply with applicable codes, specifications, state and local ordinances, industry standards, and utility company regulations. Damage or defects developing before acceptance of the work shall be repaired or replaced.

3.03 LOCATION OF CONDUIT, FIXTURES, EQUIPMENT, AND APPURTENANCES

A. Locations shall be adjusted to accommodate the work to interferences anticipated and encountered.

3.04 STRUCTURE AND FINISHES

A. Protect structure and finishes. Repair damage incurred.

3.05 SUPPORTS

A. Support plumb, rigid, and true to line work and equipment installed under this contract. Thoroughly study Drawings; shop drawings; catalog data; and manufacturer's installation instructions to determine how equipment, accessories, fixtures, and related items are to be supported, mounted, or suspended. Provide bolts, inserts, brackets, structural supports, and accessories for proper support whether or not shown on the drawings.

3.06 COORDINATION

A. Electrical Contractor shall provide service to General Contractor provided equipment as indicated on the Drawings. The General Contractor shall be consulted concerning coordination of service to his equipment. Electrical Contractor shall provide control wiring as indicated on the plans and specifications or as otherwise required for a complete and fully operational system.

3.07 PAINTING

A. Any electrical equipment which has its factory paint coat scratched or otherwise damaged shall be refinished with the same quality of paint and workmanship as used by the manufacturer.

3.08 CLEAN-UP

A. Clean electrical equipment, fixtures, and wiring device covers with cleaning material appropriate to the surface and material being cleaned.

B. Clean bottoms of equipment enclosures to remove metal filings and other debris.

C. Remove from the site all debris, crating, waste material, tools, temporary facilities, construction equipment, machinery, and surplus materials.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding electrodes and conductors.

B. Equipment grounding conductors.

C. Bonding.

1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. UL 467 – Grounding and Bonding Equipment

C. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

1.03 GROUNDING ELECTRODE SYSTEM

A. Metal underground water pipe.

B. Ductile iron force main (if required).

C. Rod electrode.

D. Ground ring.

E. Concrete-encased electrode.

F. Building structural steel columns.

G. Metallic chemical storage tanks.

1.04 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms or less.

1.05 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data for grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground.

D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Accurately record actual locations of connections to grounding electrode system components.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina Recognized Third Party Testing Agency.

PART 2 PRODUCTS

2.01 ROD ELECTRODE

A. Manufacturers:
   1. Carolina Galvanizing Corp.
   2. Blackburn
   3. Copperweld

B. Material: Copper-clad steel.

C. Diameter: 3/4 inch.

D. Length: 10 feet.

2.02 MECHANICAL CONNECTORS

A. Manufacturers:
   1. Ilsco
   2. Z. Gedney
   3. Thomas & Betts

B. Material: Bronze.

2.03 WIRE

A. Material: Copper.

B. Insulation:
   1. Grounding Electrode or Bonding Conductor: THHN/THWN-2 or bare as indicated on the drawings.
   2. Equipment Grounding Conductor: THHN/THWN-2.
   3. Insulation for conductors #6 AWG and smaller shall be green from the manufacturer. Insulation for larger conductors shall be marked with green paint or wrapped with green tape.

2.04 EXOTHERMIC CONNECTORS

A. Manufacturer's
   1. Cadweld
   2. Thermoweld
   3. Furseweld

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Bond together the metal underground water pipe, rod electrode(s), concrete-encased electrode, building steel, metal equipment mounting rack structure, ground

ring, and service equipment to the extent that these items are present at each grounding location. If there is no metal water pipe available, bond to the ductile iron force main instead.

C. Bonding of grounding electrode conductor to rod electrodes, building steel, and concrete-encased electrodes shall be accomplished by exothermic weld process.

D. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground. Additional rod electrodes shall not be less than six feet apart.

E. Provide bonding to meet Regulatory Requirements.

F. Equipment Grounding Conductor: Provide separate, green insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

G. Ground Grid
   1. A main ground grid shall be provided for each structure and interconnecting structure grids consisting of driven ground rods as shown on the Drawings. The ground rods shall be interconnected by the use of copper cable exothermically welded to the rods. The grounding cables shall be installed after the excavations for the building have been completed and prior to the pouring of concrete for the footings, mats, etc. Copper "pigtails" shall be connected to the ground grid and shall enter the buildings and structure from the outside and shall be connected to steel structures, and equipment as described in this Section and as required to provide a complete grounding system. The copper pigtails shall be exothermically welded to the ground grid, and connected to building reinforcement steel by hydraulic crimp.

3.03 EQUIPMENT AND CIRCUITS

A. Conduit Systems:
   1. Ground all metallic conduit systems.

B. Boxes, Cabinets, Enclosures, and Panelboards:
   1. Bond the equipment grounding conductors to each pull box, junction box, outlet box, cabinet, and other enclosure through which the conductors pass.
   2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
   3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs for terminating the grounding electrode and equipment grounding conductors.
   4. For metal conduit systems connect wiring device grounding terminal to outlet box with bonding jumper and to branch circuit equipment grounding conductor. Where boxes are nonmetallic, bond to equipment grounding conductor only.
   5. Grounding type insulated bonding bushings and jumpers shall be provided where conduits terminate in service entrance equipment, transformers, and where concentric, eccentric, or over-sized knockouts are encountered. The jumpers shall be sized per NEC Table 250-66 for services, generator feeders and transformers, and per Table 250.122 for branch circuits.

C. Motors and Starters:
   1. Provide lugs in motor terminal box and starter housing for equipment grounding conductor termination.

D. Lighting Fixtures:

1. Connect equipment grounding conductor to fixture grounding terminal.
2. Fixtures connected with flexible conduit shall have a green insulated equipment grounding conductor included with the power wires to the fixture through the flexible conduit.

E. Electrical Appliances and Equipment:
1. Fixed electrical appliances and equipment shall have a ground lug installed for termination of the green insulated equipment grounding conductor.

F. Dry Type Transformers and Generators (Separately Derived Systems):
1. Bond together the grounded (neutral) conductor and equipment grounding conductor of the derived system.
2. A grounding electrode conductor shall be used to connect the grounded conductor of the derived system to the nearest available effectively grounded structural metal member of the building or the nearest effectively grounded metal water pipe within 5 feet from the point of entrance into the building. Where neither of these grounding methods is available, connection may be made to a ground ring or rod electrode.

3.04 CONDUCTIVE PIPING

A. Bond all conductive piping systems in the building or at the structure which could possibly become energized to the system ground.

3.05 BONDING BUILDING STEEL

A. Bond structural steel framing system with #4/0 bare copper conductor when structure is not electrically continuous at rated walls and expansion joints.

3.06 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall- of-potential method.

END OF SECTION

SECTION 16070

SUPPORTING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

C. Cable ties.

D. Steel channel.

E. Equipment racks.

1.02 REFERENCES

A. NECA - National Electrical Contractors Association.

B. ANSI/NFPA 70 - National Electrical Code.

1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina Third Party Testing Agency.

1.04 SUBMITTALS

A. Submit the following in accordance with Division 1.
   1. Product Data: Provide manufacturer's catalog data for fastening systems.
   2. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of the product.
   3. Shop Drawings: Submit shop drawings for the equipment mounting rack to include the following:
      a. Indicate assembly dimensions, locations of support posts, and general construction details.
      b. Indicate welded connections.
      c. Provide a Bill of Materials to include all components of the assembly.
      d. Indicate location and type of insulating materials.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide adequate corrosion resistance suitable to the application. Where materials are cut, welded, or scratched leaving an unprotected area, items shall be painted with a material providing equivalent protection to the factory provided finish.

B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

C. Anchors and Fasteners:

1. Concrete Structural Elements: Use expansion anchors, powder actuated anchors, or preset inserts.
2. Steel Structural Elements: Use stainless steel bolts, nuts, and washers. Galvanized beam clamps may be used to support conduit from steel beams.
3. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
4. Hollow Masonry and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
5. Solid Masonry Walls: Use expansion anchors.
6. Wood: Use wood screws.

2.02 CABLE TIES

A. Manufacturer
   1. Burndy
   2. Panduit
   3. Gardner Bender

B. In corrosive environments: Provide Grade 304 Stainless steel cable ties with a low profile clamping bearing head and fully adjustable strap accommodating many bundle diameters. Temperature Range: -112°F to 1000°F.

C. In non-corrosive environments: Provide Nylon 6/6 UV stabilized, weather resistant grade cable ties. Temperature Range: -40°F to 185°F.

2.03 STEEL CHANNEL

A. Manufacturer
   1. Superstrut
   2. Unitstrut
   3. Kindorff
   4. Ocal

B. Description: Galvanized steel, PVC coated steel, or other material as indicated.

2.04 EQUIPMENT RACKS

A. All exterior electrical equipment shall be protected from the weather by means of a weather shield fabricated of 3/16" aluminum sheet. Panels shall be of one-piece construction; butt welds will not be accepted. Corner welds will be continuous. The weather shield shall be of adequate size to accommodate all equipment shown. The structure shall consist of galvanized pipe supports tied together with PVC coated steel channel for attachment of the weather shield. A suitable barrier of nylon or similar material shall be placed between dissimilar metals to prevent galvanic corrosion.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Obtain permission from Engineer before using power-actuated anchors.

E. Do not drill or cut structural members.

F. Install surface-mounted cabinets and panelboards with minimum of four anchors.

G. Aluminum and galvanized steel surfaces in contact with concrete or grout shall have a bituminous coating.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Wire color coding.

C. Cable markers.

D. Conduit

1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Nameplates: Engraved laminated phenolic. Edges shall be chamfered. Minimum size shall be 1 inch high by 2.5 inches wide. Identify equipment (or equipment served) and location of supply side overcurrent protective device.

B. Locations:
   1. Each electrical distribution, control equipment, and special system enclosure.

C. Letter Size: ¼ inch high.

D. Color:
   1. Blue surface with white letters for 208Y/120 volt equipment.
   2. Black surface with white core.

E. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or equal.

2.02 HIGH VOLTAGE SIGNS

A. Standard "DANGER" signs shall be of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where a larger size is needed for adequate identification.

2.03 WARNING SIGNS

A. Equipment Containing Voltage from Multiple Sources: A phenolic sign with engraved lettering shall be mounted on or adjacent to the apparent disconnecting means stating “WARNING. PARTS OF THE CONTROLLER (OR OTHER EQUIPMENT) ARE NOT DE-ENERGIZED BY THIS SWITCH”.

2.04 WIRE COLOR CODING

A. Conductors shall be identified using a color coding method. Color coding for individual power, control, lighting, and receptacle conductors shall be as follows:

1. 480/277V AC Power
   Phase A - BROWN
   Phase B - ORANGE
   Phase C - YELLOW
   Neutral - GREY
2. 120/208V or 120/240V AC Power
   Phase A - BLACK
   Phase B - RED
   Phase C - BLUE
   Neutral - WHITE
3. DC Power
   Positive Lead - RED
   Negative Lead - BLACK
4. DC Control
   All wiring - BLUE
5. 120 Vac Control
   120 Vac control wire shall be RED except for a wire entering a motor control center compartment or control panel which is an interlock. This interlock conductor shall be color coded YELLOW
6. 24 Vac Control
   All wiring - ORANGE
7. Equipment Grounding Conductor
   All wiring – GREEN

B. Individual conductors No. 2 AWG and smaller shall have factory color coded insulation. It is acceptable for individual conductors larger than No.2 AWG to be provided with factory color coded insulation as well, but it is not required. Individual conductors larger than No.2 AWG that are not provided with factory color coded insulation shall be identified by the use of colored tape in accordance with the requirements listed in Part 3 herein. Insulation colors and tape colors shall be in accordance with the color coding requirements listed above.

C. Conductors that are a part of multi-conductor control cable assemblies shall have black insulation. The conductor number shall be printed on each conductor's insulation in accordance with ICEA S-58-679, Method 4. Each conductor within the cable assembly shall also be identified with a heat shrink tag with color coded background in accordance with the requirements listed in Part 3 herein. Background color shall be in accordance with the color coding requirements listed above.

D. Conductors that are a part of multi-conductor power cable assemblies shall have black insulation. The conductor number shall be printed on each conductor's insulation in accordance with ICEA S-58-679, Method 4. Each conductor No.2 AWG and smaller within the cable assembly shall also be identified with a heat shrink tag with color coded background. Each conductor larger than No.2 AWG within the cable assembly shall also be identified by the use of colored tape. Heat shrink tags and colored tape shall be in accordance with the requirements listed in Part 3 herein. Tape color and heat shrink tag background color shall be in accordance with the color coding requirements listed above.

2.05 BOX IDENTIFICATION

A. Pull, junction, and device box identification shall be as specified in Section 16136 – Boxes.

2.06 UNDERGROUND WARNING TAPE

A. Manufacturers:
   1. Seton Name Plate Co.
   2. Thomas & Betts
   3. 3M Electrical Products Div.

B. Description: 4-inch wide tape, detectable type, colored red for power and orange for telephone with suitable warning legend describing buried electric or telephone lines below.

PART 3 EXECUTION

3.01 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Nameplates shall be attached to the equipment enclosures with (2) two stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

C. Identify underground conduits using underground warning tape. Install one tape per trench at 12 inches above duct bank or direct buried conduit.

D. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.

3.02 POWER SOURCE IDENTIFICATION

A. After installation of all field equipment (i.e. valves, motors, fans, unit heaters, instruments, etc) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC number, panelboard, etc), circuit number, conduit number from schedule and voltage/phase.

B. Contractor to coordinate with the Engineer and the Owner regarding exact nameplate placement during construction.

C. Nameplates shall be as specified herein.

3.03 CONDUCTOR IDENTIFICATION

A. In addition to the color coding identification requirements specified in Part 2 herein, individual conductors shall be provided with heat shrinkable identification tags. Identification tags for individual conductors shall have a white background where the conductor insulation is colored. Identification tags for individual conductors shall have a colored background where the conductor insulation is black. Background color shall match that of the taping provided on the individual black conductors.

B. Multi-conductor cables shall be provided with heat shrinkable identification tags in accordance with Part 2 herein.

C. All wiring shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes

where a termination is made. The Contractor shall meet with the Owner and Engineer to come to an agreement regarding a wire identification system prior to installation of any wiring. Wire numbers shall not be duplicated.

D. Wire identification shall be by means of a heat shrinkable sleeve with appropriately colored background and black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.

E. Sleeves shall be suitable for the size of wire on which they are installed. Sleeves shall not be heat-shrunk onto control cables. Tags shall remain loose on cable to promote easier identification. For all other applications, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.

F. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.

G. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.

H. Wire identification in manholes, handholes, pull boxes, and other accessible components in the raceway system where the wiring is continuous (no terminations are made) shall be accomplished by means of a tag installed around the bundled group of individual conductors or around the outer conductor jacket of a multi-conductor cable. Identification shall utilize a FROM-TO system. Each group of conductors shall consist of all of the individual conductors in a single conduit or duct. The tag shall have text that identifies the bundle in accordance with the 'FROM' and 'TO' column for that particular conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the wire bundle by the use of nylon wire ties, and shall be made of polyethylene as manufactured by Brady, Seton, Panduit, or equal.

I. Where colored tape is used to identify cables, it shall be wrapped around the cable with a 25% overlap and shall cover at least 2 inches of the cable.

3.04 CONDUIT IDENTIFICATION

A. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, condulets, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:
   1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
   2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word "TO:" and the text in the 'TO' column of the conduit and wire schedule (e.g. TO: Raw Sewage Pump No. 1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word "FROM:" and the text in the 'FROM' column of the conduit and wire schedule (e.g. FROM: MCC-SPS). This

requirement applies only to the source and load ends of the conduit, and not anywhere in between.

3. For conduits ¾" through 1½" in size, the text shall be a minimum 18 point font. For conduits 2" and larger, the text shall be a minimum 24 point font.
4. Label height shall be ¾" minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.
6. Labels shall be made of permanent vinyl with adhesive backing as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal. Labels made of any other material are not acceptable.

B. Conduits that are not exposed but installed beneath free standing equipment enclosures shall be identified by means of a plastic tag with the following requirements:
   1. The tag shall be made of white Tyvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
   2. The tag shall be affixed to the conduit by means of a nylon cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.
   3. Tags shall be White Tyvek as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal.

C. Conduits for lighting and receptacle circuits shall not require identification.

D. Alternatives to this proposed conduit identification method shall be submitted to the Engineer as part of the shop drawing submittal.

E. Any problems or conflicts with meeting the requirements above shall immediately be brought to the attention of the Engineer for a decision.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16120

WIRE AND CABLE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Building wire and cable.

B. Wiring connectors and connections.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 16075 Identification
   2. Section 16130 Conduit
   3. Section 16136 Boxes

1.03 REFERENCES

A. NECA Standard of Installation (National Electrical Contractor's Association)

B. ANSI/NFPA 70 - National Electrical Code.

C. NETA ATA - Acceptance Testing Specifications for Electrical Power

D. Distribution Equipment and Systems (International Electrical Testing Association)

1.04 SUBMITTALS

A. Submit under provisions of Division 1.

B. Provide for each cable or conductor type.

1.05 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina recognized Third Party Testing Agency.

1.06 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

1.07 COORDINATION

A. Coordinate Work under provisions of Division 1.

B. Determine required separation between cable and other work.

C. Determine routing to avoid interference with other work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years. Wire and cable shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings. Only one (1) manufacturer for each wire and cable type shall be permitted.

B. The wire and cable manufacturer shall be ISO 9000 registered.

2.02 POWER WIRE AND CABLE

A. Power cable and wire installed between the output terminals of a VFD and the respective motor shall consist of stranded copper conductor with insulation type XHHW/XHHW-2, rated 90°C and 600V.

B. Power cable and wire for all other loads shall consist of stranded, copper conductor with insulation type THHN, 90°C for dry locations and THHN/THWN-2, 75°C for wet locations.

C. Conductors shall be stranded copper per ASTM-B8 and B-3, and Class B or C stranding contingent on the size unless otherwise specified. Minimum size wire shall be No. 12 AWG.

D. Multi-conductor power cable assemblies shall be UL 1277 Listed, provided with a bonding conductor, and furnished with an overall PVC jacket.

E. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, Encore Wire Corp., General Cable, or equal.

2.03 CONTROL CABLE

A. 600 volt control cable shall consist of stranded, copper conductor with insulation type THHN, 90°C for dry locations and THHN/THWN-2, 75°C for wet locations, and 600V.

B. Conductors shall be stranded copper per ASTM B-8 and B-3, and Class B or C stranding contingent on the size unless otherwise specified. Minimum wire size shall be No. 14 AWG.

C. Multi-conductor control cable assemblies shall be UL 1277 Listed, provided with a bonding conductor, and furnished with an overall PVC jacket.

D. Control cable shall be as manufactured by the Okonite Company, the Southwire Company, Encore Wire Corp., General Cable, or equal.

2.04 LIGHTING AND RECEPTACLE WIRE

A. The lighting and receptacle branch circuit wire shall consist of solid, copper conductors with insulation type THHN, 90°C for dry locations and THHN/THWN-2, 75°C for wet locations.

B. Conductors shall be solid copper per ASTM- B-3. Minimum size wire shall be No. 12 AWG.

C. Lighting and receptacle wire shall be as manufactured by the Okonite Company, the Southwire Company, Encore Wire Corp., General Cable, or equal.

2.05 INSTRUMENTATION CABLE

A. The instrumentation cable for analog signals shall be single, shielded, twisted pairs or triads with 600 volt insulation and shall have a 75°C (minimum) insulation rating.

B. Conductors shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM-B8, Class B stranding unless otherwise specified. Minimum size wire shall be No. 16 AWG.

C. The instrumentation cable shall be Okoseal-N Type P-OS for single pair or triad applications and Okoseal-N Type SP-OS for multiple pair or triad applications as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or equal.

PART 3 EXECUTION

3.01 POWER, CONTROL, AND LIGHTING/RECEPTACLE WIRE AND CABLE INSTALLATION

A. The wire and cable shall be installed as specified herein and indicated on the Drawings.

B. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.

C. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for "copper-to-copper" connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or equal.

D. Splices shall not be allowed in the underground manhole and handhole systems. If splices are required, the Contractor shall obtain approval in writing from the Engineer prior to splicing. Splicing materials shall be barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. No splicing of instrumentation cable is allowed. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits.

E. Wire and Cable Sizes
1. The sizes of wire and cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be increased so that the voltage drop measured from source to load does not exceed 2-1/2%.

F. Wiring Supplies
1. Only electrical wiring supplies manufactured under high standards of production and meeting the approval of the Engineer shall be used.
2. Rubber insulating tape shall be in accordance with ASTM Des. D119. Friction tape shall be in accordance with ASTM Des. D69.

G. Training of Cable
1. The Contractor shall furnish all labor and material required to train cables around cable vaults within buildings and in manholes and handholes in the outdoor underground duct system. Sufficient length of cable shall be provided in each handhole, manhole, and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any

cable shall be not less than the manufacturer's recommendation. The training shall be done in such a manner as to minimize chaffing.

2. Instrumentation cable shall be racked separate from other AC and DC wiring to maintain the required separation as follows:
   a. 18 inches for 480/277VAC wiring
   b. 12 inches for 208/120VAC wiring
   c. 6 inches for 24VDC wiring

H. Conductor Terminations
   1. Where wires are terminated at equipment which requires lugs, connections shall be made by solderless mechanical lug, crimp type ferrule, or irreversible compression type lugs. Reference individual equipment specification sections as applicable for additional termination requirements.
   2. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make terminations impractical due to the size of the field wiring, the Contractor shall terminate field wiring in an adjacent junction per the requirements of Section 16130, Boxes, complete with terminal strips. Contractor shall install the smaller wiring from the device to the junction box in a conduit, using the terminal strip as the means for joining the two different wire sizes. Splicing of wires in lieu of using terminal strips is not acceptable.
   3. All spare conductors shall be terminated on terminal blocks mounted within equipment or junction boxes. Unless otherwise noted, coiling up of spare conductors within enclosure is not acceptable.

3.02 INSTRUMENTATION CABLE INSTALLATION

A. The Contractor shall install all cable or conductors used for instrumentation wiring (4 20 mA DC, etc.) in conduit as specified in Section 16111 - Conduit. Only instrumentation cable as specified herein shall exclusively occupy these conduits. No other wiring for AC or discrete DC circuits shall be installed in these conduits.

B. All shielding shall be continuous and shall be grounded at one point only.

C. Where instrumentation cables are installed in panels, manholes, handholes, and other locations, the Contractor shall arrange wiring to provide maximum clearance between these cables and other conductors. Instrumentation cables shall not be installed in same bundle with conductors of other circuits.

D. Special instrument cable shall be as specified or recommended by the manufacturer of the equipment or instruments requiring such wiring. Installation, storage, and terminations, shall be per manufacturer's recommendations.

3.03 FIBER OPTIC CABLE INSTALLATION

A. The Contractor shall install the fiber optic cable furnished by the General Contractor and/or the Instrumentation and Control Subcontractor. The cable shall be installed in its respective raceway system(s) as specified herein, indicated on the Drawings, and in accordance with the cable manufacturer's instructions. Reference Division 17 for additional information regarding the fiber optic cable.

3.04 TESTING

A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Shop Test
   a. Cable and wiring shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer's standards.

2. Field Tests
   a. After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be "test light" or "buzzer" style.
   b. After installation, some wires and cables shall be tested for insulation levels. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:
      1) For #8 AWG and larger 600V power and control cable, apply 1,000 VDC from a Megaohmeter for one (1) minute for all 600V wires and cables installed in lighting, control, power, indication, alarm and motor feeder circuits. Resistance shall be no less than 100 Megaohms. Insulation testing is not required for power and control cables smaller than #8 AWG.
      2) 600V instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter, or approved equal. The resistance value shall be 200 Megaohms or greater.

B. Wires and cables shall be tested before being connected to motors, devices or terminal blocks.

C. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner.

D. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16130

CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Rigid steel conduit

B. Flexible metal conduit

C. Liquid-tight flexible conduit

D. Liquid-tight flexible non-metallic conduit

E. Rigid nonmetallic conduit

F. PVC coated metallic conduit

G. Electrical metallic tubing

H. Conduit fittings

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Trenching for Utilities
   2. Section 16060 Grounding and Bonding
   3. Section 16070 Supporting Devices
   4. Section 16075 Electrical Identification
   5. Section 16135 Duct Bank
   6. Section 16136 Boxes

1.03 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. American National Standards Institute (ANSI)
      a. C80.1 Rigid Steel Conduit, Zinc Coated.
      b. C80.3 Electrical Metallic Tubing, Zinc Coated.
      c. C80.6 Intermediate Metal Conduit, Zinc Coated.
      d. ANSI/NFPA 70 - National Electrical Code.
   2. ETL/Intertek
      a. ETL PVC-001 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   3. National Electrical Contractors Association
      a. NECA "Standard of Installation."
   4. National Electrical Manufacturers Association
      a. RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
      b. TC2 - Electrical Plastic Tubing (EPT) and conduit (EPC-40 and EPC-80)
      c. TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
      d. FB 1-2012 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

e. FB 2.10-2012 - Selection and Installation Guidelines for Fittings for Use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing)
f. FB 2.20-2012 - Selection and Installation Guidelines for Use with Flexible Electrical Conduit and Cable
g. OS 1-2008 (R 2010) - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Supports
h. OS 2-2008 (R 2010) - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
i. OS 3-2007 - Selection and Installation Guidelines for Electrical Outlet Boxes
j. RV 3-2010 - Application and Installation Guidelines for Flexible and Liquidtight Flexible Metal and Nonmetallic Conduits

1.04 DESIGN REQUIREMENTS

A. Conduit Size: ANSI/NFPA 70.

B. Wiring method shall be wire in conduit or other raceway unless otherwise noted.

1.05 SUBMITTALS

A. Product data: Provide for each type of conduit used.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Accurately record actual routing of conduits larger than 2 inches.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handle Product in accordance with Division 1.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.08 PROJECT CONDITIONS

A. Verify routing and termination locations of conduit prior to rough-in.

B. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

2.02 CONDUITS

A. Unless specified otherwise herein, or indicated on the Drawings, all conduits shall be rigid, hot-dipped galvanized steel. Minimum size conduit shall be 3/4 inch unless otherwise indicated on the Standard Details. Unless specified otherwise herein or indicated on the Drawings, all encased conduits shall be PVC Schedule 40,

minimum size 1 inch. The Contractor, at his option, for ease of installation to accommodate saddle size, may increase the size of encased conduits to 2-inch. However, no combining of circuits/conductors will be permitted in these larger conduits.

All components (fittings, couplers, connectors, etc.) of the conduit system shall be of the same or compatible material of construction. Coated conduit systems shall include factory coated fittings couplings, connectors, and other components compatible with and approved for coated conduit systems.

Reference the "Conduit Uses" portion of this specification for additional information regarding conduit.

B. Rigid Steel Conduit
   1. Steel conduits shall be rigid type, heavy wall, hot-dipped galvanized inside and outside and as manufactured by Allied Tube and Conduit Corporation, Wheatland Tube Company, Jones & Laughlin Steel Company, or equal.
   2. Each length of conduit shall be shipped with a coupling on one end and a color coded thread protector at the other end.

C. Flexible Metal Conduit
   1. Flexible metal conduit (FMC) shall be galvanized steel, single strip. FMC shall be UL listed. FMC shall be used to connect all indoor vibrating equipment, installed in dry locations, above reflected ceilings to lighting fixtures, and other applications as accepted by the Engineer. FMC shall be Galflex Type RWS as manufactured by Southwire, Type BR as manufactured by Electri-Flex, or equal.

D. Liquid Tight Flexible Metal Conduit
   1. Liquid tight flexible conduit (LFMC) shall be galvanized steel, single strip, with a copper strip interwoven and suitable as a grounding means. LFMC shall be UL listed. LFMC shall have an extruded moisture and oil-proof PVC jacket. LFMC shall be Titan Type UL as manufactured by Southwire, Liquatite Type "LA" as manufactured by Electri-Flex, Anaconda Type UA as manufactured by Anamet Electrical, Inc., or equal.
   2. PVC coated or stainless steel watertight connectors shall be used with liquid tight flexible metal conduit on both ends. LFMC shall be used to connect all vibrating equipment installed outdoors, in wet or damp areas, and other applications as directed by the Engineer.

E. Liquid Tight Flexible Non-Metallic Conduit
   1. Liquid tight flexible non-metallic conduit (LFNC) shall be constructed of PVC. LFNC shall be UL listed. LFNC shall have an extruded moisture and oil-proof PVC jacket. LFNC shall be Ultratite Type NM as manufactured by Southwire, Type NM as manufactured by Electri-Flex, Anaconda Type NMUA by Anamet Electrical, Inc., or equal.
   2. Watertight connectors shall be used with liquid tight flexible non-metallic conduit on both ends. LFNC shall be used to connect all vibrating equipment installed in sodium hypochlorite storage and transfer areas as specified herein, and other applications as directed by the Engineer or as indicated on the drawings.

F. Rigid Nonmetallic Conduit
   1. Rigid nonmetallic conduit shall be Schedule 40 polyvinyl chloride (PVC), 90 deg C, UL rated and shall conform to NEMA TC 2. Fittings and conduit bodies shall conform to NEMA TC3.
   2. Rigid non-metallic conduit shall be as manufactured by Carlon, Triangle Conduit and Cable, Cantex, Inc., or equal.

G. PVC Coated Metallic Conduit
   1. PVC coated rigid steel conduit shall be furnished and installed as specified herein and indicated on the Drawings. The product shall be rigid galvanized steel conduit covered with a bonded 40 mil (minimum) thickness PVC jacket and coated inside with urethane. The conduit shall comply with NEMA RN-1 and shall be "Plasti-Bond Red" as manufactured by Robroy Industries, "OCAL-Blue" as manufactured by Thomas & Betts, Perma-Cote Supreme by Perma-Cote Industries, Kor Kap equivalent, or equal.

H. Electrical Metallic Tubing
   1. Electrical metallic tubing shall meet ANSI C80.3 and shall be UL listed. The conduit shall be furnished and installed in accordance with Article 358 of the NEC. Electrical metallic tubing shall be manufactured by LTV Steel Tubular Products Company, "Electrunite", Triangular PWC, Inc., Allied Tube and Conduit Corporation, or equal.
   2. The conduit shall be cold rolled steel tubing with a zinc coating on the outside and protected on the inside by a zinc, enamel, or equivalent corrosion resistant coating and conforming to the requirements of ANSI C 80.3, latest edition.

I. Conduit Fittings
   1. Fittings for all conduit types shall conform to UL 467 and UL 514 as applicable.
   2. Fittings for electrical metallic tubing shall be rain-tight and concrete-tight, and shall be plated steel hexagonal threaded compression type.
   3. Set screw or indentor type connectors shall not be used. Fittings for conduit installed in wet locations and underground shall provide a watertight joint. Fittings for rigid conduit shall be threaded.
   4. Fittings or bushings shall be installed in easily accessible locations.
   5. Where exposed conduits pass across structural expansion joints, approved weatherproof telescopic type expansion fittings shall be used. Fittings shall be OZ/GEDNEY Type AX, Crouse-Hinds Type XJG, or equal, watertight, and permit movement up to 4 inches. Each fitting shall be equipped with approved bonding jumpers around or through each fitting.

      Where embedded conduits pass through expansion joints, approved watertight, concrete-tight deflection/expansion fittings shall be used. Fittings shall compensate for movement of ¾-inch from the normal in all directions. Fittings shall be OZ/GEDNEY Type DX, Crouse-Hinds Type XD, or equal.
   6. Conduit fittings ("condulets") shall be used on exposed conduit work for changes in direction of conduit runs and breaking around beams. "Condulets" shall be cast ferrous alloy, galvanized or cadmium plated, as manufactured by Crouse Hinds, OZ/Gedney, Appleton Company, or equal. Coated fittings and boxes shall be used with coated conduit in all chemically aggressive areas or

where called for on the Drawings. Covers shall be of a design suitable for the purpose intended. In damp areas, the outside condulets shall be made watertight. Install all condulets with the covers accessible. Use proper tools to assemble conduit system to prevent injury to the plastic covering. No damage to the covering shall be permitted.

7. Conduit fittings shall be cast type of non ferrous metal or malleable iron thoroughly coated inside and outside with metallic zinc or cadmium after all machining has been completed. Cast fittings shall be provided with heavy threaded hubs to fit the conduit required. Covers shall be of the same material as the fittings to which they are attached and shall be screwed on with rubber or neoprene gaskets between the covers and fittings. Cast fittings 1 1/2 inches and above shall be of the "mogul" type.
8. PVC coated fittings shall be used with PVC coated conduit. All conduit nipples, elbows, couplings, boxes, fittings, unions, expansion joints, connectors, bushing, and other components of the raceway system shall be factory coated to maintain the corrosion-resistant integrity of the conduit system. The coated conduit and its respective components shall all be provided by the same manufacturer. Coated conduit shall be used in all areas specified herein or indicated on the Drawings.

PART 3 EXECUTION

3.01 CONDUIT AND FITTINGS

A. Unless otherwise specified herein or indicated on the Drawings, the minimum size conduit shall be 3/4 inch for exposed work and 1 inch for conduit encased in concrete or mortar.

B. Conduit home runs for lighting circuits are not necessarily indicated on the Drawings; however, the circuit numbers are shown. Conduit shall be furnished and installed for these lighting circuits and shall be installed as required to suit field conditions, subject to review and acceptance by the Engineer.

C. Conduit shall be installed concealed unless otherwise indicated or specified. Conduit may be run exposed on walls only where concealing is not practical, or at the direction of the Engineer.

D. Where exposed, maintain a minimum distance of 6 inches from parallel runs of flues or water pipes. Conduit runs shall be installed in such locations as to avoid steam or hot water pipes. A minimum separation of 12 inches shall be maintained where conduit crosses or parallels hot water or steam pipes.

E. A non-metallic raceway containing instrumentation cable (if specifically allowed herein) where installed exposed shall be installed to provide the following clearances:
   1. Raceway installed parallel to raceway conductors energized at 480 through 208 volts shall be 18 inches and 208/120 volts shall be 12 inches.
   2. Raceway installed at right angles to conductors energized at 480 volts or 120/208 volts shall be 6 inches.

F. Where practical, exposed raceways containing instrumentation cable shall cross raceway containing conductors of other systems at right angles.

G. For floor mounted equipment, conduit may be installed overhead and dropped down, where underfloor installation is not practical. Groups of conduits shall be

uniformly spaced, where straight and at turns. Conduit shall be cut with a hacksaw or an approved conduit cutting machine and reamed after threading to remove all burrs. Securely fasten conduit to outlets, junction and pull boxes to effect firm electrical contact. Join conduit with approved couplings. Conduits shall be freed from all obstructions.

H. Empty conduit systems shall be furnished and installed as indicated on the Drawings and shall have pull ropes installed. The polyethylene pull ropes shall be ¼" diameter, minimum. Not less than 12 inches of slack shall be left at each end of the pull rope.

I. Each piece of conduit installed shall be free from blisters or other defects. Each piece installed shall be cut square, taper reamed, and a coat of galvanizing and conducting compound shall be applied to the threads. Galvanizing compound shall be CRC Zinc-It or equal. Threads on conduits shall be painted with a conducting compound prior to making up in a fitting. Conduit connections shall be made with standard coupling and the ends of the conduit shall butt tightly into the couplings. Where standard coupling cannot be used, Erickson three-piece couplings shall be used. Where conduits are installed in concrete, concrete-tight three-piece couplings shall be used.

J. Conduit threaded in the field shall be of standard sizes and lengths.

K. All bends shall be made with standard factory conduit elbows or field bent elbows. Field bending of conduit shall be done using tools approved for the purpose. Heating of conduit to facilitate bending is prohibited. Field bends shall be not less than the same radius than a standard factory conduit elbow. Bends with kinks shall not be acceptable.

The equivalent number of 90 deg bends in a single conduit run are limited to the following:

1. Runs in excess of 300 feet: 0
2. Runs of 300 feet to 201 feet: 1
3. Runs of 200 feet to 101 feet: 2
4. Runs of 100 feet and less: 3

All conduit for fiber optic cable shall have a minimum bending radius of 16 inches. Final bending radius shall be determined by the fiber optic cable manufacturer.

L. Unless otherwise specified herein, indicated on the Drawings, or required by the NEC, conduit shall be supported every 8 feet (minimum) and shall be installed parallel with or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right angle turns consisting of fittings or symmetrical bends. Conduits shall be supported within 1 foot of all changes in direction. Supports shall be approved pipe straps, wall brackets, hangers or ceiling trapeze. Supports shall be in accordance with Section 16070 – Supporting Devices.

M. In no case shall conduit be supported or fastened to another pipe or installed to prevent the removal of other pipe for repairs. Fastenings shall be by expansion bolts on concrete; by machine screws, welded threaded studs, or spring-tension clamps on steel work. Powder actuated fasteners may only be used to make connections where the use of this equipment complies with safety regulations and for structures in Seismic Design Categories A or B, unless the fasteners are approved for seismic use. Wooden plugs inserted in masonry and the use of nails

as fastening media are prohibited. Threaded C clamps may be used on rigid steel conduit only. Conduits or pipe straps shall not be welded to steel.

N. The load applied to fasteners shall not exceed 1/4 of the proof test load. Fasteners attached to concrete ceilings shall be vibration and shock resistant. Holes cut to a depth of more than 1 1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joints shall not cut the main reinforcing bars. Holes not used shall be filled. Spring steel fasteners may only be used to support lighting branch circuit in EMT conduits to structural steel members. Conduits shall be fastened to all sheet metal boxes and cabinets with two (2) locknuts where required by the National Electrical Code to ensure adequate bonding for grounding. Where insulated bushings are used, or where bushings cannot be secured firmly to the box or enclosure, a bonding jumper shall be installed to maintain suitable grounding continuity. Locknuts shall be the type with sharp edges for digging into the wall of metal enclosures. Bushings shall be installed on the ends of all conduits and shall be of the insulating type where required by the National Electrical Code.

O. Conduit installed in concrete floor slabs or walls shall be located so as not to affect the designed structural strength of the slabs. Conduit shall be installed within the middle one third of the concrete slab except where necessary to not disturb the reinforcement. The outside diameter of conduit shall not exceed one third of the slab thickness, and conduits shall be spaced no closer than three (3) diameters except at cabinet locations. Curved portions of bends shall not be visible above the finish slab. Where embedded conduits cross expansion joints, suitable expansion/deflection fittings and bonding jumpers shall be provided. Conduit larger than 1 inch trade size shall be parallel with or at right angles to the main reinforcement. When at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Conduits shall not be stacked more than two (2) diameters high in floor slabs. Embedded conduits shall be placed in accordance with the latest edition of ACI-318.

P. Install polyvinyl chloride (PVC) coated steel conduits when entering or exiting concrete except under electrical equipment where the conduit is not subject to physical abuse. Also install PVC coated steel conduit when transitioning between grade and a structure or an equipment stand. Extend stub-ups at least 12 inches above and below grade or finish floor. Conduits extending through the concrete floor shall be installed using straight runs (for vertical penetrations) or factory elbows (for conduits installed within the slab) of PVC coated rigid steel conduit.

Q. All conduit extending through the floor behind panels or into control centers or similar equipment may be PVC Schedule 40 and shall extend a minimum of 6 inches above the floor elevations, where practicable, with no couplings at floor elevations.

R. Unless specifically identified on the Drawings as "Direct Buried," all conduits in the earth, including conduits below slabs-on-grade, shall be concrete encased. Joints in conduit shall be staggered so as not to occur side by side. Rigid non-metallic (PVC) conduit shall be connected to PVC coated rigid steel conduit at the point where it leaves the ground, with the transition to metal conduit occurring inside the concrete encasement.

S. No more than three (3) 90 degree bends will be allowed in any one conduit run. Where more bends are necessary, a condulet or pull box shall be installed. All bends in 3/4 inch conduit shall be made with a conduit bender, and all larger sizes shall have machine bends. Joints in threaded conduit shall be made up watertight

with the appropriate pipe thread sealant or compound applied to male threads only; and, all field joints shall be cut square, reamed smooth, and properly threaded to receive couplings. No running threads are permitted. All conduit ends at switch and outlet boxes shall be fitted with an approved locknut and bushing forming an approved tight bond with box when screwed up tightly in place.

T. Conduits stubbed up through concrete floors for connections to freestanding equipment and for future equipment shall be provided with an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Screwdriver operated threaded flush plugs shall be installed in conduits from which no equipment connections are made.

U. Where outlets are shown near identified equipment furnished by this or other Contractors, it is the intent of the Specifications and Drawings that the outlet be located at the equipment to be served. The Contractor shall coordinate the location of these outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings. Changes in outlet locations required to serve the equipment furnished by other Contractors on the Project shall be brought to the attention of the Engineer.

V. Conduit shall be protected immediately after installation by installing flat non corrosive metallic discs and steel bushings, designed for this purpose, at each end. Discs shall not be removed until it is necessary to clean the conduit and install the conductors. Before the conductors are installed, insulated bushings shall be installed at each end of the conduit.

W. Where "all-thread" nipples are used between fittings and electrical equipment, they shall be so installed that no threads are exposed.

X. Connections from rigid conduit to motors and other vibrating equipment, limit switches, solenoid valves, level controls, and similar equipment, shall be made with short lengths of liquid tight flexible metal conduit. These conduits shall be installed in accordance with the NEC and shall be furnished and installed with appropriate connectors with devices which will provide an excellent electrical connection between the equipment and the rigid conduit for the flow of ground current. Flexible metal conduit and liquid-tight flexible metal conduit length shall be three (3) feet, maximum.

Y. Flexible metal conduit or liquid-tight flexible metal conduit installed between rigid metal conduit and motor terminal box and/or any other apparatus shall have a green insulated grounding conductor running through the flexible conduit. This conductor shall be terminated to the nearest pull box, motor terminal box, or any other apparatus ground terminal. Flexible metal conduit and liquid-tight flexible metal conduit shall be grounded and bonded per NEC Articles 348 and 350, respectively.

Z. Conduits installed within or underneath floor slabs, underground direct-buried or concrete encased conduits, and all conduits installed in areas subject to liquid inadvertently entering the conduit system shall be sealed or plugged at both ends in accordance with NEC Article 300-5(g). This requirement applies to both conduits containing conductors and "spare" conduits. Where practicable, the interior of the conduit shall be sealed as well as around the conductors by using conduit sealing bushings: Type CSB as manufactured by O/Z Gedney, or equal. Where the conduit fill does not allow the use of these bushings, the conduits shall be tightly caulked or plugged.

Conduit passing through the walls and floors of buildings below grade shall be installed with appropriate watertight fittings to prevent the entrance of ground water around the periphery of the conduits. For vertical conduit penetrations through openings in concrete floors, the fittings shall be Type FSK Floor Seals as manufactured by OZ/Gedney. For conduit penetrations through openings in concrete walls, the fittings shall be Type WSK Thruwall seals as manufactured by OZ Gedney. Conduits shall be sloped away from the buildings toward splice boxes, handholes and/or manholes to provide drainage away from the building wall.

Conduits passing through sleeves in interior walls and floors shall be tightly caulked.

AA. Weatherproof, insulated throat "Meyers" hubs shall be used on all conduit entries to boxes and devices without integral hubs in process areas to maintain NEMA 4X integrity. The Contractor shall furnish and install "Meyers" hubs on all conduit entries into non-cast enclosures such as metallic or non-metallic control panels, control component enclosures, wireways, pull boxes, junction boxes, control stations, and similar type equipment when this type of equipment is located in process areas requiring NEMA 4X integrity. This specified requirement for "Meyers" hubs does not apply to any area of the plant facilities where NEMA 4X integrity is not required.

BB. The use of two (2) locknuts, one on each side of the enclosure, and a grounding bushing shall be required at all conduit terminations where hub type fittings are not required; such as electrical rooms, control rooms, and office areas.

CC. Conduit installation shall be arranged to minimize cleaning. No horizontal runs of conduit will be permitted in brick or masonry walls.

DD. Install non-metallic conduits in accordance with manufacturer's instructions where specified herein or indicated on the Drawings.

EE. Join non-metallic conduit using cement as recommended by the manufacturer. Clean and wipe non-metallic conduit dry before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for twenty (20) minutes (minimum).

FF. All PVC coated conduit shall be installed in accordance with manufacturer's instructions. The Contractor shall use tools that are specifically suited for coated conduit systems. The use of pipe wrenches and other such tools on PVC coated RGS conduit is prohibited. The Engineer and Owner reserve the right to reject any installation of coated conduit that does not meet the requirements of the Section or the manufacturer's instructions. The Engineer and Owner also reserve the right to reject any installation that exhibits damage due to the improper use of tools. All rejected installations shall be replaced by the Contractor at no additional cost to the Owner. The use of PVC coated conduit repair compounds to repair damages or improper installation is prohibited.

GG. All Contractor personnel that install PVC coated RGS conduit shall be trained by the PVC coated RGS conduit manufacturer. Training shall include proper conduit system assembly techniques, use of tools appropriate for coated conduit systems, and field bending/cutting/threading of coated conduit. The Contractor shall furnish evidence of such training as specified herein. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract for all

coated conduit installation personnel. Contractor personnel not trained within this timeframe shall not be allowed to install coated conduit, or shall be trained/re-trained as required prior to commencement of conduit installation.

HH. Conduits shall not penetrate the floors or walls inside liquid containment areas unless specifically accepted by the Engineer.

II. All conduits that are buried or encased in concrete that transition from the ground to any stationary structure or equipment shall be equipped with a longitudinal expansion coupling capable of at least four inches of expansion. Conduits with encasement that is rigidly tied to the stationary structure in accordance with the Standard Details shall not be required to have expansion couplings.

JJ. Raceways shall not be installed concealed in water-bearing walls and floors.

3.02 CONDUIT USES AND APPLICATIONS

A. Schedule 80 PVC conduit shall be installed where conduit is exposed in chemical storage and transfer areas. No PVC conduit shall be installed exposed in any other area unless specifically accepted in writing by the Engineer.

B. PVC Schedule 40 conduit shall be furnished and installed in concrete slabs (for slab-on-grade construction) and in walls when the conduit is shown to be encased. Rigid steel conduit shall be installed in all elevated slabs when the conduits are shown to be encased.

C. PVC Schedule 40 conduit shall be installed in reinforced concrete encasement. Conduit shall be "direct buried" only if specifically indicated on the Drawings.

D. All instrumentation wire and cable for analog signals shall be installed in rigid steel conduit or PVC coated rigid steel conduit to suit the application. This applies to all conduit installations including exposed, concealed in concrete encasement, and all other applications.

E. PVC coated rigid steel conduit shall be furnished and installed, where exposed, in the following areas:
   1. All outdoor locations.
   2. CO2 Facility
   3. Calcite Facility
   4. Site Vaults

F. Electrical metallic tubing may be furnished and installed in the following areas:
   1. Above reflected ceilings for lighting circuits.
   2. Within interior walls constructed of metal studs and gypsum wall board.

G. Liquid-tight flexible non-metallic conduit (LFNC) shall be furnished and installed, where required, in chemical storage and transfer areas.

H. Other conduit uses not specifically listed above shall be brought to the attention of Engineer for a decision.

END OF SECTION

SECTION 16135

UNDERGROUND ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct system

B. Electric manholes

C. Electric handholes

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Trenching for Utilities
   2. Section 03100 Cast-In-Place Concrete
   3. Section 16130 Conduit

1.03 REFERENCED STANDARDS

A. The latest revision, at the time of bidding, of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. ANSI/NFPA 70 - National Electrical Code.
   2. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   3. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
   4. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.04 SUBMITTALS

A. Submit the following in accordance with Division 1.
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Each underground conduit type.
   2. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Accurately record actual locations of exact routing of duct bank.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site under provisions of Division 1.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.09 PROJECT CONDITIONS

A. Duct bank routing is shown on Drawings in approximate locations unless dimensions are indicated. Route as required to complete duct system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

2.02 DUCT SYSTEM

A. Underground duct system shall consist of parallel runs of Schedule 40 PVC conduit or rigid galvanized steel conduit encased in concrete envelopes, unless otherwise specified herein or indicated on the Drawings.

B. Nonmetallic conduit joints shall be made with standard Schedule 40 PVC couplings and PVC solvent cement of the same manufacturer as the conduit. All PVC conduit shall be supplied by the same manufacturer. All joints shall be staggered, installed in accordance with the manufacturer's recommendations, and made watertight.

C. Base and intermediate conduit spacers shall be furnished to provide a minimum of two-inch (2") separation between conduits. Conduit spacers shall be provided in the proper size as required for the conduit that they secure. For example, a 4" conduit spacer shall not be used to secure a 2" conduit. Conduit spacers shall be as manufactured by Carlon Electrical Products Company, Aeroquip Corporation, Underground Devices, Incorporated, or equal.

D. All 90 degree conduit elbows and/or combinations of adjacent conduit elbows that form a 90 degree bend shall be rigid galvanized steel conduit.

2.03 ELECTRIC MANHOLES

A. The concrete manholes shall be complete with metal frames and covers of size and location as specified herein and shown on the Drawings.

B. Manhole frames and covers shall be Neenah R-1640C1, or equal, with Type A anchor ring. Entire manhole assembly shall be AASHTO H20 heavy duty rated. Covers shall be furnished with drop handles.

C. All electric manholes shall be provided with heavy duty non-metallic cable racks. Cable racks shall be rated for the application, with a minimum loading of 450lbs per rack arm. Cable rack system shall be Heavy Duty type as manufactured by Underground Devices, Incorporated or equal.

2.04 ELECTRIC HANDHOLES

A. The electric handholes shall be a precast polymer concrete enclosure suitable for use as part of an underground electric raceway system. The enclosure shall meet or exceed the requirements of ANSI/SCTE 77-2010.

B. The enclosure design and test load rating shall be Tier 15.

C. The enclosure shall be the straight side design to allow easy adjustment of box to grade. The box shall be stackable for increased depth.

D. Handhole opening size shall be as required to suit the application, 6" X 8", minimum.

E. Extra heavy-duty covers shall be furnished and installed with Tier 15 enclosures. Covers shall be provided with cover hooks.

F. The electric handholes shall be Style "PG" or "PC" (as required) Quazite boxes as manufactured by Hubbell, Pencell Plastics equivalent, Highline Products equivalent, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. The underground duct system, manholes, and handholes shall be installed as specified herein, indicated on the Drawings, and in accordance with manufacturers' instructions.

3.02 DUCT SYSTEM

A. All underground conduit shall be encased in concrete and shall be reinforced. Encasement and reinforcement shall be as indicated in the standard details. Concrete shall be furnished and installed in accordance with Section 03100.

B. Concrete pours shall be complete from handhole to handhole and from manhole to manhole where practicable. Partial pours in general shall not be permitted. Where a complete pour is impractical, written authorization shall be obtained from the Engineer for the partial pour.

C. Conduit ductbank elevations at the manholes and handholes shall be based on minimum ductbank cover as indicated in the standard details, or deeper to avoid conflicts with other obstacles. Where deviation is necessary to clear unforeseen obstacles, the elevations may be changed after authorization by the Engineer.

D. Slope all conduits continuously away from structures and buildings with a minimum slope of 3" per 100' unless otherwise indicated on the Drawings.

E. The minimum clearance from the top of the concrete encasement and finished grade shall be as indicated in the standard details, except where otherwise accepted in writing by the Engineer or shown on the Drawings.

F. Care shall be exercised during excavation for the duct banks to prevent digging too deep. Backfilling of low spots with earth fill will not be permitted unless thoroughly compacted and acceptable to the Engineer.

G. If a specific ductbank arrangement is shown on the Drawings, the conduits in that ductbank shall be arranged as shown. Where no specific ductbank arrangement is shown on the Drawings, the Contractor shall arrange conduits within each ductbank based on field conditions. Spare conduits shown going from ductbanks into

buildings or structures shall be stubbed up in the location(s) as indicated on the Drawings.

H. A minimum of one (1) ground rod, furnished in accordance with Section 16170, shall be driven adjacent to each manhole, handhole, or other concrete box. A No. 4/0 AWG bare copper ground cable shall be connected between this rod and the copper ground strap using a silicon bronze connector. All ground rods shall be interconnected by means of the No. 4/0 AWG bare copper ground cable located within each duct bank. The ends of these cables shall also be connected to substation and/or building ground buses where the conduits terminate.

I. Care shall be exercised, and temporary plugs shall be installed during installation to prevent the entrance of concrete, mortar, or other foreign matter into the conduit system. Conduit spacers shall be utilized to support conduit during the pouring of concrete to prevent movement and misalignment of the conduits. Conduit spacers shall be installed in accordance with manufacturer's instructions unless otherwise noted. Horizontal spacing of conduit spacers along ductbank shall be as indicated on the Standard Details.

J. Large radius elbows shall be used for all 90 degree conduit bends in the duct system. The following shall be the minimum elbow radii:

TRADE SIZE	1"	1-1/2"	2"	3"	4"
MIN. RADIUS	12"	24"	24"	36"	48"

K. Prior to pulling cables, the Contractor shall thoroughly clean the inside of each length of conduit by swabbing.

L. After all cables have been installed, all spare and/or unused conduit openings shall be sealed or plugged as specified in Section 16130. A 250 lb. test pull rope shall be provided in the entire length of all spare and/or unused conduits.

M. Construct concrete-encased conduits connecting to underground structures to have a flared section adjacent to the manhole to provide shear strength. Construct underground structures to provide shear strength. Construct underground structures to provide for keying the concrete encasement of the duct line into the wall of the structure. Use vibrators when this portion of the encasement is poured to ensure a seal between the encasement and the wall of the structure.

N. Six (6) inches above all duct banks, the Contractor shall furnish and install a two (2) inch wide red plastic electrical hazard tape. Tapes shall be metallic detectable type and shall have a continuous message in bold black letters: "ELECTRIC LINE BURIED BELOW." Tape shall be Detectable Identoline by Brady, or equal.

O. The Contractor shall perform all earthwork including excavation, backfill, bedding, compaction, shoring and bracing, grading and restoration of surfaces and seeded areas disturbed during the execution of the work.

3.03 ELECTRIC MANHOLES

A. Electric manholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 14" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest

duct centerline entrance to the roof. All manholes shall be built on, or placed over a 6" layer of well-tamped gravel.

B. Duct envelopes and conduit with bell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.

C. All concrete work and fully assembled manholes shall be completely watertight and shall be furnished with sloped floors that pitch towards a sump pit. The outside surfaces shall be coated with an approved asphaltic waterproofing compound (all sides, bottom, and roof). Precast concrete manholes may be installed; however, all requirements of this section and other divisions of the Specifications and the details shown on the Drawings shall apply.

D. Install pulling eye irons imbedded in walls opposite each duct entrance securely fastened to manhole reinforcing rods. All hardware shall be hot-dipped galvanized steel. Copper bars shall be provided in the walls for grounding. No. 4/0 AWG bare copper cables shall be connected to these bars and all non-current carrying metal parts shall be grounded to these copper bars.

E. All cables shall be well supported on walls by nonmetallic cable racks. The cable racks shall be heavy-duty type for medium and low voltage power cables and light duty type for control, signal, communications and similar small conductors. All racks shall be rigidly attached to the wall and equipped with adjustable rack arms.

3.04 ELECTRIC HANDHOLES

A. Electric handholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 9" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to roof. All handholes shall be built on; or, placed over a 6" layer of well-tamped gravel.

B. Duct envelopes and conduit with bell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.

C. All fully assembled handholes shall be completely watertight.

D. All individual cables and/or bundles of conductors shall be identified and "dressed" along the wall of the enclosure. Cable racks as specified herein shall be provided if any handhole dimension exceeds 24 inches.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16136

BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet boxes.

B. Pull and junction boxes.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 16075 Electrical Identification
   2. Section 16140 Wiring Devices

1.03 REFERENCES

A. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies

B. ANSI/NFPA 70 – National Electrical Code

C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

D. UL 514A – Metallic Outlet Boxes

E. UL 514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers

F. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations

G. UL 50E – Enclosures for Electrical Equipment, Environmental Considerations

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina recognized third party testing agency.

1.05 SUBMITTALS

A. Product data: Provide for each type of box used.

1.06 IDENTIFICATION

A. Each pull and junction box shall be identified with the box name as indicated on the Contract Drawings (e.g. CPB-ROFP-1) or as directed by the Engineer. A nameplate shall be securely affixed in a conspicuous place on each box. Nameplates shall be as specified in Section 16195, Electrical – Identification.

PART 2 PRODUCTS

2.01 PULL AND JUNCTION BOXES

A. General
   1. All pull and junction boxes shall be UL listed and labeled.
   2. Pull and junction boxes shall not be provided with eccentric or concentric knockouts.

3. Pull and junction boxes mounted embedded in concrete shall be UL listed for embedment.
4. Where metallic boxes are used they shall be of all welded construction.

B. Pull Boxes
1. All Pull boxes shall be provided with a matching gasketed cover. For covers with dimensions of 24 inches by 24 inches or less, the cover shall be held in place by machine screws. For covers with dimensions greater than 24 inches by 24 inches, the cover shall be hinged and held in place by screw-operated clamp mechanisms. Hinge pins shall be removable. Clamp mechanism material of construction shall match that of the associated box.
2. Pull boxes shall not have any wire terminations inside, other than those for grounding/bonding. A ground bar shall be provided with the necessary number of screw type terminals. Twenty percent of the total amount of terminals otherwise required for the pull box (minimum of two) shall be provided as spare terminations. Boxes requiring any other wire terminations shall be furnished and installed in accordance with the requirements for junction boxes herein.
3. Pull boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC.
4. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolations shall be provided between the following groups:
   a. Power wiring
   b. AC control wiring
   c. DC control wiring
   d. Instrumentation wiring

C. Junction Boxes
1. Junction boxes used for lighting and receptacle circuits only shall be provided with matching gasketed cover held in place by machine screws.
2. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with a hinged, gasketed cover. Hinge pins shall be removable. Cover shall be held in place by screw-operated clamp mechanisms. Clamp mechanism material of construction shall match that of the associated box.
3. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolations shall be provided between the following groups:
   a. Power wiring
   b. AC control wiring
   c. DC control wiring
   d. Instrumentation wiring
4. Junction boxes used for lighting and receptacle circuits only shall be allowed to have screw-on (wire nut) type connectors for wire terminations/junctions.
5. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with terminal strips, consisting of the necessary number of screw type terminals. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected, with a 10A minimum capacity. Terminal strips shall be rated for the voltage of the circuits connected. A separate ground bar shall be provided with the necessary number of screw type terminals. Twenty percent of the total amount of the terminals otherwise required for the junction box (minimum of two) shall be provided as

spare terminations. When barriers are provided within the box, separate terminal strips shall be provided in each barrier area.

6. Junction boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC. Terminal blocks (including spare terminals) shall be considered when sizing the junction box.

D. Enclosure Types and Materials

1. In non-hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed.
   a. Indoor Wet Process Area – NEMA 4X, Type 304 Stainless Steel
   b. Indoor Dry Process Area – NEMA 12, Painted Steel
   c. Indoor Dry Non-process Area – NEMA 1, Painted Steel
   d. Indoor Chemical Storage/Transfer Area – NEMA 4X, Type 304 Stainless Steel
   e. All Outdoor Areas – NEMA 4X, Type 304 Stainless Steel
2. In hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.
   a. Class 1, Division 1, Group D – NEMA 7, Die Cast Aluminum
   b. Class 1, Division 2, Group D – NEMA 4X, Type 304 Stainless Steel
   c. Class 2, Division 1, Group F – NEMA 9, Die Cast Aluminum
   d. Class 2, Division 2, Group F – NEMA 4X, Type 304 Stainless Steel
3. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.

2.02 OUTLET BOXES

A. General

1. Outlet boxes shall be provided with a trim appropriate for the wiring device installed inside. Reference Section 16140, Wiring Devices, for outlet box trim requirements. An appropriate outlet box trim is required to achieve the NEMA rating of the outlet boxes as specified herein.

B. Surface Mount Outlet Boxes
   1. Outlet boxes shall be the deep type, no less than 2.5 inches deep.
   2. Outlet boxes shall be provided in single or multi-gang configuration as required, sized in accordance with the requirements of the NEC.
   3. In non-hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed.
      a. Indoor Wet Process Area – NEMA 4X, Cast Aluminum
      b. Indoor Dry Process Area – NEMA 1, Cast Aluminum
      c. Indoor Dry Non-process Area – NEMA 1, Cast Aluminum
      d. Indoor Chemical Storage/Transfer Area – NEMA 4X, Cast Aluminum
      e. All Outdoor Areas – NEMA 4X, Cast Aluminum
   4. In hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.
      a. Class 1, Division 1, Group D – NEMA 7, Die Cast Aluminum
      b. Class 1, Division 2, Group D – NEMA 4X, Cast Aluminum
      c. Class 2, Division 1, Group F – NEMA 9, Die Cast Aluminum
      d. Class 2, Division 2, Group F – NEMA 4X, Cast Aluminum
   5. Outlet boxes shall be provided with integral threaded conduit hubs mounted external to the box. Boxes with threaded conduit hubs mounted internal to the box or as part of the box wall are not acceptable.

C. Flush Mount Outlet Boxes
   1. Outlet boxes shall be no less than 2-1/8 inches deep, and 4-11/16 inches square. Boxes shall be UL listed and labeled. Pre-punched single diameter conduit knockouts are acceptable; however, concentric and eccentric knockouts are not acceptable.
   2. Outlet boxes mounted flush in CU walls shall be made of galvanized, tack welded steel, and suitable for installation in masonry walls. Sectional type boxes are not acceptable for this application.
   3. Outlet boxes mounted flush in gypsum walls shall be made of galvanized pressed steel. Tack welded boxes or sectional type boxes are not acceptable for this application.
   4. Outlet boxes mounted cast into concrete shall be concrete tight, and shall be made of galvanized steel or PVC.

2.03 FLUSH FLOOR BOXES

A. Slab on Grade: Steel City 664-CI with 664-GP & RP plates, and type 664-CST-SW-GRY cover or equal.
   1. Provide duplex receptacle and two Cat 6, RJ45 communication jacks in each box.
   2. Carpet/Tile coverplate with exposed finished trim color to be selected by Architect.
   3. Provide all trim, fittings, coverplate and accessories for complete installation.

2.04 CEILING PROJECTOR MOUNT

A. Peerless model PFJ2-45 mount and CMJ455 plate or equal.

B. Lightweight suspended ceiling plate and projector mount, consisting of a 8" x 24" filler tray and a 15.75" x 24" ceiling tray suspended by four tie wires from structure above.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pull and Junction Boxes
   1. Pull boxes and junction boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
   2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
   3. Box penetrations for conduits shall be made with a punch tool, and penetrations shall be the size required for the conduit entry and/or hub. Oversized penetrations in boxes are not acceptable.
   4. Watertight conduit hubs shall be provided for boxes where a NEMA 4X enclosure rating is specified. Referenced Section 16130, Conduit, for conduit hub requirements.
   5. Pull and junction boxes may be installed flush mounted in gypsum, concrete, or CMU walls where appropriate provided that covers are easily removed or opened.
   6. Pull and junction boxes shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirement in Part 2 herein.

B. Outlet Boxes
   1. Outlet boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
   2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
   3. Flush mounted outlet boxes shall be arranged and located so that tile and grout lines fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.
   4. Outlet boxes shall be flush mounted in finished areas and other areas where practical. Flush mounted outlet boxes shall not be installed in hazardous areas or chemical storage/transfer areas.
   5. For the below-named items, mounting heights from finished floor, or finished grade to top is applicable, depending on the type of wiring device to be installed in the outlet box. Mounting heights for outlet boxes shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):
      a. Light switches and wall mounted occupancy sensors, 48 inches
      b. Receptacles in indoor dry process/non-process areas, 16 inches
      c. Receptacles in indoor wet process areas and all indoor chemical storage/transfer areas, 48 inches
      d. Receptacles in outdoor locations, 24 inches
   6. Outlet boxes shall be provided in the material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein.

3.02 FLUSH FLOOR BOXES

A. Locate floor boxes at locations shown on plans. Set slab on grade boxes and associated conduit prior to pouring concrete.

B. Verify locations of floor box with furniture plan prior to installation.

C. Provide one 3/4" data conduit from each floor box to accessible ceiling void.

D. Protect floor box from entry of dirt and debris during construction process.

E. After concrete pour, pull wiring and install devices when room finishes are in process.

F. Trim coverplate shall not be installed until carpet is laid. Coordinate installation of carpet on cover plate with carpet installation.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Light switches.

B. Receptacles.

C. Device covers.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 16136 Boxes

1.03 REFERENCES

A. NEMA WD 1 - General Purpose Wiring Devices.

B. NEMA WD 6 - Wiring Device Configurations.

C. UL 20 – General Use Snap Switches

D. UL 498 – Standard for Attachment Plugs and Receptacles

E. UL 943 – Ground Fault Circuit Interrupters

F. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations

1.04 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Manufacturer's Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
   2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years experience.

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown or other North Carolina Recognized Third Party Testing Agency.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The Contractor shall use the products of a single manufacturer for each type of wiring device.

C. The Contractor shall use the products of a single manufacturer for all device plates. Plate variations are allowed for the following devices:
   1. Where the selected plate manufacturer does not manufacture a suitable finish plate.
   2. For heavy duty receptacles rated at more than 30A.
   3. Where non standard plates are required, specified, or shown.

D. The Contractor shall furnish and install all wiring devices and device plates.

E. In non-hazardous areas, provide specification grade devices manufactured by Appleton, Crouse-Hinds, Leviton, Hubbell, Pass & Seymour, or Engineer approved equal.

F. In hazardous areas, provide devices manufactured by Appleton, Cooper Crouse-Hinds, Hubbell-Killark, or Engineer approved equal.

2.02 WIRING DEVICES

A. Wall switches for non-hazardous areas shall be rated for the current required to suit the application, but not less than 20A. Double pole, three-way, and four-way switches shall be provided where indicated on the Drawings, and as required. Switches shall be rated for 120-277VAC, and shall be UL 20 Listed.

B. Convenience receptacles for non-hazardous areas shall be rated for 20A at 125VAC. Convenience receptacles shall be UL 498 Listed. Tamper resistant receptacles are not acceptable.

C. Special purpose receptacles (welders, lab equipment, etc.) shall be provided with the proper NEMA configuration and ampacity as indicated on the Drawings. The coordinating plug for each special purpose receptacle shall be provided with the equipment which it is serving.

D. Ground fault circuit interrupter receptacles shall be rated for 20A at 125VAC. Ground fault circuit interrupter receptacles shall be UL 943 Listed. Tamper resistant receptacles are not acceptable.

E. Wall switches for hazardous areas shall be the factory sealed type, UL 1203 Listed for use in the hazardous area. Wall switches shall be rated for 120-277VAC, and shall be rated for the current required to suit the application, but not less than 20A

F. Receptacles for hazardous areas shall be rated 20A at 120-240VAC. Receptacles shall be UL 1203 listed for use in the hazardous area, utilizing delayed-action construction.

G. All wiring devices shall be approved for use with stranded conductors, if stranded conductors are to be used with the device. Reference Section 16123, Low Voltage Wire and Cable for conductor requirements

2.03 DEVICE PLATES

A. Device plates for indoor flush mounted receptacles and switches shall be made of Type 304 stainless steel, not less than 0.032 of an inch thick, with beveled edges and milled on the rear so as to lie flat against the wall. Devices plates shall be provided with a gasket.

B. Device plates for outdoor installations, indoor wet process areas, and chemical storage/transfer areas shall be Appleton Type FSK, Crouse Hinds #DS185, or equal for wall switches. Device plates for receptacles shall be "in-use" style. "In-use" weatherproof covers shall be rugged, minimum 3 ¼" depth, die-cast aluminum as manufactured by Thomas & Betts "Red Dot," Intermatic International, Inc., or equal.

C. Device plates for indoor dry process and non-process areas with surface mounted boxes shall be Crouse-Hinds DS32, or equal for switches, and Crouse-Hinds DS23 or equal for receptacles.

2.04 PLUGS

A. The Contractor shall furnish suitable plugs with equipment furnished under the respective specification Section. Plugs shall be black rubber or plastic. For waterproof receptacles, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided with clamping nuts and stuffing gland cable outlets.

2.05 PROCESS INSTRUMENTS

A. The Contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument etc.,) to disconnect the 120VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch without overload protection as manufactured by Crouse-Hinds, Appleton equivalent, or equal. For hazardous locations, the device shall be UL 1203 Listed.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean debris from outlet boxes.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Connect wiring device grounding terminal to outlet box with bonding jumper and to branch circuit equipment grounding conductor.

E. All receptacles shall have a self-adhesive label installed on the top at the respective device plate that indicates which panel and which circuit number the receptacle is supplied from.

3.03 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.04 ADJUSTING

A. Adjust devices to be installed plumb.

END OF SECTION

SECTION 16210

UTILITY SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Utility Coordination Requirements

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 02315 Trenching for Utilities.
   2. Section 03100 Cast-in-Place Concrete.
   3. Section 16060 Grounding and Bonding.
   4. Section 16130 Conduit.
   5. Section 16135 Duct Bank.

1.03 REFERENCES

A. NECA Standard of Installation

B. ANSI/NFPA 70 - National Electrical Code.

1.04 SYSTEM DESCRIPTION

A. Utility Company: Brunswick Electric – Wesley Thomas – 910.754.4391

B. System Characteristics: 480Y/277 volts, 3 phase, 4 wire, 60 hz.

1.05 SUBMITTALS

A. Submit the following in accordance with Division 1:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following.
      a. Meter bases.
   2. Manufacturer's installation instructions.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with Utility Company requirements.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI / NFPA 70.

1.08 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on the Drawings.

1.09 REQUIREMENT

A. The Contractor shall examine the site and become familiar with conditions affecting the work. The Contractor shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction. All costs, both temporary and permanent to connect all utilities, shall be included in the Bid. The Contractor shall be

responsible for scheduling and coordinating with the local utility for temporary and permanent services.

B. The Contractor is responsible for coordinating all electric utility equipment installations with the serving electric utility. The Contractor shall furnish and install all electric utility equipment required by the electric utility to be installed by the Contractor whether specifically shown on the Drawings or not. The Contractor shall furnish and install the following electrical utility equipment as a minimum:
   1. Concrete transformer pads constructed as instructed by the electric utility
   2. Primary and or secondary ductbank and manholes
   3. Metering equipment cabinets and/or bases
   4. Conduit and wire required from metering cabinet to metering current transformers and potential transformers
   5. Secondary conductors
   6. Secondary terminations

   The electric utility will furnish and install the following equipment:
   1. Primary conductors and terminations

C. The Contractor is responsible for ensuring all electric utility equipment and construction installed by the Contractor is furnished and installed in accordance with the electric utility's design specifications and requirements. The Contractor is fully responsible for coordinating his scope of work with the electric utility. Any additional required electric utility construction or equipment not specified herein or shown on the Drawings shall be supplied by the Contractor at no additional cost to the Owner.

PART 2 PRODUCTS - NONE

PART 3 EXECUTION

3.01 PREPARATION

A. Provide temporary electric service in conformance with requirements of Section 01500, Temporary Facilities.

B. Obtain permanent electric service to the facility in a timely manner to meet the requirements of the construction schedule. Establish account with Utility in Owner's name. Contractor shall not use the permanent electric service for construction of project. Permanent electric service shall only be used for testing of equipment after installation. All usage fees acquired during testing by the Contractor from the Utility shall be paid for by the Contractor until the point of substantial completion has been obtained. Once substantial completion is obtained, the Owner shall then pay for usage fees. All fees from the Utility in regards to establishing a physical permanent electric service to the site shall be paid for by the Owner, separate from this Contract.

C. Coordinate location of Utility Company's facilities to ensure proper access is available.

3.02 INSTALLATION

A. Utility company to provide primary power, metering at transformer and pad mounted transformers. Coordinate with the Utility for delivery and installation of primary service and pad mounted transformer.

B. Provide transformer pads and secondary service laterals as indicated on drawings. Coordinate exact location and dimensions with utility company prior to installation. Install pad in strict accordance with utility standards.

C. Provide service lateral from load side of transformer to service equipment. Utility company will make all terminations at transformer.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16230

ENGINE GENERATOR SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Provide complete packaged engine generator as indicated on the Drawings and specified herein. System shall be complete and operational including necessary accessories and shall include, but not be limited to, the following:
   1. Generator set
   2. Battery and charger.
   3. Exhaust silencer and fittings.
   4. Control panel.
   5. Weatherproof enclosure.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of the work:
   1. Section 16060 Grounding and Bonding
   2. Section 16412 Enclosed Transfer Switch

1.03 SYSTEM DESCRIPTION

A. Description: NFPA 110, UL 2200 listed engine generator system to provide source of power for Level 1 applications.

B. Generator shall deliver its rating continuously for the duration of any normal power failure. System shall be rated for standby duty.

C. Generator system shall be sized as indicated on the Drawings for the following requirements:
   1. Rating: As indicated on the Drawings.
   2. Power factor: 0.8
   3. Operating fuel: Ultra-low sulfur diesel Grade No. 2D S15 in accordance with ASTM D-975
   4. Fuel tank size: Sized for 24 hour operation at 100% load.

1.04 REFERENCES

A. EPA

B. ISO STD 3046 – Performance Standard for Reciprocating Internal Combustion Engines

C. ISO STD 8528 – Reciprocating Internal Combustion Engines

D. NEMA AB1 - Molded Case Circuit Breakers.

E. NEMA MG1 - Motors and Generators.

F. NEMA MG2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum.)

H. NFPA 30 - Flammable and Combustible Liquids Code.

I. NFPA 37 – Installation and Use of Stationary Engines.

J. NFPA 54 – National Fuel Gas Code.

K. NFPA 58 – LP Gas Code.

L. NFPA 70 - National Electrical Code, Article 701 Legally Required Standby Systems.

M. NFPA 70E – Standard for Electrical Safety in the Workplace

N. NFPA 101 - Life Safety Code.

O. NFPA 110 - Emergency and Standby Power Systems.

P. UL 142 – Steel Aboveground Tanks for Flammable and Combustible Liquids

Q. UL 508 – Industrial Control Equipment

R. UL 2200 – Stationary Engine Generators

1.05 SUBMITTALS

A. Submit the following in accordance with Division 1.

1. Certificate of Compliance: A Compliance, Deviations, and Exceptions (CD&E) letter shall be submitted. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations, and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer or Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter, "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation or exception.
2. Catalog Data: The catalog data shall show the following information as a minimum:
    a. Show plan and elevation views with overall dimensions and connection point requirements for electrical and fuel lines.
    b. Provide weight of unit.
    c. Indicate electrical characteristics.
    d. Wiring diagrams for engine, generator, and control panel.
    e. Label major components of system.
    f. Listing and description of system components and accessories.
    g. Technical data and requirements for engine and fuel, lubricating, and cooling system.
3. Test and Start Up Reports: Upon testing of the installed system, field test reports shall be submitted showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
4. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
5. Operation and Maintenance Instructions: Submit complete manufacturer's operation and maintenance manual for the total system. Parts list shall include schedule of type and quantity of parts recommended for stock. Submit sufficient copies to allow the Engineer and Owner to retain five copies. Submit three copies – one for the Engineer and two for the Owner.

1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing of generator sets with a minimum of 10 years experience.

B. Supplier: Authorized distributor of specified manufacturer with minimum 10 years experience. Supplier shall maintain a service facility within 150 miles of the project.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept unit on site on skids. Inspect for damage.

B. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.08 WARRANTY

A. Provide five-year warranty from the date of Substantial Completion. Warranty shall cover the cost of parts, labor, and travel for repairs at the site.

1.09 SERVICE AGREEMENT

A. Provide a two-year service plan to become effective on the date of Substantial Completion. Provide a detailed report of each service visit. The plan shall include semi-annual inspections. Each of the following checks and services shall be performed at least annually:
   1. Oil change; check for leaks.
   2. Oil filter replacement.
   3. Engine check; inspect, run and test.
   4. Fuel tank test for water and leaks.
   5. Check for hose leaks.
   6. Top off of fluids.
   7. Automatic transfer switch test.
   8. Inspection of housing for corrosion, unusual noises, and excessive vibration.
   9. Inspection and cleaning of batteries. Seal terminals and check voltage.
   10. Analysis of oil for contaminates.
   11. Fuel filter replacement.
   12. Replace air filter.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Caterpillar

B. Cummins

C. Generac

D. Kohler

E. MTU – Onsite Energy

2.02 ENGINE

A. Type: Water-cooled inline or V-type, four stroke cycle compression ignition diesel internal combustion engine.

B. Rating: 100 percent of rated kW for duration of an emergency outage.

C. Governor: Isochronous type to maintain engine speed within 0.5 percent, steady state, and 0.5 percent, no load to full load, with recovery to steady state within 2

seconds following sudden load changes. Equip governor with means for manual operation and adjustment.

D. Safety Devices: Automatic engine shutdown on high coolant temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

E. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors as required by manufacturer. Include remote starting control circuit, with Run-Off-Auto selector switch on engine / generator control panel.

F. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 240 volts AC, 1 phase.

G. Radiator: Unit mounted radiator using glycol coolant, with blower type fan. Size fan to maintain safe engine temperature in ambient temperature of 110 degrees F with a maximum of 0.5 inches of water static pressure on the fan.

H. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear driven water pump, and gear type lube pump. A bypass valve shall be provided to allow lube oil circulation in the event of a failure of the filtering system.

I. Mounting: Provide vibration isolators between engine/alternator and base frame.

2.03 GENERATOR

A. Generator: NEMA MG1 three phase, four pole, reconnectable brushless synchronous generator with brushless exciter, twelve lead, 2/3 pitch, random wound, permanent magnet generator.

B. Rating: As indicated on the Drawings.

C. Alternator Insulation Class: H.

D. Temperature Rise: Class F. 130 degrees C rise @ 40 degrees C ambient (Standby duty).

E. Enclosure: NEMA MG1, open drip proof.

F. Voltage Regulation: Include generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Include manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

G. Frequency Regulation: 3 hertz maximum from no load to rated load.

H. Anti-Condensation space heater.

2.04 ACCESSORIES

A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions. The silencer shall be mounted within the generator enclosure. The silencer shall be industrial standard construction, all welded, for stationary engine application. The entire exhaust system shall be supported independently of the generator set to prevent transmission of vibration and allow for thermal expansion. Long radius, low restriction fittings shall be used throughout, and pipe size shall be sufficiently large to handle the engine exhaust flow at full load without causing back pressure in excess of that allowed by the engine manufacturer. A stainless steel rain cap shall be provided.

B. Batteries: Heavy duty, lead-acid storage batteries of sufficient capacity to provide a minimum of five full cycle starts for ten seconds crank with ten second rest periods between cranks. Match battery voltage to starting system. Include necessary cables and clamps.

C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

D. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide enclosure to meet NEMA 1 requirements and NFPA 110 requirements.

E. Line Circuit Breaker: NEMA AB 1, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole, sized as indicated on the Drawings. Unit-mount in enclosure to meet NEMA 1 requirements.

F. Control Panel: NEMA 1 generator mounted control panel enclosure with engine and generator controls and indicators conforming to NFPA 110 Level 1. Panel shall be mounted with vibration isolators. Unit shall include the following devices and features:
   1. Panel lighting.
   2. Fused DC circuit to protect controls.
   3. 3-position Run - Off – Auto selector switch.
   4. Frequency Meter: 45-65 Hz. range, 3.5-inch dial (or digital display).
   5. AC Output Voltmeter: 3.5-inch dial, 2 percent accuracy, with phase selector switch (or digital display).
   6. AC Output Ammeter: 3.5-inch dial, 2 percent accuracy, with phase selector switch (or digital display).
   7. Output voltage adjustment.
   8. Provide indicator lights to show the following:
      a. Generator Off (Red)
      b. Generator Auto (Green)
      c. Generator Run (Yellow)
      d. Generator Warning (Yellow)
      e. Generator Shutdown (Red)
   9. Provide a scrolling digital display or indicator light to show the following critical data:
      a. Overcrank. (Shutdown)
      b. Low water temperature. (Shutdown)
      c. High engine temperature prealarm.
      d. High engine temperature.(Shutdown)
      e. Low lube oil pressure prealarm.
      f. Low lube oil pressure.(Shutdown)
      g. Overspeed.(Shutdown)
      h. Low coolant level warning.
      i. Low coolant temperature.(Shutdown)
      j. Generator supplying load.
      k. Control switch not in auto position.
      l. High battery voltage warning.
      m. Low voltage in battery warning.
      n. Battery charger ac failure warning.
   10. Audible alarm for any of the above conditions. Provide silence switch; however, activation shall not inhibit any subsequent alarms from sounding.
   11. Engine running time meter.

12. Oil pressure gauge.
13. Coolant temperature gauge.
14. Emergency stop switch.
15. Auxiliary Relay for indicating that generator set is running or shut down, with contact terminals prewired to terminal strip.
16. Common Failure Relay: Remotely signals auxiliary fault, emergency stop, high engine temperature, low oil pressure, overcrank and overspeed
17. Terminal strip for remote signaling of the following alarms and statuses to SCADA:
    a. Overcrank alarm.
    b. Low water temperature alarm.
    c. High engine temperature alarm.
    d. Low lube oil pressure alarm.
    e. Overspeed alarm.
    f. Low coolant level alarm.
    g. Low battery voltage alarm.
    h. Low fuel alarm (less than 25% full).
    i. Common alarm for an audible signal when any of the above goes into alarm.
    j. Generator is running status.
    k. Generator is shutdown status.

2.05 SUB-BASE FUEL TANK

A. Fuel system shall include a double walled, UL approved, welded construction, base mounted fuel tank with integral stub-up area. It shall have the structural integrity to support the engine generator set. The tank must be supplied and warranted by the engine generator set manufacturer and be factory installed. Minimum features shall include:
    1. Lockable fuel filler cap.
    2. Fuel gauge.
    3. Low fuel level alarm.
    4. Tank rupture alarm.
    5. Fuel line check valve.
    6. Fittings for fuel supply, return, fill and vent.

2.06 EMERGENCY STOP SWITCH

A. Heavy duty, red mushroom push button, push-to-stop/pull-to-activate maintained contacts, mounted in NEMA Type 12 enclosure. Provide phenolic label attached to enclosure stating, "GENERATOR EMERGENCY STOP".

2.07 WEATHERPROOF GENERATOR ENCLOSURE

A. Furnish and install an outdoor, weather-protective housing. The housing shall be furnished complete with a full sub-base floor resulting in complete enclosure. "Skin-tight" or "Drop-over" housings are not acceptable.

The enclosure shall be factory-assembled to the engine-generator set base and radiator cowling. Lifting eyes shall be provided. Housing shall provide ample airflow for generator set operation. The housing shall be constructed of 12 gauge (minimum) aluminum or 14 gauge (minimum) galvanized steel sheet metal, suitably reinforced to be vibration free in the operating mode. Housings constructed of aluminum sheet metal are acceptable; however, the material thickness shall be increased to provide the equivalent structural strength and

rigidity. The housing shall have hinged side-access doors and rear control panel access door. Each door shall have at least two latch-bearing points. All doors shall be lockable with panic hardware. All steel sheet metal shall be primed for corrosion protection and finish painted in a color as selected by the Owner. Roof shall be peaked to allow drainage of rain water. Unit shall have sufficient guards to prevent entrance by small animals. Batteries shall fit inside enclosure and alongside the engine (batteries under the generator are not acceptable). Unit shall have engine coolant and oil drains outside the unit to facilitate maintenance. Each drain line shall have a high quality valve located near the fluid source. The generator enclosure shall cover the entire length and width of the base mounted fuel tank so that no part of the fuel tank's top surface is exposed.

B. Aluminum stairs shall be furnished as required at each door. The aluminum stairs shall be as specified in Section 05510-Metal Stairs. The Contractor shall coordinate with the Engineer as necessary to accommodate the installation of the aluminum stairs.

C. All air intake louvers shall be furnished with rain guards or designed to eliminate water intrusion to the interior of the enclosure when the generator is operating at its full load capacity during rainy weather events.

D. The enclosure shall be furnished with a 25kVA, 120/240VAC combination power unit as shown on the drawings and as specified in Section 16441, Panelboards. This panel shall serve as the power distribution panel for all accessories specified herein and indicated on the Drawings (e.g. space heaters, battery charger, leak detection system, etc.). The Contractor shall furnish and install all conduit and wire necessary to provide the power supply to the combination power unit and from the power unit to all accessories.

   The unit shall be a combination of a dry type transformer and a lighting panelboard. Combination power units located outdoors shall be suitable for outdoor use rated NEMA 3R.

   The combination power unit shall be a Mini-Power Zone as manufactured by Square D Company, a Mini-Power Center as manufactured by Cutler-Hammer, General Electric Company equivalent, or equal.

E. Provide walk-around access within the enclosure. Access shall be two feet (minimum) measured from the outermost engine generator component or four feet from the rails, whichever is greater. Interior height from the sub-base floor to the ceiling shall be 84" minimum. Door height shall be 72" minimum.

F. Enclosure shall be sound attenuated to provide sound level of 76 dBA at 7 meters.

G. Linear LED lighting shall be provided in sufficient quantity to maintain 20 foot-candles of illumination at floor level. Interior lighting shall be controlled by 3-way light switches located at the doors. Reference Section 16140.

H. Convenience receptacles shall be furnished within the enclosure. Receptacles shall be 125V, 20A, two-pole, three wire grounded type. Reference Section 16140.

I. Conduit and wire shall be in accordance with Sections 16130 and 16120, respectively.

J. The weather-proof engine-generator enclosure shall be manufactured by Chillicothe Metal Company, Pritchard-Brown, Atkinson, Tramount or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide fuel system piping as recommended by generator set manufacturer.

C. Provide wiring for fuel shutoff valve powered from generator set batteries and controlled by generator set control panel.

D. Provide interconnecting wiring between generator control panel and pump control panel.

E. Provide interconnecting wiring between generator control panel and telemetry system.

F. Provide interconnecting wiring between generator control panel and automatic transfer switch for automatic start.

G. Provide duplex receptacle, battery charger, alternator heater, and jacket heater branch circuits from an external source.

3.02 START UP SERVICES

A. Provide the services of manufacturer's representative to check the equipment installation, supervise initial start up, and instruct Owner's personnel in proper operation and maintenance of the equipment. A minimum of one trip to the site will be required, consisting of a minimum of one 8-hour working day. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) month of operation.

B. Provide a four hour full load test utilizing portable test bank. Simulate power failure including operation of transfer switch, automatic starting cycle, automatic shutdown, and return to normal. The load bank test shall be performed at the job site and shall include one hour at 50% load, one hour at 75% load, one hour at 100% load, and one hour at 50% load. Any defects that become evident during the test shall be corrected. Safety shutdown features shall be tested by simulating the primary device contact closure.

C. Record in 20 minute intervals during four hour test:
   1. Kilowatts.
   2. Amperes.
   3. Voltage.
   4. Coolant temperature.
   5. Ambient temperature.
   6. Frequency.
   7. Oil pressure.

D. Test alarm and shutdown circuits by simulating conditions.

E. Describe loads connected to standby system and restrictions for future load additions.

F. Adjust generator output voltage and engine speed.

3.03 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters at time of Substantial Completion.

3.04 FUEL, OIL, AND ANTIFREEZE

A. Provide required fuel for testing and start up services.

B. Provide complete charges of oil and antifreeze at time of Substantial Completion.

C. Fuel tank shall be filled at time of Substantial Completion.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16280

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surge protective devices.

1.02 DESCRIPTION

A. This section covers surge protection devices (SPDs). The work shall include all materials, labor, and auxiliaries required to provide complete surge suppression for the protection of electrical and electronic systems from the effects of line and electromagnetic induced transient voltage surges and coupled lightning discharged transients as indicated on drawings or as specified in this section.

B. SPDs shall limit transient voltage by diverting or limiting surge current. They shall prevent continued flow of follow current while remaining capable of repeating their transient voltage limiting functions.

1.03 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.04 CODES AND REFERENCES

A. Qualification Data: Third Party testing lab or U.S. Department of Labor/OSHA approved NRTL.
   1. Agency Approval/Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
   2. All SPDs shall be tested and listed to UL 1449 3rd Edition and Complimentary Listed to UL 1283 by a NRTL.

B. Applicable Documents – Most Recent Editions of:
   1. ANSI/IEEE Std C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
   2. ANSI/IEEE Std C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   3. ANSI/IEEE Std C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
   4. ANSI C84.1, American National Standard for Electric Power Systems and Equipment – Voltage Ratings (60 Hertz).
   5. IEEE Standard 1100, IEEE Recommended Practice for Power and Grounding Electronic Equipment - Clause 8.6.1.
   6. National Fire Protection Association (NFPA) 70 (N.E.C.) – Article 285.
   7. ANSI/UL 1283, Electromagnetic Interference Filters.
   8. ANSI/UL 1449, Surge Protective Devices.
   9. IEEE Std C62.72 – IEEE Guide for the Application of Surge-Protective Devices for Low-Voltage (1000 V or less) AC Power Circuits.

1.05 DEFINITIONS

A. Modes Of Protection:

1. System shall provide discrete protection for all modes with directly connected protection elements including line to line, line to neutral, line to ground, and neutral to ground. Distinct and independent protection circuitry for each mode is required.

B. Per Phase Ratings:

1. 'Per-Phase' ratings for a three-phase Wye-connected SPD are determined by multiplying the kA per mode times the number of discrete modes of protection (directly connected suppression components), minus the value for the Neutral to Ground mode, divided by the number of phases.

   Per-Phase = (((kA per mode) X (# of modes))-(N-G mode kA)) / (# of phases)).

1.06 SUBMITTALS

A. Product Data: For each type of product indicated, include the following testing and manufacturer information:

1. Short Circuit Current Rating (SCCR).
2. Voltage Protection Ratings (VPRs) for all modes.
3. Maximum Continuous Operating Voltage rating (MCOV).
4. I-nominal rating (I-n).
5. Operating weights.
6. Electrical characteristics.
7. Accessories.
8. NEMA Enclosure Type.

B. IEEE Std. C62.41.2TM-2002 test reports. Include complete let-through voltage/measured limiting voltage test data (not SVR or VPR), test graphs and scope traces for each and every mode for each product submitted for Category's C, B, A (including Cat A, 2 kV, 67 A, 100 kHz ring wave at both 90 & 270 degree electrical phase angles). Testing shall be conducted as follows:

1. **Test** Parameters: Positive Polarity, Net voltages are peak (±10%). All tests are static (unpowered) except 150 V MCOV modes. Let-through voltages on static tests calculated by subtracting sinewave peak from let-through measured from zero. 150 V MCOV mode let-through voltages measured from the insertion point on the sinewave. Each phase is the average of the 3 modes. In order to duplicate the results, the specified mode must be tested for all three phases (except N-G) and averaged together. (Individual mode or shot results may not vary by more than 10%. Scope Settings: Time Base = 10 microseconds, Sampling Rate = 250 Megasamples/sec. These settings assure Let-through voltages test results are accurate). All tests performed with 6" lead length (external to the enclosure), simulating actual installed performance per the ANSI/UL 1449-2006 standard.
2. Let-through voltages furnished within this testing must not exceed the following to be considered for approval, no exceptions:
   a. **Service Entrance 120/208 V 3Ph Wye** (IEEE Cat C High Current Driven Surge Test Results (10 kA)) (L-N 730 V) (L-L 965 V) (L-G 785 V) (N-G 995 V)

b. **Service Entrance 120/208 V 3Ph Wye** (IEEE Cat C High Current Driven Surge Test Results (10 kA)) (L-N 730 V) (L-L 965 V) (L-G 785 V) (N-G 995 V)
c. **Distribution 120/208 V 3Ph Wye** (ANSI/UL 1449-2006 VPRs): (L-N 600 V) (L-G 600 V) (L-L 1000 V) (N-G 600 V)
d. **Distribution 277/480 V 3Ph Wye** (ANSI/UL 1449-2006 VPRs): (L-N 1200 V) (L-G 1200 V) (L-L 1800 V) (N-G 1200 V)
e. **Branch 120 V** (IEEE Cat A Ringwave (2 kV)) Test Results (@ 270° phase angle)): (L-N 30 V) (L-L 40 V) (L-G 50 V) (N-G 50 V)
f. **Branch 277 V** (IEEE Cat A Ringwave (2 kV)) Test Results (@ 270° phase angle)): (L-N 60 V) (L-L 105 V) (L-G 80 V) (N-G 60 V)

C. Certificates of Conformity: For SPDs, certifying compliance with and NRTL listing/certification to, the following standards:
   1. UL 1449 3rd Edition.
   2. UL 1283 (complimentary listed).
D. Operation and Maintenance Data.
E. Warranty duration and replacement policy.
F. Manufacturer's installation instructions to include wiring diagram to show field connections and manufacturer's recommended wire and breaker sizes.

1.07 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a NRTL testing agency, and marked for intended location and application.
B. Manufacturer's Qualifications: At least 10 years engineering experience in the engineering, design, and manufacture of permanently connected SPDs.
C. Manufacturer operates a Quality System Certified manufacturing facility as ISO 9001:2000 Compliant.

1.08 WARRANTY

A. The manufacturer shall provide unlimited free replacement of the entire SPD or defective modules for a period of 10 years from date of Substantial Completion

PART 2 PRODUCTS

2.01 SERVICE ENTRANCE

A. SPD in main switchboard may be integral to switchboard enclosure and may be manufactured by switchboard provider. Manufacturers:
   1. Surge Suppression, Inc. model no. CSEB3Y2.
   2. Equal by Liebert
   3. Equal by Advanced Protection Technologies.
   4. Equal by Current Technologies.
B. Description:
   1. UL 1449, 3rd Edition Listed.
   2. Dedicated, discrete Ten Mode Protection: L-N, L-G, L-L & N-G.
   3. Permanently-mounted, parallel connected.
   4. Sine wave tracking.

5. Self-restoring and fully automatic.

C. Ratings:
1. Voltage: 480Y/277 volts, 3 phase, 4 wire, 60 Hz.
2. Peak Single-impulse Surge Current Rating: 200 kA per phase minimum.
3. Nominal Discharge Current: 20 kA per mode.
4. Maximum Continuous Operating Voltage (MCOV): 115% of nominal RMS voltage.
5. Short Circuit Current Rating (SCCR): 200 kAIC.
6. Voltage Protection Ratings (VPRs) as follows:

Nom. System Voltage	Mode		VPR
120/240V, 1 Ph., 3W	L-N	150V	700V
	L-L	300V	1000V
	L-G	150V	700V
	N-G	150V	700V
208Y/120V, 3 Ph., 4W	L-N	150V	700V
	L-L	300V	1000V
	L-G	150V	700V
	N-G	150V	700V
240/120V, 3 Ph., 4W, High Leg Delta	L-N	150V	700V
	HL-N	320V	1500V
	L-L	300V	1800V
	L-G	150V	700V
	HL-G	320V	1800V
	N-G	150V	700V
480Y/277V, 3 Ph., 4W	L-N	320V	1200V
	L-L	550V	1800V
	L-G	320V	1200V
	N-G	320V	1200V

D. Options:
1. LED indicator lights for power and protection status.
2. Audible alarm to actuate when any part of the surge circuitry has been damaged. Provide silence button.
3. Integral disconnect switch with exterior handle.
4. Weathertight, corrosion resistant NEMA 4X, Type 304 stainless steel enclosure.

2.02 FUSING

A. Provide as a minimum, over-current, over temperature protection in the form of component-level thermal fusing to ensure safe failure and mitigate thermal runaway.

B. Provide integral short circuit current fusing within each device. This fusing will be independent of the "component-level" fusing and specifically for over-current protection and shall be constructed utilizing surge rated, cartridge fuses.

C. The fusing mechanisms employed must effectively coordinate their performance in conjunction with the high current abnormal over-voltage testing under UL 1449 3rd Edition.

PART 3 EXECUTION

3.01 INSTALLATION

A. SPDs shall be installed at locations indicated.

B. Shall be installed in accordance with manufacturer's instructions and NFPA 70.

C. Shall not be installed at a point on the system where the available fault current exceeds that of the SPD rating.

D. Service Entrance:

1. Suppressor shall be installed on the load side of the service disconnect overcurrent device.
2. Conductors between the suppressor and point of attachment shall be #6 stranded copper or as recommended by the manufacturer.
3. Conductors shall be kept as short and straight as possible; do not exceed manufacturer's recommended lead length.
4. Phase conductors shall be twisted one turn per 12 inches of conductor length to reduce inductive effects.
5. Do not energize or connect service entrance equipment and panelboards to their sources until SPDs are properly installed and connected.
6. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect all SPDs before conducting insulation resistance tests, and reconnect immediately after the testing is over.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16410

ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Disconnect Switches

B. Manual Transfer Switches

1.02 RELATED SECTIONS

A. Section 16070 – Supporting Devices

B. Section 16075 – Electrical Identification

1.03 REFERENCES

A. NECA - Standard of Installation.

B. NEMA FU1 – Low Voltage Cartridge Fuses.

C. NEMA KS 1 - Enclosed Switches and Miscellaneous Distribution Equipment Switches (600 volts maximum).

D. NFPA 70 - National Electrical Code.

E. UL 198E - Class R Fuses.

F. UL 1008 – Transfer Switches

G. UL 991

H. NFPA 70 – National Electrical Code

I. NFPA 110 – Emergency and Standby Power Systems

J. NEMA ICS 10 – AC Transfer Switch Equipment

1.04 SUBMITTALS

A. Submit under provisions of Division 1.
   1. Product Data: Provide switch ratings and enclosure dimensions.
   2. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

B. Maintain one copy of each document on site.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL as suitable for purpose specified and shown or other North Carolina Recognized Third Party Testing Agency.

1.08 EXTRA MATERIALS

A. Furnish under provisions of Division 1.

B. Provide three of each size and type fuse installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Switches shall be manufactured by the Square D Company, Eaton, the General Electric Company, or Siemens Energy and Automation, Inc.

2.02 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Drawings and as required by the NEC. Handles shall be lockable.

B. Disconnect switches for non-hazardous areas shall be UL 98 Listed. Disconnect switches for hazardous areas shall be UL 1203 Listed.

C. Switches shall meet NEMA Standard KS 1 type HD requirements, be, single throw, be externally operated, and be fused or non fused as indicated on the Drawings. Switches shall have the number of the poles, voltage, and ampere ratings as shown on the Drawings.

D. In non-hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

1. Indoor Wet Process Area – NEMA 4X, Type 304 Stainless Steel
2. Indoor Dry Process Area – NEMA 12, Painted Steel
3. Indoor Dry Non-process Area – NEMA 1, Painted Steel
4. Indoor Chemical Storage/Transfer Area – NEMA 4X, Type 304 Stainless Steel
5. All Outdoor Areas – NEMA 4X, Type 304 Stainless Steel

E. Disconnect switches shall be quick make, quick break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.

F. A complete set of fuses for all switches shall be furnished and installed as required. Time current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.

G. Disconnect switches shall be furnished with a factory installed internal barrier kit that helps prevent accidental contact with live parts and provides "finger-safe" protection when the door of the enclosed switch is open.

H. Disconnect switches shall be furnished with a manufacturer-supplied ground lug kit for termination of equipment grounding conductors. Where a grounded (neutral) conductor is shown on the Drawings in the conduits connected to the disconnect switch, a manufacturer-supplied neutral bar shall be furnished for termination of the grounded conductors. Third party ground lug and neutral lug kits not supplied by the disconnect switch manufacturer are not acceptable.

I. Disconnect switches for all motors connected to variable frequency drives (VFDs) shall be furnished with a factory installed electrical interlock kit that includes one (1) early-break auxiliary contact rated for 5A (minimum) at 120 VAC to be used to open the control circuit before the main switch blades break.

2.03 MANUAL TRANSFER SWITCHES

A. Ratings
   1. The transfer switch shall have equal 3-second withstand; closing and interrupting ratings 35KAIC at 480V.
   2. The manual transfer switches shall be fully rated for all types of loads, inductive and resistive, without over-sizing, either open or enclosed.

B. Construction
   1. Manual Transfer Switch (MTS) shall be manually operated by a permanently attached manual operator.
   2. Main contacts shall be designed to withstand multiple fault currents and shall meet UL 489 and/or UL 1087 requirements.
   3. The transfer switch shall be mechanically interlocked to prevent cross connection of sources when operated.
   4. Manual transfer switches shall be capable of being operated manually under full rated load conditions. Removable manual operating handles are not acceptable.
   5. Neutral shall be fully rated with equal withstand, closing and interrupting ratings to the power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.

C. Wiring/Terminations
   1. Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

D. Enclosure
   1. Each manual transfer switch shall be provided in a NEMA 4X shall be stainless steel, non-painted enclosure suitable for use in environments indicated in the drawings.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

B. Insulation check to ensure the integrity of insulation and continuity of the entire system

C. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards

D. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances

E. Electrical tests to verify the complete electrical operation of the switch.

3.02 INSTALLATION

A. Install in accordance with NECA "Standard of Installation", per the manufacturer's recommendations and the contract drawings..

B. Height: 5 ft. to center of operating handle unless otherwise shown or conditions dictate otherwise.

C. Install switches plumb. Attach to wall or equipment rack panel in accordance with Section 16070.

D. Install fuses in fusible disconnect switches. Install fuses with label oriented such that manufacturer, type, and size are readable.

E. Provide engraved plastic nameplates under the provisions of Section 16075.

F. All necessary hardware to secure the assembly in place shall be provided by the contractor.

G. The equipment shall be installed and checked in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 16410

ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 RELATED WORK

A. Section 16070 - Supporting Devices.

B. Section 16075 - Electrical Identification: Engraved nameplates.

1.03 REFERENCES

A. NECA (National Electrical Contractors Association) "Standard of Installation."

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NFPA 70 - National Electrical Code.

D. NEMA 250 – Enclosures for Electrical Equipment

E. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

1.04 SUBMITTALS

A. Submit under provisions of Division 1.

1. Product Data: Provide circuit breaker ratings and enclosure dimensions.

2. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

1. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Square D Co.

B. Siemens Energy & Automating Corp.

C. Eaton Corporation

D. General Electric Co.

2.02 MOLDED CASE CIRCUIT BREAKER

A. Circuit breakers shall be molded case type with trip and frame ratings as indicated on the Drawings. Provide electronic trip unit where indicated on the Drawings, with adjustable functions as indicated on the drawings.

B. Circuit breakers shall have an interrupting rating of 42,000 amperes symmetrical at 480 VAC, unless otherwise indicated on the Drawings.

C. Enclosed circuit breakers in non-hazardous locations shall be UL 489 Listed.

D. Enclosed circuit breakers shall be quick-make, quick-break and with an interlocked cover which cannot be opened when the breaker is in the "ON" position and capable of being locked in the "OPEN" position.

E. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the enclosure.

F. Enclosed circuit breakers shall be suitable for use as service entrance equipment where indicated on the Drawings and so labeled to suit the application.

2.03 PRODUCT OPTIONS AND FEATURES

A. For service entrance equipment provide load side lugs suitable for connection of two conductors per phase; one set of conductors to be installed to the surge protective device and the other set of conductors to be installed to the automatic transfer switch.

2.04 ENCLOSURE

A. In non-hazardous locations, enclosed circuit breakers shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed.

1. Indoor Wet Process Area – NEMA 4X, Type 304 Stainless Steel

2. Indoor Dry Process Area – NEMA 12, Painted Steel

3. Indoor Dry Non-process Area – NEMA 1, Painted Steel

4. Indoor Chemical Storage/Transfer Area – NEMA 4X, Type 304 Stainless Steel

5. All Outdoor Areas – NEMA 4X, Type 304 Stainless Steel

B. In hazardous locations, enclosed circuit breakers shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

1. Class 1, Division 1, Group D – NEMA 7, Die Cast Aluminum

2. Class 1, Division 2, Group D – NEMA 4X, Type 304 Stainless Steel

3. Class 2, Division 1, Group F – NEMA 9, Die Cast Aluminum

4. Class 2, Division 2, Group F – NEMA 4X, Type 304 Stainless Steel

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 16070, Supporting Devices.

C. Height: 5 ft. to operating handle.

D. Provide engraved plastic nameplates under the provisions of Division 1.

3.02 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Inspect and test each circuit breaker to NEMA AB 1.

C. Inspect each circuit breaker visually.

D. Perform at least 10 mechanical On-OFF operations on each circuit breaker.

E. Verify circuit continuity on each pole in closed position.

F. Conduct a ground fault performance test in accordance with instructions provided with equipment.

G. Include description of testing and results in test report.

3.03 ADJUSTING

A. Adjust work under provisions of Division 1.

END OF SECTION

SECTION 16420

ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Individual magnetic motor starters

B. Individual manual motor starters

C. Reduced voltage solid state starters

D. Variable frequency drives

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 16070 Supporting Devices.
   2. Section 16075 Electrical Identification: Engraved nameplates.
   3. Section 16422 Controls & Relays

1.03 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NECA "Standard of Installation," published by National Electrical Contractors Association.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

E. NEMA ICS 5 – Industrial control and systems: Control circuit and Pilot Devices.

F. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.04 SUBMITTALS

A. Submit under provisions of Division 1.
   1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
   2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of individual motor controller. For RVSS starters, in free-standing enclosures, show conduit stub-up area locations on the Drawings.
   3. Custom wiring diagrams for each individual motor controller. Standard wiring diagrams that are not custom created by the manufacturer for the individual

motor controllers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. high service pump) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

4. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
5. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.
   1. Maintenance Data: Include spare parts data listing; source and current prices for replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina recognized third party testing agency.

1.09 EXTRA MATERIALS

A. Furnish under provisions of Division 1.
   1. Provide three of each size and type fuse installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 INDIVIDUAL MAGNETIC MOTOR STARTERS

A. Individual magnetic motor starters shall be combination type complete with motor circuit protectors (MCP's). Starters shall be rated 480 VAC, 3-pole, sized for the intended load unless otherwise indicated. In no case shall a starter smaller than a NEMA Size 1 be used. Each starter shall be furnished with a minimum of two spare auxiliary contacts.

B. In non-hazardous locations, motor starters shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

1. Indoor Wet Process Area – NEMA 4X, Type 304 Stainless Steel
2. Indoor Dry Process Area – NEMA 12, Painted Steel
3. Indoor Dry Non-process Area – NEMA 1, Painted Steel
4. Indoor Chemical Storage/Transfer Area – NEMA 4X, Type 304 Stainless Steel
5. All Outdoor Areas – NEMA 4X, Type 304 Stainless Steel

C. Starters shall be provided with all coils and controls for 120 VAC operation, unless otherwise indicated on the Drawings.

D. The minimum control power transformer VA requirements are as shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.

Size 1 150 VA
Size 2 150 VA
Size 3 200 VA
Size 4 300 VA
Size 5 500 VA

The motor controller manufacturer is advised to review the total Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this Division or shown on the Drawings. Control power transformers shall be fused on both the primary and secondary sides.

E. Each starter shall be supplied with a manual reset overload relay. Manual reset shall be accomplished by a door mounted overload reset pushbutton. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy and bi-metallic type overload relays are not acceptable.

F. Control Devices

1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16422, Electric Controls and Relays:
   a. Pilot devices (switches, indicating lights, etc)
   b. Relays and timers
   c. Control Terminal blocks

G. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power

wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105ºC. Wire color coding shall be as specified in Section 16123, Low Voltage Cable.

H. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid state equipment (e.g. programmable logic controller) wired as part of the control circuit.

I. Individual magnetic motor starters shall be as manufactured by Eaton using NEMA rated Freedom Series starters and contactors, the General Electric Company equivalent, the Square D Company equivalent, or Siemens Energy & Automation, Inc. equivalent.

2.03 INDIVIDUAL MANUAL MOTOR STARTERS

A. Individual manual motor starters in enclosures as specified above shall be furnished and installed for outdoor and indoor exposed work. Furnish and install manual motor starters in outlet boxes with flush wall plates as required for concealed work.

B. Furnish and install manual motor starters with pilot lights and overload heater elements of correct rating based on motor nameplate data.

C. Manual motor starters shall be equipped with either a push button or toggle operator with reset device or mechanism accessible without opening the enclosure.

D. Individual manual motor starters for motors one (1) horsepower and less shall be Eaton Type MS, the General Electric Company equivalent, the Square D Company equivalent, Allen-Bradley equivalent, or Siemens Energy & Automation, Inc. equivalent.

E. Individual manual motor starters for integral horsepower motors shall be Eaton Type B100 or B101, the General Electric Company equivalents, the Square D Company equivalents, Allen-Bradley equivalent, or Siemens Energy and Automation, Inc. equivalents.

2.04 REDUCED VOLTAGE SOLID STATE STARTERS

A. The solid-state reduced-voltage starter shall be UL Listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, an integral paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing. The starter shall meet all applicable requirements of this Section and other sections in this Division.

B. The RVSS shall be suitable for continuous operation at 115% of its continuous ampere rating. The Contractor is fully responsible for the review of the mechanical specifications to determine specified motor speed, horsepower and full load amperes. This information is available in the applicable mechanical specifications for each piece of equipment (e.g. backwash blower).

C. The RVSS shall be suitable for the following environmental conditions:
   1. Operating Temperature: 0-50 degrees C
   2. Humidity: 0-95 percent non-condensing.
   3. Altitude: up to 3,300 feet.

D. The RVSS shall be suitable for operation on a 480 VAC, 3-phase, 60 Hertz system.

E. The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV. Units using

triacs or SCR/diode combinations are not acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt effects.

F. The paralleling run bypass contactor shall energize when the motor reaches full speed and close/open under one (1) times motor current.

G. The starter shall be provided with electronic overload protection as standard and shall be based on an inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter. The starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad. The starter shall be capable of either an electronic or mechanical reset after a fault. Units using bimetal or eutectic alloy overload relays are not acceptable.

H. The starter shall provide protection against the following conditions:
   1. Improper line-side phase rotation. The starter shall stop the motor load if a line-side phase rotation other than A-B-C exists.
   2. Phase loss or unbalanced conditions. The starter shall stop the motor load if a 50% current differential between any two phases is encountered.
   3. Motor stall conditions.
   4. Motor jam conditions.

I. The starter shall be provided with a form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. The contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate the type of fault (Overtemp, Phase Loss, Jam, Stall, Phase Reversal, and Overload).

J. The starter shall be provided with an unpowered internal "Run" contact rated for 24VDC or 120 VAC operation.

K. The following control function adjustments on the device keypad shall be provided:
   1. Selectable Torque Ramp Start or Current Limit Start
   2. Adjustable Kick Start Time, 0-2 seconds
   3. Adjustable Kick Start torque, 0-90%
   4. Adjustable Ramp Start Time; 0.5-180 seconds
   5. Adjustable Initial Starting Ramp Torque; 0-100%
   6. Adjustable Smooth Stop Ramp Time; 0-60 seconds.

   The Human Interface Module (HIM) provided for the RVSS shall be the same as provided for the variable frequency drives.

L. Enclosed units shall include a motor circuit protector (MCP) for short-circuit protection and quick disconnect means. If required, the unit shall include a 24 VDC power supply to be used as the primary control voltage source. A 120 VAC control power transformer, fused on both the primary and secondary sides, shall be provided as an additional control power source to power such devices as motor space heaters, solenoid valves, and similar control elements as required. Input and output isolation contactors shall be furnished as indicated on the Drawings.

M. Unless otherwise specified or indicated on the Drawings, the RVSS enclosure shall be dead-front, with front accessibility. The enclosure shall be designed for both bottom and top entry. The enclosure shall be designed so rear access is not

required for operations, maintenance, and repair tasks. The doors shall have full length piano type hinges and shall be braced to prevent sag when fully open. Other enclosure requirements are:

1. Finish exterior of the enclosures in ANSI-61 gray enamel or furnish in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.

The Contractor shall reference the Drawings for maximum dimensions of the RVSSs.

N. In non-hazardous locations, the RVSS shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings .

1. Indoor Wet Process Area – NEMA 4X, Type 304 Stainless Steel
2. Indoor Dry Process Area – NEMA 12, Painted Steel
3. Indoor Dry Non-process Area – NEMA 1, Painted Steel
4. Indoor Chemical Storage/Transfer Area – NEMA 4X, Type 304 Stainless Steel
5. All Outdoor Areas – NEMA 4X, Type 304 Stainless Steel

O. The complete starter assembly shall be rated per UL 508 for a minimum withstand rating of 65 kAIC rms. Starters enclosed in motor control centers shall be by the same manufacturer.

P. Control Devices

1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16422, Electric Controls and Relays:
   a. Pilot devices (switches, indicating lights, etc)
   b. Relays and timers
   c. Control Terminal blocks

Q. The reduced voltage solid state starter shall be the SMC-Flex with integral bypass as manufactured by Allen-Bradley, Eaton equivalent, the General Electric Company equivalent, the Square D Company equivalent, or Siemens Energy and Automation, Inc. equivalent.

2.05 VARIABLE FREQUENCY DRIVES

A. Manufacturers

1. The equipment covered by this Specification is intended to be standard equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
2. It is the intent of these specifications that the VFD's be provided as stand-alone drive systems.
3. The Contractor shall obtain the VFD's from one manufacturer who shall also manufacture the enclosure and major equipment components. The manufacturer shall have a minimum of five years experience in the manufacture of similar units and shall have a general distribution to the electrical trade. Subcontracting of wiring will not be acceptable.

The VFD's shall be be as manufactured by Square D Company PowerGard Series C, Halmar Robicon Group Clean Power Series, ABB ACS-600, Cutler-Hammer CP9000, the Allen Bradley equivalent, General Electric or equal. The VFD systems shall be furnished complete with bypass starters, harmonic distortion suppression equipment (as required), and all other equipment specified herein and indicated on the Drawings for a complete and operable system.

4. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard three-wire "start-stop" and the Contractor shall furnish wiring accordingly.
5. Variable frequency drive manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all load, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.
6. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.

B. Product Requirements

1. Variable speed drives shall be adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 480 volt AC NEMA Design B induction motors. Variable frequency drives for other than NEMA Design B induction motors (e.g. NEMA Design C) shall be coordinated with the requirements of that respective load.

   Drive units shall perform continuous self diagnostics as well as load and drive self check on startup.
2. All drives shall have permanently mounted programming and display modules. These modules shall provide programming access to all drive parameters, display all fault codes to assist with diagnostics and provide a display of output speed in percent or load.
3. This specification describes variable speed motor control which includes the design, fabrication, testing, installation and support requirements for variable frequency drive systems for 3-phase, squirrel cage rotor, induction motors driving pumps. In addition to the variable frequency drive system, provide a motor controller for bypass starting during variable frequency drive downtime, where specified herein and indicated on the Drawings.
4. Each variable frequency drive to be a complete alternating current electric drive system including hardware, software, technical data, and spare parts necessary to accomplish variable speed operation of an induction motor and load combination in accordance with the requirements as indicated on the Drawings and as described in these Specifications.

5. Variable frequency drive system manufacturer shall be responsible for the design and performance of the entire drive system and shall either manufacture all items of equipment or supply them using coordinated specifications furnished to the original equipment manufacturers to insure compatibility and performance in accordance with this Specification. Variable frequency drive manufacturer shall coordinate with suppliers of the drive motors and driven equipment.
6. Variable frequency drive system shall be suitable for operation as part of a 480 VAC, 3 phase, 60 Hertz power distribution system. The complete variable frequency drive system shall withstand the mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.
7. The variable frequency drive system shall be suitable to operate, at times, on a limited power source engine-generator set. The system shall be provided with equipment and devices to prevent waveform distortion as specified herein.
8. Provide control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks.
9. Design each variable frequency drive motor drive speed control system so that through simple programming by either factory engineers or Owner's trained operating personnel, specific control and protection functions can be attained.

C. Design Requirements
1. Each variable frequency drive system shall meet the requirements of this Specification without derating any of the induction motor operating parameters including service factor and nameplate horsepower. The variable frequency drive system manufacturer shall specifically identify special requirements or restrictions of the motor-load combination that may result from operation on the variable frequency drive system.
2. The variable frequency drive shall consist of a 18 pulse diode semiconductor rectifier system, direct current link, and pulse width modulated inverter. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the induction motor at the desired speed.
3. Variable frequency drive shall operate from fixed frequency power supply and convert this input power into variable speed induction motor shaft power as required by this Specification. Provide each variable frequency drive and bypass starter with padlockable externally operable circuit breakers. Provide each variable frequency drive with a 3 or 5 percent (size as required) line reactor at the input. Include the necessary drive controllers, input contactors, and output contactors to accomplish the intended control of the variable frequency drive system.
4. The drive shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.

5. The overall drive system efficiency shall be a minimum of 95 percent when operating the specified motor-load combination at rated voltage, frequency, and current.

   This efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$

6. Power (Load) is the total 3-phase power delivered to the motor, measured at the output terminals of the drive system, including output filters or transformers. Power (Supply) is the total electrical power delivered to the drive system, measured at the input terminals of the variable frequency drive including input filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment. Include power input required for auxiliary equipment (e.g., controls, fans, air conditioning, pumps) for complete system operating in this Power (Supply) total.
7. Variable frequency drive shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed (revolutions per minute). The variable frequency drive shall be provided with maximum and minimum frequency limits.
8. Variable frequency drive system to maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5 percent of rated frequency of 60 Hertz for a 24 hour period.
9. Variable frequency drive to have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The variable frequency drive shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.

   Variable frequency drive shall be furnished with programmable electronic overload and torque limits.
10. Drive system shall achieve a desired output frequency (setpoint) with a repeatability of 0.1 percent of rated frequency of 60 Hertz.
11. Drive system to be capable of operating the specified load continuously at any speed within the operating speed range of 10 percent to 100 percent of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.
12. Drive system controls to be microprocessor-based and have controlled linear acceleration capability to ramp up the speed, revolutions per minute, of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Provide two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. Provide controlled linear deceleration capability. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.
13. Voltage or current unbalance between phases of the variable frequency drive output voltage shall not exceed 3 percent of the instantaneous values. The variable frequency drive system shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3 percent. The

system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.

14. Variable frequency drive system to operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10 percent for a duration of 15 cycles. Unacceptable voltage fluctuations on the supply bus shall cause under or overvoltage protection to trip and remove supply voltage from the drive system. Variable frequency drive output voltage regulation shall be plus or minus 2 percent.

    The variable frequency drive system shall be furnished with line surge protection.

15. The Contractor shall size variable frequency drive system and components to provide, indefinitely, motor load current equal to 125 percent of the motor nameplate full load current.

    The Contractor is fully responsible for the review of the mechanical specifications to determine specified motor speed, horsepower and full load amperes. This information is available in the applicable mechanical specifications for each pump, drive, conveyor, blower, etc. Reference the Table of Contents.

16. The audible noise (sound pressure) level of a motor when operated from no load to full load with the variable frequency drive described herein shall not increase more than 5 decibels (dbA), at 5 feet in any direction from the motor, above its noise level when operated from a utility power source without the variable frequency drive.
17. Variable frequency drives shall be provided with output reactors or filters to prevent elevated voltage levels at the motor terminals.

D. Operating Conditions
    1. The following operating conditions are applicable for all equipment of this Specification.
        a. Humidity: 0-95 percent.
        b. Ambient Temperature: Minus 20 degrees Celsius to plus 50 degrees Celsius.
        c. Altitude: up to 3,300 feet
        d. Power Supply: 480 volts, 3-phase, 60 Hertz.
        e. Available Short Circuit Duty: as specified herein.

E. System Features and Characteristics
    1. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings. As a minimum, each VFD shall provide indication of the following:
        a. Digital Speed Indicator: Revolutions per minute.
        b. Variable Frequency Drive Mode Indicator: Red; as required.
        c. Bypass Mode Indicator: Red; as required;
        d. Input Voltage
        e. Output Voltage
        f. Output Current
        g. Output Frequency
        h. Output Speed: 0-100%
        i. Drive Ready Indicator: White
        j. Run Indicator: Red.

k. Stop Indicator: Green.
l. Running Time Meter.
m. Enclosure Overtemperature.
n. Alarm Indicator: Amber.
o. Alarm Read-out: Display.

2. Each VFD shall provide the following automatic and manual controls:
   a. Hand-Off-Auto Selector Switch (as required).
   b. Start and Stop pushbuttons (as required).
   c. VFD - Bypass Selector Switch (as required).
   d. Local - Remote Speed Control Selector Switch (as required).
   e. Local Speed Potentiometer.
   f. Alarm Reset Pushbutton.
   g. 24 VDC coil pilot relay for remote run command.
   h. Alarm auxiliary contacts and other devices as indicated on the Drawings and specified.
   i. Provision for a run permissive from other equipment when the drive is in "Auto".
3. Each VFD shall provide "potential-free" output contacts for the following conditions:
   a. Drive running.
   b. Drive in "Auto" and all trip conditions cleared.

   Pilot devices shall be as specified in Section 16422, Electrical Controls and Relays.
4. Variable frequency drive system shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback or control and remote speed indication.
5. Variable frequency drive system shall accept a 4-20 mADC input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed, revolutions per minute, equal to or less than 0.1 percent of rated speed.
6. When operating in the automatic mode, the variable frequency drive system shall shut down during a power outage. Upon restoration of normal power and after an adjustable time delay (0-2 minutes; motor has coasted to zero speed and there is no backspin), the variable frequency drive system shall automatically restart and then ramp up to speed as required by the control system. The process operator shall not be required to reset the system manually after a shutdown caused by a power outage.
7. Variable frequency drive shall be furnished with a multiple attempt restart feature.
8. Furnish a door mounted selector switch or other pilot device for those variable frequency drives where an additional speed reference signal (e.g., from a remote potentiometer, an analog output from a setpoint (PID) controller, an analog output from a programmable logic controller, or similar analog signal) is to be supplied to the variable frequency drive in addition to the door mounted manual speed control.
9. Provide a NEMA rated (IEC or dual rated not acceptable) motor circuit protector and current-limiting fuses (as required) for each variable frequency drive. Provide each variable frequency drive with its respective drive controller and output contactors for each motor.

10. Include in each variable frequency drive system an automatic trip feature which will open the output contactor and remove the drive output from the motor and allow it to decelerate safely. This automatic system shall trip and indicate the fault only upon the following conditions:
    a. Output voltage unbalance (trip threshold field set).
    b. Open phase.
    c. Motor overload.
    d. Motor stator winding fault (phase-to-ground, phase-to-phase).
    e. Loss of input power to the variable frequency drive or unacceptable voltage variation.
    f. High variable frequency drive equipment temperature.
    g. Variable frequency drive system failure as determined by the manufacturer.
    h. Component failure.
    i. Overcurrent.
    j. Undercurrent.
11. Provide variable frequency drive system with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the drive controller as standard, this feature shall be capable of being disabled.
12. Variable frequency drive design shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure which in turn affects motor operation and generates an alarm contact output rated for 125 VDC suitable for interfacing with the control system.
    a. Diagnostics shall operate a visual alarm indicator that is visible on the variable frequency drive equipment cabinets without opening the cabinet doors.
    b. Diagnostics shall provide an easily readable output that will isolate a failure.
    c. Provide an event and diagnostic recorder to printout in narrative English of the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.
    d. Provide a normally open dry contact for each alarm function to enable remote indication. A communication port shall be provided for possible future link to the plant control system.

F. Enclosures
1. Unless otherwise specified or indicated on the Drawings, the variable frequency drive enclosures for the well sites shall be NEMA 4X SST and the variable frequency drive enclosures for the RO Plant shall be NEMA 12, force ventilated, dead-front, with front accessibility. Enclosures shall free-standing as indicated on the Drawings. Design enclosures for both bottom and top entry of cables. Design variable frequency drive system so that rear cabinet access is not required for operations, maintenance, and repair tasks. Other enclosure requirements are:
    a. Treat metal surfaces and structural parts by phosphatizing prior to painting.
    b. Apply a gun-metal gray undercoat to enclosures which is equal to zinc chromate.
    c. The doors shall have full length piano type hinges.
    d. Brace each door to prevent sag when fully open.

e. For the well site VFDs, provide an A/C unit as well as a cabinet heater.

The Contractor shall reference the Drawings for maximum dimensions of the VFDs.

2. Furnish each variable frequency drive system with the control switches, alarm lights and indicators as specified herein and as indicated on the Drawings. Furnish main circuit breakers with an external operating handle interlocked with the door so that the door cannot be opened unless the disconnect is in the OFF position. Power supply to the motor from both the variable frequency drive and the bypass starter shall be capable of being positively locked in the OFF position. The disconnect shall be interlocked so that equipment cannot be energized when the door is open.
3. Electrical bus, including ground bus, shall be tin-plated copper. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.
4. Equipment shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.

G. Harmonic Distortion Suppression
1. A comprehensive pre-equipment-selection harmonic study shall be prepared by the Contractor. The results of this pre-equipment selection study shall be submitted to the Engineer as part of the submittals specified herein. Should this study indicate the need for tuned filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment, these shall be supplied at no additional cost to the Owner. Indicate the location of the harmonic suppression equipment in the submittal data. Location is subject to acceptance by the Engineer.
2. The harmonic distortion values resulting from operation of all or any variable frequency drive-driven motor-load combinations operating at full load shall be as defined in IEEE Standard 519.
   a. Maximum allowable total harmonic voltage distortion (THD): 5 percent of the fundamental.
   b. Maximum allowable individual frequency harmonic voltage distortion: within the limits of IEEE standard 519.
   c. Maximum allowable total demand distortion (TDD): within the limits of IEEE Standard 519-1992, Table 10.3.
   d. Maximum allowable individual frequency harmonic demand distortion: within the limits of IEEE Standard 519-1992, Table 10.3.
   e. The harmonic distortion levels shall be specific to the "Point of Common Coupling" (PCC) as defined in IEEE Standard 519.
3. System single line diagrams and field access to the plant site will be provided to the Contractor for the purpose of providing this study. Contractor shall obtain from others other information that may be necessary to perform this study. Input data and other pertinent information used in harmonic study shall be coordinated by the Contractor with the following:
   a. Input data/information/results of the short circuit fault analysis specified herein.
   b. Electrical system configuration and electrical equipment shop drawing submittal data including, but not being limited to new non-linear loads, new linear loads, and new capacitors.

4. Preparation of this pre-equipment selection study does not relieve the requirement for the Contractor to perform and submit the results of a second, final comprehensive study prepared by a recognized independent authority acceptable to the Owner after equipment installation.
5. In addition, the Contractor shall field measure actual harmonic distortion and verify with tests performed by an independent authority acceptable to the Owner after satisfactory full-load operation.
6. As part of the specified harmonic studies and other work for this project, identify and correct resonance conditions in the electrical distribution system at no additional cost to the Owner. Shop drawings, data, location of the respective equipment and its connection to the electrical distribution system shall be acceptable to the Engineer.
7. The VFD's shall be provided with an input isolation transformer connected to an 18 pulse diode front-end.

H. Miscellaneous
1. Encapsulate critical components in ceramic or metal.
2. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100 percent redundant. A new and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be acceptable.
3. Circuit boards and electrical components shall meet the corrosion protection requirements specified in these Specifications. Varnished or epoxy encapsulated circuit boards and tropicalized contactors suitable for corrosive environments shall be furnished where the VFDs are not located in climate controlled areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.

B. Install enclosed controllers plumb. Provide supports in accordance with Section 16070.

C. Height: 5 ft. to operating handle unless otherwise indicated.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Provide engraved plastic nameplates under the provisions of Section 16075.

F. Install control wiring inside starter enclosures in a neat, workmanlike manner and run in PVC wiring duct where practical. Where not practical, wiring shall be supported and tied in position with nylon ties.

G. Identify wiring by a number code. Terminate wiring for external connection to a numbered terminal strip.

H. Label control components inside controller enclosures. Match information included in control wiring diagram.

I. Provide a copy of the control wiring diagram for each controller and place inside each starter enclosure.

3.02 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Division 1.

B. Inspect and test each enclosed controller to NEMA ICS 2.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16422

ELECTRIC CONTROLS AND RELAYS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pushbutton and selector switches.

B. Control stations.

C. Relays.

D. Time delay relays.

E. Control power transformers.

F. Control panels.

1.02 RELATED SECTIONS

A. Section 16137 – Cabinets and Enclosures.

1.03 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control Systems.

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

D. NEMA ST 1 - Standard for Specialty Transformers (Except General Purpose Type).

1.04 SUBMITTALS

A. Submit shop drawings under provisions of Division 1.
   1. Submit shop drawings to NEMA ICS 1 indicating control panel layouts, wiring connections and diagrams, dimensions, support points.
   2. Submit product data under provisions of Division 1.
   3. Submit product data for each component specified.

1.05 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 1.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation data under provisions of Division 1.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data under provisions of Division 1.

D. Include recommended preventive maintenance procedures and materials.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years experience.

PART 2 PRODUCTS

2.01 CONTROL COMPONENTS

A. Manufacturers
   1. Control components shall be manufactured by Eaton, The Square D Company, General Electric, Allen-Bradley, Siemens Energy and Automation, or Engineer approved equal.

B. Pilot Devices
   1. General
      a. All pilot devices shall be provided with a legend plate. Legend plates shall have a white background and black lettering and indicate the function of the respective pilot device. The text shown on the Drawings or indicated in the specifications shall be used as the basis for legend plate engraving (i.e. HAND-OFF-AUTO, RUN, EMERGENCY STOP, etc).
      b. All pilot devices shall be selected and properly installed to maintain the NEMA 250 rating of the enclosure in which they are installed. All pilot devices shall be UL 508 Listed.
      c. All pilot devices shall be 30.5mm in diameter, unless otherwise indicated. 22mm devices are not acceptable.
      d. Pilot devices for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.
      e. In Class 1 Division 2 hazardous locations, pilot devices shall be the hermetically-sealed type, constructed in accordance with ANSI/ISA 12.12.01.
   2. Pushbuttons
      a. Pushbuttons shall be non-illuminated, black in color, and have momentary style operation unless otherwise indicated on the Drawings.
      b. Pushbuttons shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each pushbutton. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.
      c. Pushbuttons shall be provided with a full guard around the perimeter of the button. Where a lockout style pushbutton is specified or indicated on the Drawings, provide a padlockable guard.
   3. Selector Switches
      a. Selector switches shall be non-illuminated, black in color, and have the number of maintained positions as indicated on the Drawings and as required. Handles shall be the extended type that provide a greater surface area for operation.
      b. Selector switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each selector switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.
      c. Where indicated in the Drawings or Specifications, provide spring return positions.

d. Selector switches shall be provided with an indexing component that fits into the keyed portion of the cutout for the device and prevents the switch from spinning when operated.

4. Indicating Lights
   a. Indicating lights shall LED type, with the proper voltage rating to suit the application, and push-to-test feature.
   b. Indicating light lens colors shall be as required in equipment specifications and/or as indicated on the Drawings. If lens colors are not indicated, the following colors shall be used:
      1) Red - "Run", "On", "Open"
      2) Green - "Off", "Closed"
      3) Amber - "Alarm", "Fail"
      4) White - "Control Power On"
5. Emergency Stop and Tagline Switches
   a. Emergency stop switches shall be non-illuminated, red in color, with a minimum 35mm diameter mushroom head. Once activated, switch shall maintain its position and require a manual pull to release/reset.
   b. Tagline switches shall have a plunger that activates upon tension from the associated safety cable. Once activated, switch shall maintain its position and require a manual release/reset.
   c. Emergency stop and tagline switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

C. Relays and Timers
1. General
   a. Relays and timers shall be furnished with an integral pilot light for positive indication of coil energization.
   b. Relays and timers shall have tubular pin style terminals with matching 11-pin DIN rail mount socket. Spade or blade style terminals are not acceptable.
   c. Relays and timers for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.
2. Control and Pilot Relays
   a. Miniature or "ice-cube" type relays are not acceptable.
   b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
   c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have 3-pole, double-throw (3PDT) contact arrangement.
3. Time Delay Relays
   a. Timers delay relays shall utilize electronic timing technology. Mechanical timing devices are not acceptable.
   b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
   c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have double-pole double-throw (DPDT) contact arrangement.

d. Time delay ranges shall be as indicated on the Drawings and/or as required to suit the application. Timing range shall be adjustable from the front of the relay. On delay and off delay timer configurations shall be provided as indicated on the Drawings and/or as required to suit the application.

4. Elapsed Time Meters
   a. Elapsed time meters shall be non-resettable type with no less than a 4 digit display. Coil voltage shall be as required to suit the application and/or as indicated on the Drawings.

D. Control Terminal Blocks
   1. Control terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or subpanel. Terminals shall be tubular screw type with pressure plate that will accommodate wire size range of #22 - #8 AWG.
   2. Control terminal blocks shall be single tier with a minimum rating of 600 volts and 20A. Separate terminal strips shall be provided for each type of control used (i.e. 120VAC vs. 24VDC). Quantity of terminals shall be provided as required to suit the application. In addition, there shall be a sufficient quantity of terminals for the termination of all spare conductors.
   3. Terminals shall be marked with a permanent, continuous marking strip, with each terminal numbered. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

2.02 LOCAL CONTROL STATIONS

A. Local control stations shall be furnished and installed complete with pushbuttons, selector switches, indicating lights, and other devices as indicated on the Drawings.

B. Specific devices installed in local control stations shall be provided in accordance with the requirements specified elsewhere in this Section.

C. In non-hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.
   1. Indoor Wet Process Area – NEMA 4X, Type 304 Stainless Steel
   2. Indoor Dry Process Area – NEMA 12, Painted Steel
   3. Indoor Dry Non-process Area – NEMA 1, Painted Steel
   4. Indoor Chemical Storage/Transfer Area – NEMA 4X, Type 304 Stainless Steel
   5. All Outdoor Areas – NEMA 4X, Type 304 Stainless Steel

D. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs. Conduit hubs shall be external to the enclosure.

E. Local control stations for use in non-hazardous locations shall be UL-508 Listed. Local control stations for use in Class 1 Division 1 and Class 2 Divisions 1/2 hazardous locations shall be UL-1203 Listed. Local control stations for use in Class

1 Division 2 hazardous locations shall be in accordance with ANSI/ISA 12.12.01-2013.

F. Provide a nameplate on each local control station in accordance with Section 16075, Electrical Identification. The name and/or number of the equipment associated with each control station shall be engraved on the nameplate, followed by the words "LOCAL CONTROL STATION".

PART 3 EXECUTION

3.01 INSTALLATION

A. Install devices and equipment in accordance with manufacturer's instructions.

B. Make electrical wiring interconnections as shown on Drawings.

C. Local control stations shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

D. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices.

E. Pilot devices shall be properly bonded to the equipment enclosure door where they are installed. If proper bonding cannot be achieved through the locknuts that affix the device in place, a green colored bonding screw shall be provided on the pilot device. The bonding screw shall be bonded to the equipment enclosure through the use of an insulated green bonding conductor.

F. Local control station covers shall be bonded to the local control station enclosure through the use of an insulated green bonding conductor.

G. Wiring to devices at each local control station shall be provided with enough slack to permit the local control station cover to be removed and pulled at least 6 inches away from the enclosure.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16440

DISTRIBUTION SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Switchboards.

B. Automatic Transfer Switch.

C. Switchboard accessories.

1.02 RELATED SECTIONS

A. Section 03100 - Cast-in-Place Concrete: Concrete for supporting foundations and pads.

B. Section 16060 - Grounding and Bonding.

C. Section 16210 - Utility Service Entrance.

D. Section 16230 - Engine Generator System: Testing requirements

1.03 REFERENCES

A. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments.

B. ANSI C57.13 - Requirements for Instrument Transformers.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches.

E. NEMA PB 2 - Dead Front Distribution Switchboards.

F. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

G. NEMA 260 - Safety Labels for pad mounted Switchgear and Transformers Sited in Public Areas.

H. NFPA 70 - National Electrical Code.

I. NFPA 110 - Emergency and Standby Power Systems

J. NEMA ICS 1 - General Standards for Industrial Control and Systems.

K. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

L. NEMA ICS10 – Electromechanical AC Transfer Switch Equipment.

M. UL 508 – Standard for Industrial Control Equipment.

N. UL 1008 – Standard for Automatic Transfer Switches for Use in Emergency Standby Systems.

1.04 SUBMITTALS FOR REVIEW

A. Submittals: Provide in accordance with Division 1.

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter

shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Complete single line diagram for each switchboard line-up. The drawing shall indicate devices comprising the switchboard assembly including, but not limited to, circuit breakers, control power and instrument transformers, meters, relays, and control devices. Clearly indicate electrical ratings of all devices.
3. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
4. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.
5. Report on Performance Testing of Ground Fault Protection System: Provide written report as required by NFPA 70, 230-95(c) to authority having jurisdiction and to engineer.

1.05 SUBMITTALS FOR INFORMATION

A. Submittals: Provide in accordance with Division 1.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

C. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions when engine generator is running.

D. Maintenance Data: Include routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.06 SUBMITTALS FOR CLOSEOUT

A. Submittals for project closeout: Submit in accordance with Division 1.

B. Record actual locations of switchboard in project record documents.

C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL or other North Carolina Recognized Third Party Testing Agency.

C. Transfer switch shall be UL 1008 listed as a complete package with timers, relays, and accessories and approved for use on 'Emergency Systems'.

D. Transfer switch shall be capable of switching all classes of load and shall be rated for continuous duty when installed in a non-ventilated enclosure in accordance with UL 508.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

1.09 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated.

1.10 WARRANTY

A. Provide three-year warranty from the date of Substantial Completion. Warranty shall cover the cost of parts, labor, and travel for repairs at the site.

1.11 SHORT CIRCUIT AND PROTECTIVE COORDINATION STUDY

A. Provide a short circuit and protective coordination study. Study shall cover the main switchboard main and feeder circuit breakers only. Provide information to the Organization performing the study including conductor sizes and lengths, conduit types, utility information, and generator information. Study shall assume an infinite bus on the primary of the utility transformer, and the resulting short circuit current shall be calculated and compared to the interrupting ratings of the main and feeder breakers. The protective coordination study shall determine the settings for the main and feeder breakers which result in the best possible coordination between these breakers. Provide study report which includes an identification of any inadequately rated devices and a tabulation of the recommended settings for the main and feeder breakers. Set the main and feeder breakers in accordance with the study recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that the switchboard be produced by a single manufacturer who shall be responsible for matching all components and providing equipment which functions together as a system.

C. The equipment shall be Pow-R-Line C as manufactured by Eaton, Spectra Series as manufactured by the General Electric Company, Square D Company equivalent, or Siemens Energy & Automation, Inc. equivalent.

D. The manufacturer of the automatic transfer switch shall verify that the switches are listed by Underwriters Laboratories, Inc., standard UL-1008, with 3-cycle withstand and close-in values as indicated on the Drawings or specified herein.

E. The automatic transfer switches shall be draw-out power circuit breaker design, Type ATC (Closed Transition) Magnum as manufactured by Eaton, Siemens Energy and Automation Inc. equivalent, General Electric equivalent, or equal.

2.02 CIRCUIT BREAKER SWITCHBOARD

A. General

1. Furnish and install dead front type, completely metal enclosed, self supporting electrical equipment including main circuit breaker(s) and molded case branch circuit breaker assemblies of the number, rating and type noted on the Drawings. The equipment shall meet Underwriters' Laboratories requirements and shall be a furnished with a U.L. service entrance label where indicated on the Drawings.
2. The main breaker section and distribution section shall be NEMA Type 1 industrial use enclosures. The main circuit breaker section shall be totally accessible from the front and the sides. The distribution switchboard shall be totally accessible from the front and the sides. The framework shall be of U.L. gauge steel. Ventilation shall be provided as required.
3. All wire troughs shall have hinged doors.
4. The equipment assemblies shall be suitable for operation at the available fault current, 65 kA (minimum). The equipment assemblies shall be labeled to indicate the maximum available fault current rating, taking into account the structure, bussing, main circuit breaker and switchboard branch circuit devices. The short circuit current rating shall not be less than that specified herein or indicated on the Drawings. The distribution switchboard branch circuit devices short circuit current rating shall be fully rated.
5. All bus shall be silver-plated copper. The bussing shall be of sufficient cross sectional area to meet U.L. standard 891 for temperature rise. The fully rated main bus shall have a maximum ampacity as indicated on the Drawings and extend the full length of the equipment. The main bus shall be 100 percent rated. The ground bus shall be sized per U.L. standard 891, installed in the entire length of the equipment assemblies. The distribution switchboard bus shall be rated as required by the rating of the mounted branch devices, including spares or spaces. Full height vertical bus shall be provided to accommodate future circuit breakers. Less than full height vertical bus which will only accommodate the circuit breakers included for this project is unacceptable.
6. Provide engraved plastic nameplates to identify the main circuit breaker and each branch circuit breaker. The circuit number and circuit name shall appear on the nameplate in accordance with the single line diagram(s) indicated on the Drawings. Nameplates shall be as specified in Section 16195, Electrical - Identification.

B. Utility Pull and Metering Section
   1. The Contractor shall furnish and install a pull and metering section, as required, in accordance with all applicable utility requirements. This section shall be suitable for outdoor use if so directed by the utility.
   2. During the design period, some information was gained from the utility regarding service requirements and is specified herein or shown on the Drawings.
   3. The Contractor shall be responsible for all final coordination with the electric utility to furnish and install the necessary equipment to meet the latest utility requirements. This includes pull and metering section dimensions, materials of construction, location, bus/cable restrictions, and requirements for concrete pad, utility vault, bumper posts, and similar equipment.

C. Main Circuit Breaker Section
   1. The main circuit breaker section shall be furnished and installed for front and side accessibility and manufactured to accept a bus duct connection.
   2. The main circuit breaker shall be a fixed type, insulated case, manually operated, on-off breaker, 80 percent rated with full-function trip system, sensors, and rating plug.
   3. The main circuit breaker shall be Square-D Company SED type, Cutler Hammer/Westinghouse SPB type, General Electric Power Break 2, or equal. The breaker shall be rated for 65,000 A RMS symmetrical at 480V. The full function trip system shall be MICROLOGIC by Square D Company, Cutler Hammer/Westinghouse Digitrip RMS 810, or General Electric Company equivalent with adjustable instantaneous, long-time pick-up and delay, short-time pick-up and delay, ground fault pick-up and delay, and trip indicator, minimum. The main breaker shall be capable of being tripped from a remote control circuit (e.g. command from computer control system or hard-wired trip circuit).
   4. Provide control power and current transformers as required. Provide a minimum of two (2) auxiliary contacts for remote indication of breaker position. Provide other accessories as specified herein or indicated on the Drawings.

D. Distribution Switchboard
   1. The distribution switchboard shall be furnished complete with auxiliary section to accept an incoming bus duct connection. This auxiliary section shall be completely front accessible.
   2. The auxiliary section shall also contain a CM-2150 Circuit Monitor as manufactured by Square D Company, an IQ Data Plus-4000 as manufactured by Cutler-Hammer/Westinghouse, or equal. All voltage and current transformers, fuses, wiring, and other devices shall be furnished and installed to produce a complete monitoring system.
   3. The distribution switchboard shall include individually mounted branch circuit breakers which are to be totally front accessible and front connectable. The circuit breaker connections to the distribution panel bussing shall be of bolt-on design such that the connections grip the bus bars firmly under high-fault conditions.
   4. The switchboard manufacturer shall provide all the proper lugs for all cable connections as required to avoid field modifications.
   5. Branch circuit breakers shall be molded case type with ratings as indicated on the Drawings. Branch circuit breakers shall be rated for 65,000 A RMS symmetrical at 480V.

2.03 AUTOMATIC TRANSFER SWITCH

A. General

1. Switches shall have ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation.
2. For three phase, four-wire systems where a neutral is required, a true four-pole switch shall be supplied with all four electrically and mechanically identical poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.
3. The switch shall be capable of switching all classes of load and rated for continuous duty when installed in a non ventilated enclosure.
4. The three-cycle closing and withstand current rating of the switch shall be 65,000 amperes RMS (minimum). This rating shall not be restricted by the use of a specific manufacturer's circuit breaker.
5. This switch shall be complete with all accessories and listed by UL under Standard UL-1008 for use on emergency systems.
6. All bolted bus connections shall have Belleville compression type washers. Switches for four-wire systems shall be furnished with a fully rated solid neutral bus.
7. The switch shall be equipped with 90□C rated copper/aluminum solderless mechanical type lugs of the proper quantity and size to accommodate the termination of field wiring.

B. Design Requirements

1. Switches shall contain two drawout, mechanically interlocked, power circuit breakers with ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation. The switch shall be service entrance rated and shall bear the service entrance label as indicated on the Drawings.
2. Switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
3. Normal and standby contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts to be of silver-tungsten alloy, mechanically locked in position in both the normal and standby positions without the use of hooks, latches, or magnets. Provide separate arcing contacts, with magnetic blowouts on each pole. Interlocked molded case circuit breakers switches or contactors are not acceptable.
4. Equip the transfer switch with a permanently attached, safe, manual operator designed to prevent injury to personnel in the event the electrical operator should become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from slowly switching the main contacts.

C. Sequence of Operation

1. Should the voltage on any phase of the normal source drop below 80 percent or increase to 120 percent, or frequency drops below 90 percent, or increase to 110 percent, or 20 percent voltage differential between phases occur, after a programmable time delay period of 0-9999 seconds factory set at three (3) seconds to allow for momentary dips, the engine starting contact(s) shall close to start the standby plant.

2. Transfer to the standby power source shall occur when 90 percent of rated voltage and frequency has been reached by the standby power source.
3. After restoration of normal power on all phases to a preset value of 90 percent to 110 percent of rated voltage, at least 95 percent to 105 percent of rated frequency, and voltage differential is below 20 percent between phases, an adjustable time delay period of 0-9999 seconds factory set at 300 seconds shall delay the transfer to allow stabilization of the normal source. Should the standby source fail during this time delay period, the switch shall automatically retransfer to the normal source.
4. After retransfer to the normal power source, the standby plant shall operate at no load for a programmable period of 0-9999 seconds factory set at 300 seconds. Should the normal power source fail during this time delay period, the transfer switch shall automatically return to the standby source.

D. Controls

1. The transfer switch shall be equipped with a microprocessor-based control system to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with Nicad battery back-up.
2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory, I/O, and communication circuits with a watchdog power fail circuit.
3. The controller shall use industry standard open architecture communication protocol for high speed serial communications via multidrop connection to other controllers and to a master terminal with up to 4000 ft of cable, or further with the addition of a communication repeater. The serial communication port shall be RS422/485 compatible.
4. The serial communication port shall allow interface to either the manufacturer's or the Owner's furnished remote supervisory control system.
5. The controller shall have password protection to limit access to authorized personnel.
6. The controller shall include a 20 character LCD display with a keypad, which allows access to the system.
7. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection, and phase differential monitoring on both normal and standby sources.
8. The controller shall be capable of storing the following records in memory for access either locally or remotely:
    a. Number of hours the transfer switch is in the standby position (total since record reset).
    b. Number of hours standby power source is available (total since record reset).
    c. Total transfer in either direction (total since record reset).
    d. Date, time, and description of the last four source failures.
    e. Date of the last exercise period.
    f. Date of record reset.
9. Light emitting diodes shall be mounted on the controller to indicate:
    a. Switch is in normal position
    b. Switch is in standby position.
    c. Controller is running.

10. A three-phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase-to-phase voltages simultaneously for both the normal and standby source.
11. A digital LCD frequency readout with 1% accuracy shall display frequency for both the normal and standby source.
12. An LCD readout shall display both normal source and standby source availability.
13. The microprocessor controller shall meet the following requirements:
    a. Storage conditions - 25□C to 85□C
    b. Operation conditions - 20□C to 70□C ambient
    c. Humidity 0 to 99% relative humidity, non-condensing
    d. Capable of withstanding infinite power interruptions
    e. Surge withstand per ANSI/IEEE C-37.90A-1978
14. All control wiring shall be 18 gauge (minimum), 600 VAC, SIS switchboard type. All control wiring shall be identified at each termination (both ends) using tubular, sleeve-type wire markers.

E. Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.
2. Programmable three phase sensing of the standby source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.
3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds.
4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds, with overrun to provide programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.
5. Time delay on transfer to standby, programmable 0-9999 seconds, factory set at 3 seconds.
6. A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.
7. A time delay bypass on retransfer to normal shall be included. Keypad initiated.
8. Contact, rated 10 A at 30VDC, to close on failure of normal source to initiate engine starting.
9. A plant exerciser shall be provided with (10) 7 day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise the standby plant programmable in one minute increments. Also include a control switch for selection of either "no load" (switch will not transfer) or "load" (switch will transfer) during the exercise period. Keypad initiated.
10. Relay contacts which close when normal source fails wired to a terminal strip.
11. Relay contacts which open when normal source fails wired to a terminal strip.

12. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on normal and wired to a terminal strip.
13. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on standby and wired to a terminal strip.

2.04 SURGE PROTECTIVE DEVICES

A. Surge protection devices shall be provided in a separate enclosure external to the switchboard enclosure. See Section 16280 – Surge Protective Devices for switchboard SPD requirements.

PART 3 EXECUTION

3.01 PREPARATION

A. Provide concrete pad under the provisions of Section 03100. Pad shall be sized to extend a minimum of 12 inches beyond equipment on all sides. Pad depth shall be 4 inches. Exposed corner shall be provided with a 1/2-inch chamfer.

3.02 INSTALLATION

A. Install switchboard in locations shown on Drawings, according to NEMA PB 2.1.

B. Install transfer switch in accordance with manufacturer's instructions.

C. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

D. Anchor to pad as recommended by manufacturer.

E. Provide four (4) 3-inch conduits stubbed from below distribution section to 5 feet beyond pad for future use. Cap ends and marks locations.

3.03 ADJUSTING

A. Adjust operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

3.04 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Division 1.

3.05 DEMONSTRATION

A. Demonstrate operation of transfer switch in normal and emergency modes.

3.06 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16441

PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Lighting panelboards

B. Power distribution panelboards

C. Combination power units

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 16060 Grounding and Bonding
   2. Section 16070 Supporting Devices
   3. Section 16075 Electrical Identification

1.03 REFERENCES

A. NECA (National Electrical Contractors Association) - Standard of Installation.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

D. NEMA PB 1 - Panelboards.

E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

F. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

A. Submit under provisions of Division 1.
   1. Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
   2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Record actual locations of Products; indicate actual branch circuit arrangement.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

B. Maintain one copy of each document on site.

1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL or other North Carolina Recognized Third Party Testing Agency.

1.09 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated.

1.10 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Division 1.

B. Provide two of each panelboard key.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 CONDUCTORS (MAIN BUS AND BRANCH CONNECTORS)

A. All main bus shall be copper sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above a maximum ambient temperature of 40 degrees C.

2.03 LIGHTING PANELBOARDS

A. General

1. Lighting panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal-overload, branch circuit breakers. Panelboards shall be of the configuration and rating as specified herein and indicated on the Drawings. Panelboards shall be service entrance rated where indicated on the Drawings.
2. Lighting panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers, as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting.
3. Lighting panelboards shall be fully rated and shall have a minimum short circuit rating of 22,000 amperes symmetrical, unless otherwise indicated on the Drawings.
4. Lighting panelboards shall be Eaton Pow-R-Line Series, the Square D Company equivalent, the General Electric Company equivalent, or Siemens Energy and Automation, Inc. equivalent.

B. Enclosures

1. Enclosures shall have a NEMA rating as indicated on the Drawings, and be constructed of No. 12 U.S.S. code gauge galvanized steel. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. The Contractor shall equip cabinet doors exceeding 40 inches in height with vertical bolt three point locking mechanism. All locks shall be keyed alike. The panelboard trim shall have a removable hinge assembly, in addition to the door hinge, that allows work inside the enclosure without the need to remove the trim. The enclosure shall have wiring

gutters on sides and shall be at least 5-3/4 inches deep. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

2. All metal surfaces of the panelboard enclosures shall be thoroughly cleaned and given one prime of zinc chromate primer. All interior surfaces shall then be given one shop finishing coat of a lacquer of the nitro cellulose enamel variety. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be light gray ANSI #61.
3. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet.

C. Bus Work
1. Main bus bars shall be of ample size so that a current density of not more than 1000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.
2. Solid neutral bus bars are required and neutral bus ampacity shall be the same as the main bus bars unless otherwise noted. Ratings shall be in accordance with applicable standards.
3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.
4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
5. All bus shall be silver plated copper and shall extend the entire useable length of the panelboard, including spaces.

D. Circuit Breakers
1. Circuit breakers shall be bolt-on, molded-case type conforming to NEMA Standard AB 1. All circuit breakers shall have quick-make, quick-break, toggle mechanism for manual as well as automatic operation. Tandem or half-size circuit breakers are not acceptable
2. Where indicated on the Drawings, or where required by Code, circuit breakers shall be equipped with integrally mounted ground fault interrupters complete with "TEST" push button and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.
3. Circuit breaker voltage ratings shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 240 VAC that matches the panelboard short circuit rating.
4. Where indicated on the Drawings, branch circuit breakers shall be provided with a padlockable hasp or handle padlock attachment for padlocking in the off position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the packlock is removed. Branch circuit breakers used for control, instrumentation, telephone, fire alarm, or auxiliary equipment circuits requiring continuous operation shall be provided with a similar lock on device where indicated on the Drawings.

E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

2.04 POWER DISTRIBUTION PANELBOARDS

A. General

1. Power distribution panelboards shall be of the configuration and rating as specified herein and as indicated on the Drawings. The panelboards shall be dead front type with automatic trip-free, non adjustable, thermal overload branch circuit breakers. Panelboards shall be service entrance rated where indicated on the Drawings.
2. Power panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting.
3. Power distribution panelboards shall be fully rated and shall have a minimum short circuit rating of 65,000 amperes symmetrical unless otherwise indicated on the Drawings.
4. Power distribution panelboards shall be Eaton Pow-R-Line Series, the Square D Company equivalent, the General Electric Company equivalent, or Siemens Energy and Automation, Inc. equivalent.

B. Enclosures

1. Enclosures shall have a NEMA rating as indicated on the Drawings, and be constructed of No. 12 U.S.S. code gauge galvanized steel. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush type catches and locks. The Contractor shall equip cabinet doors exceeding 40 inches in height with vertical bolt three point locking mechanism. All locks shall be keyed alike. The panelboard trim shall have a removable hinge assembly, in addition to the door hinge, that allows work inside the enclosure without the need to remove the trim. The enclosure shall have wiring gutters on sides and shall be at least 5 3/4 inches deep. The panel shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.
2. All metal surfaces of the panelboard enclosures shall be thoroughly cleaned and given one prime of zinc chromate primer. All interior surfaces shall then be given one shop finishing coat of a lacquer of the nitro cellulose enamel variety. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be light gray ANSI #61.
3. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet.

C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1,000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall

be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.

2. Solid neutral bus bars, where required, shall be provided. Neutral bus shall have the same ampacity as the main bus, unless otherwise indicated. Ratings shall be in accordance with applicable standards.
3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.
4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
5. All bus shall be tin plated copper and shall extend the entire useable length of the panelboard, including spaces. Panelboards Listed and Labeled as a four-wire panel shall not be used in place of a three-wire panel where a neutral conductor does not exist in the supply conductors to that panel.

D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type conforming to NEMA Standard AB 1. All circuit breakers shall have quick-make, quick-break, toggle mechanism for manual as well as automatic operation.
2. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD" where required by Article 440 by the NEC. Circuit breakers installed for air conditioning units shall be HACR type.
3. Circuit breaker voltage rating shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A, unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 480 VAC that matches the panelboard short circuit rating.
4. Where indicated on the Drawings, branch circuit breakers shall be provided with a padlockable hasp or handle padlock attachment for padlocking in the off position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the packlock is removed. Branch circuit breakers used for control, instrumentation, telephone, fire alarm, or auxiliary equipment circuits requiring continuous operation shall be provided with a similar lock on device where indicated on the Drawings.

E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be provided in each panel. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

2.05 COMBINATION POWER UNITS

A. Combination power units shall be installed as specified herein and indicated on the Drawings. The unit shall be a combination of a dry type transformer and a lighting panelboard. Transformer rating and panelboard bus rating shall be as indicated on the Drawings. The transformer and panelboard shall meet the requirements for these products as specified herein and elsewhere in these Specifications. Combination power units located outdoors shall be suitable for outdoor use and be provided in a NEMA 3R enclosure unless otherwise indicated.

B. Combination power units shall have all copper windings and terminations, and an 80°C temperature rise.

C. The combination power unit shall be a Mini-Power Zone as manufactured by the Square D Company, a Mini-Power Center as manufactured by Eaton, Servicecenter as manufactured by General Electric Company, or Siemens Energy and Automation, Inc. equivalent.

2.06 SURGE PROTECTIVE DEVICES

A. Surge protective devices shall be provided in a separate enclosure external to the panelboard enclosure. See Section 16280 – Surge Protective Devices for panelboard SPD requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1.

B. Install panelboards plumb. Provide supports in accordance with Section 16070.

C. Height: 6 ft to top of panelboard unless conditions dictate otherwise.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. In continuously wet locations, space panelboards 1-inch off mounting surface.

G. Provide engraved plastic nameplates under the provisions of Section 16075.

3.02 FIELD QUALITY CONTROL

A. Field-testing will be performed under provisions of Division 1.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

C. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

END OF SECTION

SECTION 16442

MOTOR CONTROL CENTER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Motor control centers.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 03100 Cast-in-place Concrete: Housekeeping pads.
   2. Section 16075 Electrical Identification: Engraved nameplates.

1.03 REFERENCES

A. NFPA 70 - National Electrical Code.

B. UL 198E - Class R Fuses.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

E. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.

1.04 SUBMITTALS

A. Submit under provisions of Division 1.
   1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
   2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of individual motor controller. For RVSS starters, in free-standing enclosures, show conduit stub-up area locations on the Drawings.
   3. Internal schematic and point-to-point wiring diagrams of each motor control unit including variable frequency drives integrated into the motor control center. Standard wiring diagrams that are not custom created by the manufacturer for the motor control centers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. flush pump) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

4. Complete single-line diagrams for each motor control center showing circuit breakers, motor circuit protectors, motor controllers, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete assembly. Indicate electrical ratings of equipment and devices on these single-line diagrams. Ratings include starter size and type, motor circuit protector continuous current rating, circuit breaker frame size and trip rating, motor horsepower and full load current, and similar information.
5. Shop Drawings: Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time/current curves of all equipment and components.
6. Test Reports: Indicate field test and inspection procedures and test results.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NEMA ICS 2.3.

B. Maintain one copy of each document on site.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina Recognized Third Party Testing Agency.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with NEMA ICS 2.3. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Division 1.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Square D Co.

B. Siemens Energy & Automation Corp.

C. Cutler Hammer

D. General Electric Co.

2.02 MOTOR CONTROL CENTER

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that all components of the motor control center be provided by one manufacturer who shall have the sole responsibility of matching all components and providing equipment which functions together as a system. The manufacturer of the motor control center shall also be the manufacturer of the motor controllers. The use of third-party supply and assembly of these components is not acceptable.

C. Motor control centers shall be Freedom 2100 as manufactured by Eaton using NEMA rated Freedom Series contactors and starters, Model 6 as manufactured by the Square D Company, Centerline 2100 as manufactured by Allen-Bradley, Tiastar as manufactured by Siemens Energy and Automation Inc., or the General Electric Company Evolution Series E9000, or approved equal.

2.03 MOTOR CONTROL CENTER

A. General

1. The motor control centers shall be 600 VAC class suitable for operation on a three-phase, 60 Hz system. The motor control centers and their components shall conform to the requirements of applicable standards of NEMA Part ICS 2-322 and Underwriters' Laboratories, Inc. UL-845. Wiring shall be NEMA Class II, Type B. Each vertical section shall be a NEMA 1A (gasketed) industrial use enclosure unless otherwise specified or indicated on the Drawings.
2. The enclosures shall be cleaned, primed, and finish coated in accordance with the manufacturer's standard process. The pre-treatment process shall be a zinc chromate primer followed by a "One Coat" paint process that is monitored to meet the manufacturer's specifications for paint color, texture, thickness, and durability. Enclosure interior and exterior finish color shall be ANSI 49 (medium light gray). The color of the back panel/bucket located within the MCC enclosure shall be white.
3. The motor control centers shall be capable of withstanding the fault current available at its line terminals. Minimum bus bracing, withstand, and interrupting ratings are specified herein.
4. Unless otherwise specified or indicated on the Drawings, each vertical section shall be approximately 20 inches wide, and 90 inches high, 20 inches deep, and shall not contain more than six NEMA Size 1 starters. Motor control centers shown "back-to-back" on the Contract Drawings shall be complete motor control assemblies placed back-to-back in the location shown. Motor

control center sections with common horizontal and/or vertical bus systems are unacceptable.

5. Continuous horizontal wiring troughs shall be provided at both the top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the motor control center. Each section shall be provided with a large, continuous, full height vertical wiring trough in the right side of each section. Each vertical wiring trough shall be furnished complete with tie bars for conductor support.
6. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105□C. Wire color coding shall be red for control and black for power. Wire numbers shall not be repeated in a motor control center.
7. Starter units shall contain the number of auxiliary contacts, unit-mounted pilot devices and indicating lights, control relays, elapsed time meters, and other devices as shown on the Drawings and required for the applications. A minimum of two (2) normally open (NO) and two (2) normally closed (NC) spare contacts shall be provided for each magnetic starter. These spare contacts shall be shown on the submittal wiring diagrams.
8. The motor control centers shall be furnished with warning signs to notify maintenance personnel of multiple sources of power within the motor control units.

B. Power
   1. The motor control centers shall be supplied from a 480V, 3-phase, 3 or 4 wire as indicated on the Drawings, 60 Hz power source. The incoming power feeders shall be sized as shown on the Drawings. All terminals for incoming and outgoing power cables shall be provided with compression lugs.

C. Bus
   1. Power shall be distributed by means of a continuous, tin plated copper horizontal bus, rated as shown on the Drawings. The bus shall be braced for 65,000A rms symmetrical at 480V unless otherwise indicated on the Drawings. The horizontal bus shall be effectively isolated from all wiring troughs and other working areas. Vertical bus extensions shall be tin plated copper, isolated by rigid, glass-polyester moldings so as to be a separate self-supported assembly. Silver plated vertical bus may be provided if specifically accepted by the Engineer. Full height vertical bus shall be installed in all sections including those containing spare units and "prepared" spaces. No extra safety jacks or similar devices shall be required to obtain an essentially dead-front condition. Access shall be provided for inspection and maintenance from the front. Minimum horizontal bus rating shall be 600A. Minimum vertical bus rating shall be 300A.

D. Incoming Line Units
   1. Each incoming line unit shall contain buswork and fittings as required with cable lugs for cables of sizes and quantities shown on the Drawings. Cable lugs shall be suitable for their respective conductors.
   2. A neutral landing pad shall be furnished in the incoming line section. A neutral landing pad is required to terminate the grounded conductor from the utility transformer in accordance with the NEC.

E. The Unit Compartments

1. Each unit compartment shall be provided with an individual front door hinged to the vertical structure. Each plug-in unit shall be supported and guided by a removable unit support pan, so that the unit rearrangement is easily accomplished. The rearrangement of the unit support pan from one location to the other shall be accomplished without use of tools. After insertion, each plug-in unit shall be held in place by at least one multi-turn latch, located at the front of the unit. The latch shall be located for front accessibility and installation convenience. An additional mechanical interlock shall be provided to prevent withdrawal of the unit from the stationary structure with the operating mechanism in the ON position.
2. The unit plug in power stabs shall be electromagnetically tin plated copper to yield a low resistance connection and designed to tighten during heavy current surges and short circuits. The stab shall be backed by spring steel clips to provide and maintain a high pressure, two point connection to the vertical bus. They shall be free floating and self loading plug-in. Wiring from the unit disconnecting means to the plug-in stab shall be exposed at the rear of the unit. The power cable terminations at the plug-in stab shall be mounted in a two-piece, glass polyester support assembly. This support assembly shall provide a separate isolated pathway for each phase, minimizing the probability of a unit fault condition reaching the power bus system.
3. NEMA Size 1 through Size 5 non-reversing starters shall be plug-in units. Size 1, 2, and 3 shall utilize stab assembly rated 100A. Stab assemblies for Size 4 and Size 5 starters shall be rated for the starters maximum output current rating.
4. An industrial, heavy-duty flange handle mechanism shall be supplied for the control of each disconnecting means. This mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position. The operator handles shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8 inch diameter shackle padlocks and in the "ON" position with one (1) 3/8 inch diameter shackle padlock.
5. The operator handle of all units shall be interlocked with the door units so that the disconnect means cannot be switched unless the door unit is closed. A means shall be provided for purposely defeating the interlock during maintenance or testing. This interlock shall also prevent opening the unit door unless the disconnecting means is in the off position. An externally operated defeater requiring the use of a screwdriver shall provide access to the unit without interrupting service.
6. The overload relays shall be resettable from the outside of the enclosure by means of an insulated bar or button.

F. Ground Bus
1. The horizontal ground bus shall be tin plated copper and located in the bottom horizontal wireway. The minimum size of the horizontal ground bus shall be 1/4 inch x 1 inch (6.35mm x 25.4mm) or 33% of the phase bus ampacity, whichever is greater.
2. Compression lugs shall be mounted on the ground bus in each section, in the size and quantity as required for the termination of system and equipment grounding conductors.

3. The vertical ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. This ground bus, in combination with the unit ground bus stab, establishes unit grounding before the plug-in power stabs engage the power bus, and conversely, as the unit is withdrawn, grounding is maintained until after the plug-in power stabs are disengaged.
4. The vertical load ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. The vertical load ground bus assembly, comprised of the vertical load ground bus and the unit load ground bus connector, shall provide a termination point for the load equipment grounding conductor at the unit. This fixed connection shall not have to be removed when the unit is withdrawn from the motor control center.

G. Isolation and Insulation
1. Horizontal bus access covers and vertical bus covers shall isolate the energized buses to guard against the hazard of accidental contact. These covers shall be molded of a glass polyester material.
2. The horizontal bus shall be isolated from the top horizontal wireway by a grounded steel barrier. This barrier shall be removable to allow access to the bus and connections for maintenance.
3. The vertical bus cover shall provide unit plug-in openings which shall permit unit plug-in stab assemblies to pass through and engage the vertical bus. The unit plug-in openings shall be sized to minimize the probability of inadvertent contact with the vertical bus.
4. Isolation of unused stab openings shall be accomplished by use of a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the motor control center.
5. All units shall be isolated from one another, above and below, by unit support pans or steel barriers, which can remain in place when the units are withdrawn.
6. Incoming line compartments shall be isolated from horizontal and vertical wireways by steel barriers.
7. A molded unit isolating barrier shall be provided to isolate the unit from the vertical wireway.

H. Combination Motor Control Units
1. Motor branch circuits shall be protected by a motor circuit protector (MCP).
2. The motor circuit protector shall be operated by a toggle type handle and shall have a quick make, quick break overcenter switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.
3. Each pole of these motor circuit protectors shall provide instantaneous short circuit protection by means of an adjustable magnetic only element.
4. The motor circuit protectors in combination with a contactor and overload relay shall have an interrupting rating that matches the motor control center short circuit rating at 480V.
5. Motor circuit protector's ratings, modifications, etc., shall be as specified herein and as indicated on the Drawings.
6. Motor circuit protectors shall be completely enclosed molded case devices with a current sensing coil in each of the 3 poles and have a magnetic trip

adjustment located on the front. The motor circuit protector shall be manually operable. The protector shall be designed to meet the NEC requirement concerning motor full load and locked-rotor current. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes, consisting of metal grids mounted in an insulating support.

I. Motor Starters

1. Motor starters shall conform to NEMA Standard IC1 and shall be for across-the-line starting, unless otherwise indicated. IEC rated equipment is not acceptable and shall be used as a basis for rejection of the equipment. The size of the starter shall be as required for the particular load. Minimum starter size shall be NEMA Size 1. Size 1 and 2 starters shall be completely drawout type, so that units may be withdrawn without disconnecting any wiring. Size 3 and 4 full-voltage, non-reversing starters shall be drawout type after disconnecting power leads only. Starters over three-space units high may be bolt-on type. A positive guidance system shall be provided to assure proper alignment of wedge-shaped power stabs in deadfront openings in vertical power bus.
2. A suitable control disconnect device(s) to comply with the requirements of the NEC shall be provided.
3. Magnetic starters and contactors shall be electromagnetic vertical or horizontal lift design with double break cadmium oxide silver contacts. Design shall meet or exceed the requirements of UL and NEMA Standards. Coils shall be hot molded construction to protect the coils from mechanical and environmental damage.
4. Each starter shall be able to accommodate a minimum of three (3) auxiliary contacts in addition to the hold-in contact.
5. Each starter shall be supplied with a 3 pole, manual reset overload relay. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy or bi-metallic type overload relays are not acceptable.
6. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid state equipment (e.g. programmable logic controller) wired as part of the control circuit.
7. The minimum control power transformer VA requirements are shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.
   a. Size 1 75 VA
   b. Size 2 75 VA
   c. Size 3 200 VA
   d. Size 4 300 VA
   e. Size 5 500 VA
8. The Contractor and motor control center manufacturer is advised to review the Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this

Division or shown on the Drawings. Control power transformers shall be fused on both the primary and secondary sides.

J. Circuit Breakers
   1. Where specified herein, indicated on the Drawings, or required, the main circuit breaker shall be rated for service entrance and bear a service entrance label.
   2. Unless otherwise indicated, circuit breakers shall be manually operable and shall provide thermal-magnetic, inverse-time-limit overload, and instantaneous short-circuit protection.
   3. Circuit breakers shall be molded case type, rated 480 VAC, 2 or 3 pole and have 100 ampere or larger frames. The interrupting rating shall match that of the motor control center short circuit rating at 480V.
   4. Overload protection shall be provided on all poles with trip settings as indicated on the Drawings. Breakers of 225-ampere frames and larger shall have interchangeable trip units and adjustable magnetic trip elements.
   5. Horizontally mounted operator handles for feeder circuit breaker units up to 225A are permissible if accepted in writing by the Engineer.
   6. Where indicated on the Drawings, shunt trip devices shall be provided to trip a circuit from a remote location by means of a trip coil energized from a separate circuit. A 120V shunt trip shall be capable of operating 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.

K. Terminal Blocks
   1. Terminal blocks associated with removable units within the motor control center shall be provided as follows:
      a. Terminal blocks shall be mounted within the unit insert and in the front for ease of accessibility. .
      b. Pull-apart style terminal block assemblies shall be provided. Terminal block assembly shall consist of a male and female component held together with captive screws. The terminal block assembly shall be designed to withstand the effects of vibration, yet able to be pulled apart without difficulty. The terminals of the assembly shall be recessed to isolate them from accidental contact. Terminal markings shall be provided for the purpose of identifying terminations. Terminal strips shall be suitable for use as a disconnecting means of foreign interlock voltages.
      c. For starters Size 2 and smaller, terminate all starter wiring (power and control) and external field wiring on terminal blocks provided in each unit.
      d. For starters Size 3 and larger, terminate control wiring and external field control wiring on terminal blocks provided in each unit.
   2. Terminal blocks associated with non-removable units within the motor control center shall be provided in accordance with Section 16422, Electric Controls and Relays.
   3. Provide a minimum of four (4) spare terminals in each terminal block assembly.

L. Control Devices
   1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16422, Electric Controls and Relays:
      a. Pilot devices (switches, indicating lights, etc)
      b. Relays and timers

M. Nameplates

1. Provide engraved plastic nameplates to identify the motor control center, each unit compartment, door mounted devices, and internal components.
2. Nameplates shall be as specified in Section 16075, Electrical - Identification. Equipment names and numbers as indicated on the single line diagrams shall be used as the basis to engrave the nameplates.
3. Provide a master nameplate giving motor control center designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
4. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked for identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

N. Future Space Requirements
1. Provide spaces for future combination starter and other units in the motor control centers. Furnish spaces with hardware to accommodate future plug-in control unit without modification of vertical sections. Provide the number of spaces required for future units as indicated on the Drawings, minimum.
2. Provide additional vertical sections to ensure total number of spaces as indicated on the Drawings. The number of vertical sections are contingent upon specific manufacturer's final proposed and Engineer-accepted configuration of motor control center units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify conditions under the provisions of Division 1.

B. Verify that surface is suitable for motor control center installation.

3.02 PREPARATION

A. Provide housekeeping pads under the provisions of Section 03100.

3.03 INSTALLATION

A. Install motor control centers in accordance with manufacturer's instructions.

B. Tighten accessible bus connections and mechanical fasteners after placing motor control center.

C. Select and install heater elements in motor starters to match installed motor characteristics.

D. Provide engraved plastic nameplates under the provisions of Section 16075.

E. Motor Data: Provide neatly typed label inside each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.04 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Division 1.

B. Inspect and test motor control center and each controller to NEMA ICS 2.

C. start sequence

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16460

DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Motor control centers.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 03100 Cast-in-place Concrete: Housekeeping pads.
   2. Section 16075 Electrical Identification: Engraved nameplates.

1.03 REFERENCES

A. NFPA 70 - National Electrical Code.

B. UL 198E - Class R Fuses.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

E. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.

1.04 SUBMITTALS

A. Submit under provisions of Division 1.
   1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
   2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of individual motor controller. For RVSS starters, in free-standing enclosures, show conduit stub-up area locations on the Drawings.
   3. Internal schematic and point-to-point wiring diagrams of each motor control unit including variable frequency drives integrated into the motor control center. Standard wiring diagrams that are not custom created by the manufacturer for the motor control centers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. flush pump) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

4. Complete single-line diagrams for each motor control center showing circuit breakers, motor circuit protectors, motor controllers, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete assembly. Indicate electrical ratings of equipment and devices on these single-line diagrams. Ratings include starter size and type, motor circuit protector continuous current rating, circuit breaker frame size and trip rating, motor horsepower and full load current, and similar information.
5. Shop Drawings: Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time/current curves of all equipment and components.
6. Test Reports: Indicate field test and inspection procedures and test results.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NEMA ICS 2.3.

B. Maintain one copy of each document on site.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina Recognized Third Party Testing Agency.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with NEMA ICS 2.3. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Division 1.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Square D Co.

B. Siemens Energy & Automation Corp.

C. Cutler Hammer

D. General Electric Co.

2.02 MOTOR CONTROL CENTER

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that all components of the motor control center be provided by one manufacturer who shall have the sole responsibility of matching all components and providing equipment which functions together as a system. The manufacturer of the motor control center shall also be the manufacturer of the motor controllers. The use of third-party supply and assembly of these components is not acceptable.

C. Motor control centers shall be Freedom 2100 as manufactured by Eaton using NEMA rated Freedom Series contactors and starters, Model 6 as manufactured by the Square D Company, Centerline 2100 as manufactured by Allen-Bradley, Tiastar as manufactured by Siemens Energy and Automation Inc., or the General Electric Company Evolution Series E9000, or approved equal.

2.03 MOTOR CONTROL CENTER

A. General

1. The motor control centers shall be 600 VAC class suitable for operation on a three-phase, 60 Hz system. The motor control centers and their components shall conform to the requirements of applicable standards of NEMA Part ICS 2-322 and Underwriters' Laboratories, Inc. UL-845. Wiring shall be NEMA Class II, Type B. Each vertical section shall be a NEMA 1A (gasketed) industrial use enclosure unless otherwise specified or indicated on the Drawings.
2. The enclosures shall be cleaned, primed, and finish coated in accordance with the manufacturer's standard process. The pre-treatment process shall be a zinc chromate primer followed by a "One Coat" paint process that is monitored to meet the manufacturer's specifications for paint color, texture, thickness, and durability. Enclosure interior and exterior finish color shall be ANSI 49 (medium light gray). The color of the back panel/bucket located within the MCC enclosure shall be white.
3. The motor control centers shall be capable of withstanding the fault current available at its line terminals. Minimum bus bracing, withstand, and interrupting ratings are specified herein.
4. Unless otherwise specified or indicated on the Drawings, each vertical section shall be approximately 20 inches wide, and 90 inches high, 20 inches deep, and shall not contain more than six NEMA Size 1 starters. Motor control centers shown "back-to-back" on the Contract Drawings shall be complete motor control assemblies placed back-to-back in the location shown. Motor

control center sections with common horizontal and/or vertical bus systems are unacceptable.

5. Continuous horizontal wiring troughs shall be provided at both the top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the motor control center. Each section shall be provided with a large, continuous, full height vertical wiring trough in the right side of each section. Each vertical wiring trough shall be furnished complete with tie bars for conductor support.
6. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105□C. Wire color coding shall be red for control and black for power. Wire numbers shall not be repeated in a motor control center.
7. Starter units shall contain the number of auxiliary contacts, unit-mounted pilot devices and indicating lights, control relays, elapsed time meters, and other devices as shown on the Drawings and required for the applications. A minimum of two (2) normally open (NO) and two (2) normally closed (NC) spare contacts shall be provided for each magnetic starter. These spare contacts shall be shown on the submittal wiring diagrams.
8. The motor control centers shall be furnished with warning signs to notify maintenance personnel of multiple sources of power within the motor control units.

B. Power
   1. The motor control centers shall be supplied from a 480V, 3-phase, 3 or 4 wire as indicated on the Drawings, 60 Hz power source. The incoming power feeders shall be sized as shown on the Drawings. All terminals for incoming and outgoing power cables shall be provided with compression lugs.

C. Bus
   1. Power shall be distributed by means of a continuous, tin plated copper horizontal bus, rated as shown on the Drawings. The bus shall be braced for 65,000A rms symmetrical at 480V unless otherwise indicated on the Drawings. The horizontal bus shall be effectively isolated from all wiring troughs and other working areas. Vertical bus extensions shall be tin plated copper, isolated by rigid, glass-polyester moldings so as to be a separate self-supported assembly. Silver plated vertical bus may be provided if specifically accepted by the Engineer. Full height vertical bus shall be installed in all sections including those containing spare units and "prepared" spaces. No extra safety jacks or similar devices shall be required to obtain an essentially dead-front condition. Access shall be provided for inspection and maintenance from the front. Minimum horizontal bus rating shall be 600A. Minimum vertical bus rating shall be 300A.

D. Incoming Line Units
   1. Each incoming line unit shall contain buswork and fittings as required with cable lugs for cables of sizes and quantities shown on the Drawings. Cable lugs shall be suitable for their respective conductors.
   2. A neutral landing pad shall be furnished in the incoming line section. A neutral landing pad is required to terminate the grounded conductor from the utility transformer in accordance with the NEC.

E. The Unit Compartments

1. Each unit compartment shall be provided with an individual front door hinged to the vertical structure. Each plug-in unit shall be supported and guided by a removable unit support pan, so that the unit rearrangement is easily accomplished. The rearrangement of the unit support pan from one location to the other shall be accomplished without use of tools. After insertion, each plug-in unit shall be held in place by at least one multi-turn latch, located at the front of the unit. The latch shall be located for front accessibility and installation convenience. An additional mechanical interlock shall be provided to prevent withdrawal of the unit from the stationary structure with the operating mechanism in the ON position.
2. The unit plug in power stabs shall be electromagnetically tin plated copper to yield a low resistance connection and designed to tighten during heavy current surges and short circuits. The stab shall be backed by spring steel clips to provide and maintain a high pressure, two point connection to the vertical bus. They shall be free floating and self loading plug-in. Wiring from the unit disconnecting means to the plug-in stab shall be exposed at the rear of the unit. The power cable terminations at the plug-in stab shall be mounted in a two-piece, glass polyester support assembly. This support assembly shall provide a separate isolated pathway for each phase, minimizing the probability of a unit fault condition reaching the power bus system.
3. NEMA Size 1 through Size 5 non-reversing starters shall be plug-in units. Size 1, 2, and 3 shall utilize stab assembly rated 100A. Stab assemblies for Size 4 and Size 5 starters shall be rated for the starters maximum output current rating.
4. An industrial, heavy-duty flange handle mechanism shall be supplied for the control of each disconnecting means. This mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position. The operator handles shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8 inch diameter shackle padlocks and in the "ON" position with one (1) 3/8 inch diameter shackle padlock.
5. The operator handle of all units shall be interlocked with the door units so that the disconnect means cannot be switched unless the door unit is closed. A means shall be provided for purposely defeating the interlock during maintenance or testing. This interlock shall also prevent opening the unit door unless the disconnecting means is in the off position. An externally operated defeater requiring the use of a screwdriver shall provide access to the unit without interrupting service.
6. The overload relays shall be resettable from the outside of the enclosure by means of an insulated bar or button.

F. Ground Bus
1. The horizontal ground bus shall be tin plated copper and located in the bottom horizontal wireway. The minimum size of the horizontal ground bus shall be 1/4 inch x 1 inch (6.35mm x 25.4mm) or 33% of the phase bus ampacity, whichever is greater.
2. Compression lugs shall be mounted on the ground bus in each section, in the size and quantity as required for the termination of system and equipment grounding conductors.

3. The vertical ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. This ground bus, in combination with the unit ground bus stab, establishes unit grounding before the plug-in power stabs engage the power bus, and conversely, as the unit is withdrawn, grounding is maintained until after the plug-in power stabs are disengaged.
4. The vertical load ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. The vertical load ground bus assembly, comprised of the vertical load ground bus and the unit load ground bus connector, shall provide a termination point for the load equipment grounding conductor at the unit. This fixed connection shall not have to be removed when the unit is withdrawn from the motor control center.

G. Isolation and Insulation
1. Horizontal bus access covers and vertical bus covers shall isolate the energized buses to guard against the hazard of accidental contact. These covers shall be molded of a glass polyester material.
2. The horizontal bus shall be isolated from the top horizontal wireway by a grounded steel barrier. This barrier shall be removable to allow access to the bus and connections for maintenance.
3. The vertical bus cover shall provide unit plug-in openings which shall permit unit plug-in stab assemblies to pass through and engage the vertical bus. The unit plug-in openings shall be sized to minimize the probability of inadvertent contact with the vertical bus.
4. Isolation of unused stab openings shall be accomplished by use of a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the motor control center.
5. All units shall be isolated from one another, above and below, by unit support pans or steel barriers, which can remain in place when the units are withdrawn.
6. Incoming line compartments shall be isolated from horizontal and vertical wireways by steel barriers.
7. A molded unit isolating barrier shall be provided to isolate the unit from the vertical wireway.

H. Combination Motor Control Units
1. Motor branch circuits shall be protected by a motor circuit protector (MCP).
2. The motor circuit protector shall be operated by a toggle type handle and shall have a quick make, quick break overcenter switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.
3. Each pole of these motor circuit protectors shall provide instantaneous short circuit protection by means of an adjustable magnetic only element.
4. The motor circuit protectors in combination with a contactor and overload relay shall have an interrupting rating that matches the motor control center short circuit rating at 480V.
5. Motor circuit protector's ratings, modifications, etc., shall be as specified herein and as indicated on the Drawings.
6. Motor circuit protectors shall be completely enclosed molded case devices with a current sensing coil in each of the 3 poles and have a magnetic trip

adjustment located on the front. The motor circuit protector shall be manually operable. The protector shall be designed to meet the NEC requirement concerning motor full load and locked-rotor current. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes, consisting of metal grids mounted in an insulating support.

I. Motor Starters

1. Motor starters shall conform to NEMA Standard IC1 and shall be for across-the-line starting, unless otherwise indicated. IEC rated equipment is not acceptable and shall be used as a basis for rejection of the equipment. The size of the starter shall be as required for the particular load. Minimum starter size shall be NEMA Size 1. Size 1 and 2 starters shall be completely drawout type, so that units may be withdrawn without disconnecting any wiring. Size 3 and 4 full-voltage, non-reversing starters shall be drawout type after disconnecting power leads only. Starters over three-space units high may be bolt-on type. A positive guidance system shall be provided to assure proper alignment of wedge-shaped power stabs in deadfront openings in vertical power bus.
2. A suitable control disconnect device(s) to comply with the requirements of the NEC shall be provided.
3. Magnetic starters and contactors shall be electromagnetic vertical or horizontal lift design with double break cadmium oxide silver contacts. Design shall meet or exceed the requirements of UL and NEMA Standards. Coils shall be hot molded construction to protect the coils from mechanical and environmental damage.
4. Each starter shall be able to accommodate a minimum of three (3) auxiliary contacts in addition to the hold-in contact.
5. Each starter shall be supplied with a 3 pole, manual reset overload relay. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy or bi-metallic type overload relays are not acceptable.
6. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid state equipment (e.g. programmable logic controller) wired as part of the control circuit.
7. The minimum control power transformer VA requirements are shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.
   a. Size 1 75 VA
   b. Size 2 75 VA
   c. Size 3 200 VA
   d. Size 4 300 VA
   e. Size 5 500 VA
8. The Contractor and motor control center manufacturer is advised to review the Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this

Division or shown on the Drawings. Control power transformers shall be fused on both the primary and secondary sides.

J. Circuit Breakers
   1. Where specified herein, indicated on the Drawings, or required, the main circuit breaker shall be rated for service entrance and bear a service entrance label.
   2. Unless otherwise indicated, circuit breakers shall be manually operable and shall provide thermal-magnetic, inverse-time-limit overload, and instantaneous short-circuit protection.
   3. Circuit breakers shall be molded case type, rated 480 VAC, 2 or 3 pole and have 100 ampere or larger frames. The interrupting rating shall match that of the motor control center short circuit rating at 480V.
   4. Overload protection shall be provided on all poles with trip settings as indicated on the Drawings. Breakers of 225-ampere frames and larger shall have interchangeable trip units and adjustable magnetic trip elements.
   5. Horizontally mounted operator handles for feeder circuit breaker units up to 225A are permissible if accepted in writing by the Engineer.
   6. Where indicated on the Drawings, shunt trip devices shall be provided to trip a circuit from a remote location by means of a trip coil energized from a separate circuit. A 120V shunt trip shall be capable of operating 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.

K. Terminal Blocks
   1. Terminal blocks associated with removable units within the motor control center shall be provided as follows:
      a. Terminal blocks shall be mounted within the unit insert and in the front for ease of accessibility. .
      b. Pull-apart style terminal block assemblies shall be provided. Terminal block assembly shall consist of a male and female component held together with captive screws. The terminal block assembly shall be designed to withstand the effects of vibration, yet able to be pulled apart without difficulty. The terminals of the assembly shall be recessed to isolate them from accidental contact. Terminal markings shall be provided for the purpose of identifying terminations. Terminal strips shall be suitable for use as a disconnecting means of foreign interlock voltages.
      c. For starters Size 2 and smaller, terminate all starter wiring (power and control) and external field wiring on terminal blocks provided in each unit.
      d. For starters Size 3 and larger, terminate control wiring and external field control wiring on terminal blocks provided in each unit.
   2. Terminal blocks associated with non-removable units within the motor control center shall be provided in accordance with Section 16422, Electric Controls and Relays.
   3. Provide a minimum of four (4) spare terminals in each terminal block assembly.

L. Control Devices
   1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16422, Electric Controls and Relays:
      a. Pilot devices (switches, indicating lights, etc)
      b. Relays and timers

M. Nameplates

1. Provide engraved plastic nameplates to identify the motor control center, each unit compartment, door mounted devices, and internal components.
2. Nameplates shall be as specified in Section 16075, Electrical - Identification. Equipment names and numbers as indicated on the single line diagrams shall be used as the basis to engrave the nameplates.
3. Provide a master nameplate giving motor control center designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
4. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked for identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

N. Future Space Requirements
1. Provide spaces for future combination starter and other units in the motor control centers. Furnish spaces with hardware to accommodate future plug-in control unit without modification of vertical sections. Provide the number of spaces required for future units as indicated on the Drawings, minimum.
2. Provide additional vertical sections to ensure total number of spaces as indicated on the Drawings. The number of vertical sections are contingent upon specific manufacturer's final proposed and Engineer-accepted configuration of motor control center units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify conditions under the provisions of Division 1.

B. Verify that surface is suitable for motor control center installation.

3.02 PREPARATION

A. Provide housekeeping pads under the provisions of Section 03100.

3.03 INSTALLATION

A. Install motor control centers in accordance with manufacturer's instructions.

B. Tighten accessible bus connections and mechanical fasteners after placing motor control center.

C. Select and install heater elements in motor starters to match installed motor characteristics.

D. Provide engraved plastic nameplates under the provisions of Section 16075.

E. Motor Data: Provide neatly typed label inside each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.04 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Division 1.

B. Inspect and test motor control center and each controller to NEMA ICS 2.

C. start sequence

END OF SECTION

SECTION 16475

PROTECTIVE DEVICE STUDY

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies the requirements of the Electrical System Protective Device Study and Arc Flash Analysis.

B. A short circuit and coordination study shall be prepared for the electrical over current devices to be installed under this project to assure proper equipment and personnel protection.

C. The study shall present an organized time-current analysis of each protective device in series from the utility transformer. The study shall reflect the operation of each device during normal and abnormal current conditions.

D. The incident energy study shall include arc flash analysis on each piece of distribution equipment on the system. The study shall include actual PPE level requirements labels for all distribution equipment.

1.02 RELATED WORK

A. Section 16050 - General Provisions Related to Electrical Work.

B. Section 16210 - Utility Service.

1.03 SUBMITTALS

A. In accordance with Section 16050 - General Provisions Related to Electrical Work, submit the following:
   1. Complete short circuit and coordination study as described herein.
   2. Protective equipment shop drawings shall be submitted simultaneously with or after the protective device study. Protective equipment shop drawings will not be accepted prior to protective device study.
   3. Certification: Two weeks prior to final inspection, submit four copies of the following to the Engineer:
   4. Certification by the Contractor that the protective devices have been adjusted and set in accordance with the approved protective device study.

1.04 QUALIFICATIONS

A. The protective device study shall be prepared by qualified engineers of the switchgear manufacturer or an approved consultant. The Contractor is responsible for providing all pertinent information required by the preparers to complete the study.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 REQUIREMENTS

A. The complete study shall include a system one line diagram, short circuit and ground fault analysis, protective coordination plots, arc flash analysis, and PPE level requirements for all equipment.

B. One Line Diagram:

1. Show, on the one line diagram, all electrical equipment and wiring to be protected by the overcurrent devices installed under this project. Clearly show, on the one line, the schematic wiring of the electrical distribution system.
2. Also show on the one line diagram the following specific information:
   a. Calculated fault impedance, X/R ratios, and short circuit values at each bus.
   b. Breaker and fuse ratings.
   c. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   d. Voltage at each bus.
   e. Identification of each bus.
   f. Conduit material, feeder sizes, length, and X/R ratios.

C. Short Circuit Study:
1. Systematically calculate the fault impedance to determine the available short circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
2. The study shall be calculated by means of a computer program. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
3. Present the data determined by the short circuit study in a table format. Include the following:
   a. Device identification.
   b. Operating voltage.
   c. Protective device.
   d. Device rating.
      1) Calculated short circuit current.

D. Coordination Curves:
1. Prepare the coordination curves to determine the required settings of protective devices to assure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between series devices, including the utility company upstream device. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices will be clearly depicted on one sheet.
2. The following specific information shall also be shown on the coordination curves:
   a. Device identification.
   b. Voltage and current ratio for curves.
   c. 3-phase and 1-phase ANSI damage points for each transformer.
   d. No-damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum short circuit cutoff point.
3. Develop a table to summarize the settings selected for the protective devices. Include the following in the table:
4. Device identification.
5. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
6. Fuse rating and type.
7. Ground fault pickup and time delay.

E. Labels:

1. Based on the results of the incident energy study, the supplier shall produce and install a warning label (orange <40 cal/cm^2) or danger label (red > 40 cal/cm^2) for each piece of equipment as specified in "Section A" in accordance with ANSI Z535.4-2002. The label must be readable in both indoor and outdoor environments for at least 3 years and contain the following information.
   a. Arc hazard boundary (inches)
   b. Working distance (inches)
   c. Arc flash incident energy at the working distance (calories/ cm^2)
   d. PPE category and description including the glove rating
   e. Voltage rating of the equipment
   f. Limited approach distance (inches)
   g. Restricted approach distance (inches)
   h. Prohibited approach distance (inches)
   i. Equipment/bus name
   j. Date prepared

3.02 ANALYSIS

A. Analyze the short circuit calculations, and highlight any equipment that is determined to be underrated as specified. Propose approaches to effectively protect the underrated equipment. Provide minor modifications to conform to the study (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics, etc.).

B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

3.03 ADJUSTMENTS, SETTINGS AND MODIFICATIONS

A. Necessary final field adjustments, settings and minor modifications shall be made to conform with the protective device study without additional cost to the Owner.

B. All final circuit breaker settings and fuse sizes shall be made in accordance with the recommendations of the protective device study.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16483

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable Frequency Drives for pump applications.

1.02 RELATED SECTIONS

A. Section 232123 - Pumps.

B. Section 230923 - Building Automation System.

PART 2 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

2.02 SUBMITTALS

A. Submit under provisions of Division 1 and Section 230500.

B. Shop Drawings: Include front and side views of enclosures and pumps with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

C. Product Data: Provide catalog sheets and wiring diagrams showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, drive options, dimensions, and enclosure details.

D. Test Reports: Indicate field test and inspection procedures and test results.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation and starting of Product.

F. Manufacturer's Field Reports: Indicate start-up inspection findings.

2.03 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Operation Data: Include instructions for starting and operating controllers and pumps, and describe operating limits that may result in hazardous or unsafe conditions.

C. Maintenance Data: Include routine preventive maintenance schedule.

2.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience, and with service facilities within 100 miles of Project.

2.05 REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc., (UL) and/or Electrical Testing Laboratories (ETL) as suitable for purpose specified and indicated.

2.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Accept controllers on site in original packing. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

2.07 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

2.08 EXTRA MATERIALS

A. Furnish under provisions of Division 1.

B. Provide three of each fuse size and type.

PART 3 PRODUCTS

3.01 MANUFACTURERS

A. Honeywell Smart Drives

B. JCI Smart Drive

C. Danfoss.

D. Substitutions: Under provisions of Division 1.

3.02 GENERAL

A. The variable frequency drive (VFD) motor controller shall convert 460 Volt, three-phase, 60 Hertz utility power to adjustable voltage (0-460V) and frequency (0-60 Hz.) three-phase, AC power for stepless motor speed control with a capability of 10:1 speed range. All general options and modifications shall mount within the standard adjustable frequency controller enclosure.

B. The adjustable frequency controller shall be a space vector sine-coded Pulse-Width Modulated (PWM) design. Modulation methods which incorporate "gear-changing" techniques are not acceptable. All drives shall be supplied by one manufacturer.

C. The controller(s) shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor or with existing standard NEMA-B squirrel-cage induction motor(s) with nameplate data as shown on the plans. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.

D. The variable frequency control shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10% total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other VFDs are operated from the same bus.

E. The variable frequency control shall include transient voltage suppression to allow reliable operation on a typical industrial or commercial power distribution system.

3.03 BASIC DESCRIPTION

A. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz. despite incoming voltage variations.

B. The controller shall have a continuous output current rating of 100% of motor nameplate current.

C. The VFD shall be of the Pulse-Width Modulated type and shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-coded output voltage.

D. The inverter output shall be generated by power transistors which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

3.04 BASIC FEATURES

A. The door of each power unit shall include a "POWER ON" light, a VFD fault light, a VFD run light, stop pushbutton, start pushbutton, a fault reset pushbutton, a "HAND-OFF-AUTOMATIC" selector switch, and a manual speed control potentiometer.

B. The VFD shall have a manual restart after a trip condition resulting from overcurrent, overvoltage, undervoltage, or overtemperature. The drive shall shut down and require manual reset and restart.

C. A speed droop feature shall be included which reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.

D. Manual restart after drive trip or utility failure.

E. Speed profile. Individual adjustable settings for start, stop, entry, slope, and minimum and maximum speed points.

F. Process signal inverter. Software selectable to allow speed of drive to vary inversely with input signal.

G. Proportional and integral process controller with menu driven selection and programming via door-mounted keypad.

H. Pick up a spinning load. The VFD shall be able to determine the motor speed and resume control of motor which is spinning in either direction without tripping.

I. A door-mounted digital keypad/display unit shall be provided and capable of controlling the VFD and setting drive parameters.

   1. The digital display shall normally display:

      a. Speed demand in percent.

      b. Output current in amperes.

      c. Frequency in hertz.

      d. Control Mode: Manual/Automatic.

      e. Total three-phase KW.

   2. The keypad will display diagnostic messages and parameter values when accessed.

   3. The digital keypad shall allow operators to enter exact numerical settings in English engineering units. A user menu is to be provided as a guide to parameter setting. Coded messages on the keypad will not be acceptable. Drive parameters are to be factory set in EEPROM and resettable in the field through the keypad.

a. Six (6) levels of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.

4. The keypad/display shall have a key switch to control operation of the keypad. Key to be removable in either "ENABLED" or "DISABLED" positions. Keypad module shall contain a "self-test" software program that can be activated to verify proper keypad operations.

3.05 SERVICE CONDITIONS

A. The controller shall be designed and constructed to operate within the following service conditions:

1. Elevation: To 330 Feet.

2. Ambient Temperature Range: O°C to 40°C.

3. Atmosphere: Non-Condensing relative humidity to 95%.

4. AC Line Voltage Variation: -5% to +10%.

5. AC Line Frequency Variation: ±3 Hertz.

B. ENCLOSURE

C. All VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-12 or NEMA-4XSS enclosure. If a free-standing enclosure is provided, it shall be suitable for mounting on a concrete housekeeping pad.

3.06 PROTECTIVE FEATURES AND CIRCUITS

A. Single phase fault or 3-phase short circuit on VFD output terminals without damage to any power component.

B. Static instantaneous overcurrent and overvoltage trip with inverse overcurrent protection.

1. Static overspeed (overfrequency) protection.

2. Line or fuse loss and undervoltage protection.

3. Power unit overtemperature protection.

4. Electronic motor overload protection.

5. Responsive action to motor winding temperature detectors or thermostatic switches.

6. LED monitor lamps for each inverter stage.

7. LED status indicators on regulator, printed circuit board face plates.

8. Isolated operator controls.

9. Input line fuses.

10. Be insensitive to incoming power phase sequence.

11. Have desaturation circuit to drive inverter section transistor base current to zero in event of controller fault.

12. Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.

13. Input line noise suppression with line reactor.

14. Individual transistor overcurrent protection.

3.07 ADJUSTMENTS

A. The controller shall have the following adjustments accessible through a keypad display unit:

1. Maximum Frequency: 60, 90 or 120 Hz.

2. Speed: Frequency:-Max., Frequency-Min.

3. Independent acceleration/deceleration rates: 2 - 300 seconds.

4. Voltage Parameters: V-min., V-max., V/Hz/.

5. Current Limit: 50 - 100% of drive rating.

6. Inverse time overload, limit, time.

7. Current Boost.

8. Speed shedding current limit.

9. Speed Profile: Entry, Exit, Min. Speed, Max. Speed.

10. Auto Start: Delay on/off, on/off levels.

11. Inverse Profile.

12. Selectable follower/setpoint control.

13. Internal P.I. Controller, Proportional and Integral.

14. Terms.

B. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the

current set values. This parameter log shall be accessible via an RS232 serial port as well as on the keypad display.

3.08 DIAGNOSTIC FEATURES AND FAULT HANDLING

A. The following conditions shall cause a safe drive shutdown:

1. Loss of input power.

2. Undervoltage.

3. Sustained gradual overload.

4. Instantaneous severe overload.

5. Power transistor overtemperature.

6. Blown fuse.

7. Logic power supply failure.

B. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.

C. A "FAULT LOG" shall record the VFD operating mode, elapsed time, reset and mode of fault for the 50 most recent events.

D. An "HISTORIC LOG" shall record the actual drive control variables at 5 millisecond intervals for the 100 intervals immediately preceding a fault trip accessible through RS232 port.

E. The fault log record shall be accessible via a RS232 serial link as well as line by line on the keypad display.

3.09 DRIVE OPTIONS

A. Provide the following options/modifications to the VFD. All special features shall be factory mounted and wired within the VFD enclosure unless otherwise specified.

1. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power. The circuit breaker shall be rated for the application.

2. A monitor and hold P/C board will be provided to accept 120 VAC contact closure signals for increase and decrease speed commands. Drive will maintain its speed in the absence of signals.

3. The drive is to be provided with isolated 4-20mA DC output signals proportional to speed, current, voltage and/or KW for connection to the Building Automation System.

4. The drive is to be provided with isolated digital inputs and outputs as follows for connection to the Building Automation System.

   a. Digital Input: To receive start/stop signal from the SCADA.

   b. Digital Output: To send fault signal to the SCADA.

   c. Analog Input: To receive 4-20 mA speed control signal from SCADA.

   d. Analog Output: To send a speed or frequency output signal to the SCADA.

3.10 QUALITY ASSURANCE AND FACTORY TEST

A. The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:

   1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.

   2. All printed circuit boards shall be tested at 50 deg. C. for 50 hours. The VFD manufacturer shall provide certification that the tests have been completed.

   3. Every controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

PART 4 EXECUTION

4.01 EXAMINATION

A. Verify that surface is suitable for controller installation.

B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

4.02 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage and grounding.

4.03 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems.

B. Provide start-up and adjustment services for a minimum period of twenty four hours.

4.04 ADJUSTING

A. Adjust work under provisions of Division 1.

B. Make final adjustments to installed drive to assure proper operation of system. Obtain performance requirements from installer of driven loads.

4.05 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

4.06 DEMONSTRATION

A. Demonstrate operation of controllers in automatic and manual modes to the Owner and Engineer.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16510

LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Luminaires.

B. LED Fixtures.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 16136 Boxes

1.03 REFERENCES

A. Underwriter's Laboratories, Inc. (UL):
   1. UL 924 – Emergency Lighting and Power Equipment
   2. UL 935 – Fluorescent Lamp Ballasts
   3. UL 844 – Luminaires for Use in Hazardous (Classified) Locations
   4. UL 1029 – High Intensity Discharge Lamp Ballasts
   5. UL 1598 – Luminaires

B. American National Standards Institute (ANSI):
   1. ANSI C82.11 – High Frequency Fluorescent Lamp Ballasts
   2. ANSI C62.41 – Guide for Surge Voltages in Low-Voltage AC Power Circuits

C. National Electrical Code (NEC), latest edition.

1.04 SUBMITTALS

A. Submit under provisions of Division 1.
   1. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Product Data: Provide dimensions, ratings, and performance data.
   3. Pole calculations.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Accurately record actual locations of each luminaire.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Product Data: Provide lamp requirements, listing of available accessories, and photometric data.

C. Maintenance Data: Include available accessories data listing, source and current prices of accessories, and recommended cleaning and maintenance procedures.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Conform to requirements of NFPA 101.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina recognized third party testing agency.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Each fixture shall bear the Underwriters Laboratories, Inc. label. All ighting fixture shall be furnished complete with lamps of the size and type as indicated on the Drawings an all fittings and hardware necessary for a complete installation. Lighting fixtures shall have all the parts and fittings necessary to completely and properly install the fixtures.

B. Fixture leads shall be required by NEC and shall be grounded by the equipment grounding conductor in the conduit.

C. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be rounded and free from chips or rough edges.

D. Fixtures specified to be damp or wet locations rated shall be UL 1598 listed.

E. Substitutions: Under provisions of Division 1.

F. Fixtures shall be as specified in the fixture schedule below:

FIXTURE TYPE	LAMPE/FIXTURE WATTAGE	DESCRIPTION	MANUFACTURER AND MODEL
LL1	129W (max)	Pole-mounted 120-277 VAC, LEC light fixture, color temperature of 4000 K, 30 LEDs, IESNA roadway Type 3 distribution, black die cast aluminum housing, 1300 mA driver, 13,000 lumen minimum, full-cutoff optics, Wet Location Listed. Round, black, base mounted, tapered, 15 ft for well sites, 25 ft for plant site, painted steel pole.	AEL Autobahn ATB0 Series, GE Evolve LED EAMT, or Gardco Radiant RL Series
LP1	75W (max)	Pendant-mounted, 120-277 VAC, LED light fixture, color temperature of 4000 K, 90 CRI, lineal ribbed frosted acrylic lens, spread distribution, gasketed fiberglass housing, stainless steel latches, 4ft, 8,000 lumen minimum, and Wet Location Listed	Holophane EMS LED Series, Cooper Vaportite LED Series, or Lithonia FEM LED Series
LP1A	75W (max)	Same as LP1 but with emergency battery backup	Holophane EMS LED Series, Cooper Vaportite LED Series, or Lithonia FEM LED Series
LP2	255W (max)	Pendant-mounted, 120-277 VAC, LED light fixture, color temperature of 4000 K, 90 CRI, prismatic borosilicate glass lens, medium distribution, white cast aluminum housing, 30,000 lumen minimum, and Wet Location Listed	Holophane Phuzion PHZ 30L 4K AG W MSE6L3VDL, or approved equal
LP2A	255W(max)	Same as LP2 but with emergency battery backup.	Holophane Phuzion PHZ Series, or approved equal
LP3	400W (max)	Pendant-mounted, 120-277 VAC, LED light fixture, color temperature of 4000 K, 90 CRI, prismatic borosilicate glass lens, medium distribution, white cast aluminum housing, 45,000 lumen minimum, and Wet Location Listed	Holophane Phuzion PHZ 45L 4K AG W MSE6L3VDL, , or approved equal
LR1	47W (max)	Recessed troffer, 2 ft x 4 ft LED light fixture, color temperature of 4000 K, 120 VAC, cold rolled steel, pre-painted housing, acrylic linear prismatic diffuser.	Lithonia VTL Series or equal

FIXTURE TYPE	LAMPE/FIXTURE WATTAGE	DESCRIPTION	MANUFACTURER AND MODEL
LR1A	47W (max)	Same as LR1 but with emergency battery backup	Lithonia VTL Series or equal
LR2	34W	4' LED surface mounted strip	Cooper Model#: 4SRL-LD5-41SL-LW-UNV-L840-CD1-SPVD2-U or equal.
LR3	18W	6" square LED recessed down light	Juno model #: SDSQ6-15-40-2 with SDSQ6-WHT trim or equal
LR3A	18W	Same as LR3 but with emergency battery backup	Juno model #: SDSQ6-15-40-2 with SDSQ6-WHT trim or equal
LW1	20W	Wall-mounted LED, 120/277 VAC, Vanity luminaire, 25" wall sconce half cylinder enclosed with acrylic diffuser, white solid aluminum frame. damp label	Eaton Model #:605-25-W-L3/840-UNV-MW or equal
LXW2	28W	Wall-mounted LED, 120/277 VAC, Exterior bronze heavy duty, die cast aluminum housing, battery back-up, fully gasketed and Wet Location Listed	Hubbell model LNC2-12L-4-4K-3-1-BBU or equal
XW1	5W	Wall-mounted, red LED exit sign, 120/277 VAC, white die cast aluminum housing, gasketed impact resistant polycarbonate cover, brushed aluminum stencil with field-selectable chevrons, single/double face as indicated on the drawings, nickel cadmium battery with self-diagnostics, low voltage battery disconnect, brownout and surge protected, and Wet Location Listed	Holophane DeLeon LNTLL Series, Chloride Hz Series or Emergilite IL Series.
XW2	3W	Wall-mounted, red LED exit sign, 120/277 VAC, clear acrylic panel, cast brushed aluminum trim, chevrons, single/double face as indicated on the drawings, nickel cadmium battery.	Emergilite x40 Edge-Lit Series or equal..
LC1	71W	Vapor tight, 4 ft. LED surface mounted fixture with stainless steel latches. UL Listed for wet locations.	Daybrite # DWPE51L840-4-UNV; Cooper # VT-LD2-55-DR-W-UNV-L840-WL-SSL; Hubbell # LXEM4-40ML-RFP-EU-SSL or equal.

2.02 LED DRIVERS

A. Drivers shall have a voltage range of (120-277) +/- 10% at a frequency 60 Hz.

B. All drivers shall be designed to a power factor >90% with a total harmonic distortion THD <20% at full load.

C. Case temperature shall be rated for -40°C through +80°C.

D. Drivers shall have overheat protection, self-limited short circuit protection and overload protection.

E. Drivers shall be furnished with a fused primary.

F. Drivers shall have an output current ripple <30%

G. Drivers shall have a five year (50,000 hour) warranty.

H. Drivers shall be manufactured by Advance, Universal, or equal.

I. Drivers shall be UL Listed for damp location, UL 1012, UL 935, & ROHS.

J. Drivers shall meet FCC 47 Sub Part 15.

K. All Drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

2.03 LEDS

A. Luminaires provided with LED technology shall utilize high brightness LEDs with a group binning code of P and/or Q.

B. Junction point shall be designed and manufactured to allow adequate heat dissipation.

C. LEDs shall be rated for 50,000 hours of life, minimum.

2.04 POLES

A. Poles shall be designed to withstand calculated wind force based on wind velocity in accordance with the provisions of the North Carolina Building Code.

B. Pole mounted fixtures shall be mounted on poles as designated in the fixture schedule or as indicated on the Drawings. Poles shall have adequate handholes and weatherproof receptacles where indicated. All anchor bolts and nuts shall be stainless steel.

2.05 LIGHTING CONTROLS

A. Lighting contactors shall be as manufactured by Eaton, the Square D Company, General Electric Company, or Siemens Energy and Automation, Inc. Lighting contactors shall be heavy duty industrial type with 30A minimum rating and shall have the number of contacts required. Contactor ampere rating shall be increased

as required to suit the application. Contactor coil voltage shall be as indicated on the Drawings. Contactors shall be the electrically or mechanically held type as indicated on the Drawings. Contactors shall include fused integral control power transformers. Any auxiliary relays, or other devices required for proper operation shall be included.

B. In non-hazardous locations, lighting contactors shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.
   1. Indoor Wet Process Area – NEMA 4X, Type 304 Stainless Steel
   2. Indoor Dry Process Area – NEMA 12, Painted Steel
   3. Indoor Dry Non-process Area – NEMA 1, Painted Steel
   4. Indoor Chemical Storage/Transfer Area – NEMA 4X, Type 304 Stainless Steel
   5. All Outdoor Areas – NEMA 4X, Type 304 Stainless Steel

C. Photocells shown on the Drawings that are not integral to a fixture provided by the (lighting manufacturer) shall be provided by the Contractor. Photocells shall be rated for 120 VAC, 1800W, and be provided with 1/2" or 3/4" threads for box mounting. Photocells shall be Model K4121C by Intermatic, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Lighting fixtures shall be located symmetrically with building lines as shown on the Drawings. The Contractor shall furnish and install the lighting fixtures to allow "convenient" access for maintenance such as cleaning, relamping, and other activities. The fixtures shall be installed to be accessed by a 12 ft. (max.) ladder. Where fixtures are shown in locations on the Drawings where maintenance would be difficult, the Contractor shall notify the Engineer for direction.

B. The Contractor shall provide and install all inserts, conduit, structural supports as required, lamps, ballasts, poles, wiring, and any other items required for a complete system. Contractor shall properly adjust and test, to the satisfaction of the Engineer, the entire lighting system. The Contractor shall provide pigtails and flexible conduit connected to an outlet box where necessary or required resulting in a neat and complete installation.

C. The Contractor shall protect all fixtures at all times from damage, dirt, dust, and the like. Before final acceptance, all fixtures and devices shall be cleaned of all dust, dirt or other material, be fully re-lamped (except LED fixtures) and in operating condition to the satisfaction of the Engineer.

D. The Contractor shall furnish and install all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hanger permitting normal fixture motion and self alignment. Fixture pendants shall be Appleton Type UNJ ball type flexible hanger at the fixture and supports from an Appleton JBLX junction box with JBLX hub cover, or equal. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be one piece, with matching canopies and fittings.

E. Fixtures located on the exterior of the building shall be provided with neoprene gasket and non ferrous metal screws finished to match the fixtures.

F. The finish or exposed metal parts of lighting fixtures and finish trims of all recessed lighting fixtures shall be as directed by the Engineer.

G. The Contractor shall furnish and install recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.

H. The Contractor shall furnish and install all boxes for lighting fixtures such that the box is not the sole support of the fixture. The boxes shall be offset to allow maintenance such that access to wiring within the box can be attained without having to consider supporting (holding) the fixture.

I. All lighting units, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.

J. The Contractor shall install fixtures at mounting heights indicated on the Drawings or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer.

K. The Contractor shall support each fixture securely. Each fluorescent fixture shall be secured to the building structure. The Contractor shall not secure fixtures to the work of other trades, unless specified or noted otherwise, and shall not support fixtures from plaster. The Contractor shall furnish and install all steel members and supports as required to fasten and suspend fixtures from the structure.

L. In all mechanical equipment areas, the Contractor shall install lighting fixtures on the ceiling after all piping and equipment therein has been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.

M. Upon completion of work, and after the building area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, and lamps.

N. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures and/or lamps, as directed.

O. Relamping access of fixtures including LED fixtures shall require no special tools. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of special tools. No fixture part that may be removed, for maintenance, shall be held in place by metal tabs that must be bent to remove said part.

P. The Contractor shall furnish and install time switches and photocells as specified herein or indicated on the Drawings. Time switches shall be provided with a manual

bypass switch controlling the lights locally and remotely. Time switches shall control contactors, relays, or direct controlling of one, two, or three lighting circuits, as indicated. The Contractor shall furnish and install photocells as specified herein or indicated on the Drawings for automatic "ON/OFF" switching of outdoor lighting.

Q. Lighting contactors shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

R. The Contractor shall furnish and install a concrete foundation for the pole mounted fixtures as required. This applies to foundations for pole mounted fixtures located in the yard (i.e. site lighting) and foundations that are part of a structure (e.g. filters). Foundation shall be approved by a Professional Structural Engineer currently registered in the State of North Carolina. The wind design shall be in accordance with ASCE 7 and the North Carolina Building Code. Pole structure/foundation shall be able to handle fixture/pole weight and withstand wind velocity of up to 110 mph with a 1.3 gust factor. Provide calculations signed and sealed by a Professional Structural Engineer for review.

S. One (1), 3/4" diameter, 10'-0" long ground rod, furnished in accordance with Section 16060, Grounding & Bonding, shall be driven adjacent to each pole. The pole, anchor bolts, steel reinforcement bar in the base, and equipment grounding conductor shall all be bonded to the ground rod.

3.02 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.03 ADJUSTING

A. Adjust Work under provisions of Division 1.

B. Relamp luminaires that have failed lamps at Substantial Completion.

3.04 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosure.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Description: This Section includes Specifications for furnishing, installing, and testing a complete grounded lightning protection system with air terminals installed along the entire roof (ridge line) as described and as required by the system manufacturer.

B. Lighting protection system shall apply to the RO Treatment Facility Building and perimeter fencing at all sites.

1.02 REFERENCES

A. The following publications form a part of these Specifications to the extent indicated by their references. The exclusion of a publication from this Section will not relieve the Contractor from complying with the publication reference elsewhere.

Sponsor	Number	Subject
ASTM	C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
LPI	175	Installation Standard
NFPA	70	National Electrical Code (NEC)
NFPA	780	Standard for The Installation of Lightning Protection Systems
UL	96	Lightning Protection Components
UL	96A	Installation Requirements for Lightning Protection Systems
UL	651	Schedule 40 and 80 Rigid PVC Conduit

1.03 DEFINITIONS

A. Counterpoise: Conductor placed in the earth around perimeter of the facility and interconnected with the ground grid.

B. Ground Grid: Grid of conductors and rods placed in the earth to form a low resistance connection to the earth.

C. Earth Electrode System: System in which ground grids, ground rods, counterpoise, rock anchors, and piling are bonded together.

D. Lightning Protection System: Materials attached to a common ground for purpose of protecting a structure from lightning.

1.04 SUBMITTALS

A. General: Submit required information in accordance with the requirements of Section 01331 – Submittals, and Section 01332 – Shop and Working Drawings, Product Data, and Samples, except as modified herein.

B. Perform tests on the specified earth electrode system and the certified results submitted in accordance with Section 01401 – Quality Assurance and Quality Control.

C. Submit lightning protection system schedule not less than 30 days before starting work and show estimated time of each concealed installation stage and substage.

D. Submit a completed UL Master Label "C" Certificate.

1.05 QUALITY ASSURANCE

A. General: Provide quality assurance and quality control in accordance with the requirements of Section 01401 – Quality Assurance and Quality Control, except as modified herein.

B. Products: UL master labeled or labeled to indicate that the products are manufactured for use in lightning protection systems and have been tested and inspected for compliance by either a recognized independent testing agency or UL-qualified and certified agent.

C. Workmanship:

1. Lightning protection: In accordance with NFPA 70 (NEC) and UL 96A.

2. Testing: In accordance with Section 16950 – Testing.

D. Molds, metal powders, materials, and tools required to melt and fuse cables, rods, plates, and other components of grounding system into a solid, homogeneous mass shall be suitable for the specific connection.

1.06 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store, and handle products and materials in accordance with the requirements of Section 01600 – Product Requirements, except as modified herein.

1.07 PROJECT CONDITIONS

A. Schedule installation of the earth electrode system to occur when excavation, such as hole and trench digging, can be performed while other excavating and earth moving operations are in progress. If the system is installed prior to completion of other earth moving operations, take precautions to ensure that system components are not damaged. If system components are protected with temporary coverings, remove coverings before the system is buried.

B. Before covering the electrode system, the Engineer will check joints and connections for integrity, to verify complete physical bonding, and to ensure that indicated interconnections have been completed.

PART 2 PRODUCTS

2.01 GROUND RODS

A. Copper-clad steel cores 3/4 inch diameter by 10 feet long; cladding shall be not thinner than 0.10 inch. Couplers for joining ground rods to form assemblies longer

than 10 feet shall be designed for the purpose and be electrically and mechanically compatible.

2.02 GROUND GRID AND COUNTERPOISE CONDUCTORS

A. Bare soft-drawn copper, seven-strand, 4/0 AWG cable or as required by NFPA 780.

2.03 NONMETALLIC CONDUIT AND CONDUIT FITTINGS

A. Rigid, polyvinyl chloride, Schedule 40 conforming to the requirements of UL 651.

2.04 AIR TERMINALS

A. UL approved, solid copper or bronze, and not less than 1/2 inch in diameter.

2.05 HARDWARE FOR LIGHTNING PROTECTION SYSTEM

A. UL approved type and of the same material as the air terminals.

2.06 ROOF/DOWN CONDUCTORS FOR LIGHTNING PROTECTION SYSTEM

A. Copper cable meeting UL 96, Tables 8.1 and 8.2 or Table 18.1, as applicable.

2.07 ROOF CONDUCTORS FOR LIGHTNING PROTECTION SYSTEM

A. Bare stranded copper (or bare stranded aluminum) wire meeting UL 96, Table 8.1 or Table 18.1, as applicable.

2.08 LIGHTNING PROTECTION SYSTEM

A. Consists of cables, air terminals, mounting bases, fittings, couplings, connectors, fasteners, and other devices for a complete, coordinated system.

1. Cables and air terminals: UL labeled.

2. Materials, except bolts, screws, and related type hardware: Copper or high-copper content bronze and the standard product of a manufacturer regularly engaged in production of lightning protection systems. Materials shall comply in weight, size, and composition for a Class II structure to be protected in accordance with NFPA 780. Bolts, screws, and related type hardware shall be stainless steel.

3. Fittings, except cable holders: Heavy-duty type bronze castings; stamped, pressed, and crimp type pressure devices are not permitted.

4. Methods of fastening air terminals to roofing: Compatible with roof composition. Do not attach copper materials to aluminum; adhesives for attaching materials to single ply membrane roofing shall be approved for use by the specific membrane roofing manufacturer.

2.09 BOND AND WELD SEALANT

A. Vinyl-backed compound, Class 200; Bishop Electric Co.'s No. 4000 Electro-Seal, or accepted equivalent.

2.10 WELDED GROUND CONNECTIONS

A. Either Burndy Corp.'s Thermoweld, ERICO Products, Inc.'s Cadweld Process, or other exothermic welding process acceptable to the Authority.

2.11 GROUND CONNECTORS

A. Mechanical type, two-piece, consisting of copper wedge and "C" spring; suitable for required connections; AMP Special Industries AMPACT, or accepted equivalent.

2.12 ALUMINUM/COPPER CONNECTIONS

A. Compression type, cast aluminum; Kearney's 104741 Series, or accepted equivalent.

2.13 BITUMEN

A. Cold-applied type coal tar, fast drying, Koppers Co. Inc.'s Bitumastic No. 505, or accepted equivalent.

PART 3 EXECUTION

3.01 INSPECTION

A. Ensure that surfaces and structures to and on which products will be affixed, placed, and installed are capable of supporting the products.

3.02 INSTALLATION

A. Earth electrode systems:

1. Place ground rods in compacted backfill around foundations. Rods in drainage gravel beds shall project through beds and into underlying undisturbed earth for not less than 8 feet. Drive rods either by hand, sleeve hammers, or power drivers. Install driving nuts on end of rods. Attach ground rods to ground grid at nodal points. Connections to ground rods shall be exothermic welded, brazed, or mechanically connected in accordance with manufacturer's printed instructions. Buried and other inaccessible connections shall be welded type.

2. Exothermically weld each crossover point within the grid and between grid and counterpoise.

3. Ground conductors installed underground, unless otherwise protected, shall be laid slack. Install no conductors in gravel beds.

4. Install counterpoise conductors for at-grade and aerial structures at least 2 feet from outside boundaries of structure and not less than 3 feet below finished grade. Coordinate installation of conductor with foundation work.

5. Exothermically weld or braze ground grid conductors to steel piling.

6. Exothermically weld or braze ground conductors connecting to the station reinforcing steel.

7. Bond ground grids or lightning air terminals to structural steel.

8. Attach lightning down conductors and equipment grounding cables to earth electrode system, and enclose in nonmetallic conduit. Exothermically weld or braze connections to the earth electrode system.

9. Test for continuity and apply bitumen to welded and brazed connections before burying those connections.

3.03 LIGHTNING PROTECTION SYSTEM

A. Install in accordance with LPI-175 and NFPA 780.

3.04 TESTING

A. Conform to applicable requirements of Section 16950 – Testing.

B. Perform the following tests and inspections and prepare test reports:

1. After installing lightning protection system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed lightning protection system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Ground resistance: Test resistance to ground of the lightning protection system with a resistance tester. Where resistance to ground is over 5 ohms, take action to reduce it to 5 ohms by driving up to two additional ground rods for each rod shown. When resistance still exceeds 10 ohms, notify the Engineer promptly and include recommendations of the steps that can be taken to reduce the ground resistance to below 10 ohms.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16705

INTRUSION DETECTION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Alarm control panel.

B. Intrusion detection devices.

C. Accessory devices.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the Contractor of his responsibility of proper coordination of all the work:
   1. Section 16120 Wire and Cable.

1.03 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.04 SYSTEM DESCRIPTION

A. Intrusion Detection System: Protect buildings and selected areas from intrusion during secure hours.

B. System shall monitor status of detection devices and provide signal to the SCADA system when placed in alarm.

1.05 SUBMITTALS

A. Submit under provisions of Division 1.
   1. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection required.
   2. Product Data: Provide electrical characteristics and connection requirements.
   3. Test Reports: Indicate satisfactory completion of required tests and inspections.
   4. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Accurately record actual locations of initiating devices and alarm panel.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Operation Data: Operating instructions.

C. Maintenance Data: Maintenance and repair procedures.

1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other North Carolina recognized third party testing agency.

PART 2 PRODUCTS

2.01 INTRUSION DETECTION CONTROL PANEL

A. Description: System shall accept inputs from up to 4 motion sensors and output alarm conditions to a SCADA system. Alarm outputs shall be coordinated with the SCADA system for compatibility. Provisions shall be made to disarm the system through a keypad. System shall be rated for operation in an environment of 5%-85% relative humidity and 32 degrees F to 120 degrees F. Battery backup shall be provided for a minimum of 12 hours operation in the monitoring mode. System shall accept a 120 volt input. The control panel shall be Bosch B5512 or approved equal.

B. Substitutions: Under provisions of Division 1.

2.02 KEYPAD

A. The keypad shall be by the same manufacturer as the control panel.

2.03 MOTION SENSORS

A. Passive infrared, suitable for use at 0 degrees F to 130 degrees F, 180 degree field of view, range up to 75 feet. Sensor shall be compatible with the control panel.

2.04 CONDUCTORS

A. As required by the system manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. All wiring shall be installed in conduit.

C. Install keypad at entry door.

3.02 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Division 1.

B. Include services of technician to supervise installation, adjustments, final connections, system testing, and Owner training.

END OF SECTION

SECTION 16727

ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Access control panel.

B. Access control devices.

C. Accessory devices.

1.02 RELATED SECTIONS

A. Section 08710 – Door hardware.

B. Section 16123 - Building Wire and Cable.

1.03 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 72H - Guide for Test Procedures for Protective Signaling Systems.

1.04 SYSTEM DESCRIPTION

A. Access Control System: Complete system that controls access to indicated doors. System includes control panels, power supplies, card readers, wire and all accessories required for a complete system. Connect to exit devices and strike plates provided with doors by GC.

1.05 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection required.

C. Product Data: Provide electrical characteristics and connection requirements.

D. Test Reports: Indicate satisfactory completion of required tests and inspections.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

F. Protection Plan: Indicate doors with readers and device locations on floor plan for approval by Owner.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Record actual locations of all devices and path of wiring.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Operation Data: Operating instructions.

C. Maintenance Data: Maintenance and repair procedures.

1.08 QUALIFICATIONS

A. Electrical Contractor shall employ an alarm system subcontractor that is licensed in the State of North Carolina and who specializes in installation of Products specified in this section with minimum five years of experience, and with service facilities within one hour of Project so as to provide prompt service.

1.09 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish Products listed and classified by UL or other third party testing agency recognized by The State of North Carolina as suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.01 ACCESS CONTROL SYSTEM

A. Control Panel
   1. Provide S2 Security Netbox Access Control Solution with up to 32 doors of access control.
   2. Provide additional S2 Network Nodes where needed to accommodate additional access controlled doors.
   3. 120VAC input, 13.8VDC – 7Ah max – 1Ah min battery output.
   4. All doors shall have:
      a. REX (Motion or internal switch)
      b. Door Contact Switch (flush mount or internal)

B. Power Supplies
   1. Precision Hardware #ELR-150 or equal with Precision Hardware #BT-150-07 battery backup for each door.

C. Proximity Readers
   1. Provide HID multiclass mini-mullion contactless card readers – Part #: 18 S2900PTNNEK0060-S2SEC or approved equal.

D. Cards
   1. Provided by 50 Prox Cards II.

E. Hardware
   1. Provided under provisions pf Section 08710 – Door hardware.

F. Conductors
   1. 18awg 4c + 22awg 3pr o/s + 22awg 2c + 22awg 4c + yellow jacket. Shielded, stranded, plenum type, or as required by manufacturer,.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Prior to installation, final device locations and zoning shall be submitted and approved by Owner.

C. All conductors shall be concealed. And installed in ¾"C. to accessible ceiling void. Conductors installed above ceiling shall be tight to structure in bridle rings or J hooks.

D. Control panel shall be wall mounted with all circuiting routed in concealed conduit(s) to accessible ceiling void. No exposed surface raceway will be acceptable.

E. No splices in conductors shall be permitted at any point in system.

F. Coordinate installation of devices and connection to exit devices / strike plates with hardware and door providers.

3.02 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Test in accordance with NFPA 72H.

3.03 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Division 1.

B. Include services of technician to supervise installation, adjustments, final connections, system testing, and Owner training.

END OF SECTION

SECTION 16741

COMMUNICATION NETWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The Contractor shall provide the required protection in accordance with the requirements of these specifications and NEC 2002, Article 800. The protection shall be provided on both ends of all inter-building cables where required by code or otherwise indicated in the contract documents (i.e., building-to-building, building-to-modular classroom, or building-to-modular complex).

1.02 SUMMARY

A. This Section includes a Telecommunications Distribution System which is ready for the installation of active electronic equipment such as hubs, routers, bridges, switches, repeaters, adapters, etc. The system shall incorporate all requirements of this specification.

1.03 PRELIMINARY MEETING / CONTRACTOR DELIVERABLES

A. An initial planning meeting will be held with the Contractor to clarify all requirements (systems, services, distribution methods, etc.), identify responsibilities, and schedule the events that will transpire during the implementation of the project. This meeting should be held no later than thirty (30) days after NTP has been issued.

B. Within ninety (90) days of the completion of the facilities planning meeting, the Contractor shall prepare and provide two (2) copies of the following documentation for review and approval by the Architect:

C. MDF and FDE Diagrams - Include cable routing, position of all components and apparatus, detailed layout of the wall field, and a labeled cable plant drawing.

D. Work Area Floor Plans - Include detailed cable routes and labeling plan for all work areas. The Contractor may obtain floor plans from the Architect in AutoCAD format, if so desired, to aid in preparing the submittal.

E. Cross-Connect Documentation - Provide cross-connect records for all voice and data devices.

F. Backbone Distribution Plan

G. Upon completion of the project, the Contractor shall prepare "As-Built" documentation showing actual site conditions and installation as constructed, and provide copies of such documentation as per paragraph 1.3B.

H. In addition to the engineering diagrams, the following items shall be provided by the Contractor at substantial completion:

I. Laminated cable schedule, sized 8-1/2" x 11", to be hung in the appropriate rooms in an approved manner
   1. Record of field tests of System

2. The voice/data TCO identification numbers and fiber identification numbers used in recording test results shall be the same as those shown on the "As-Builts" and cable schedules.
3. Building Control Plans in the following format:
   a. Four (4) copies and one reproducible sepia of all diagrams and drawings, "D" size (24" x 36") or "E" size (30" x 42") as appropriate.
   b. Two (2) copies of all cross-connect documentation in printed form.
4. One size "E" laminated drawing of "As-builds" and one "E" size laminated drawing of riser diagrams and outlet schedules shall be attached to the wall with approved fasteners in the MDF. Color key voice cabling gray, copper data cabling blue, and fiber optic data cabling orange. Highlight, in some manner, the MDF/IDF/FDE rooms.

J. Technical Support Staff and Experience
1. The Contractor shall provide a list of its project management staff and technical support staff to be assigned to this project together with their resumes and working experience.
2. The Contractor shall utilize certified cable installers and technicians with approved vendor specific certification. The Contractor shall supply certification documentation for cable installers.
3. The Contractor shall state their nearest branch office and dealer's office in relation to the proposed site of the cabling system. If none, the location of the main office shall be stated.
4. The Contractor shall state their nearest location of their principal support center. This center shall have permanently stationed support staff that is capable of providing technical support if required.

K. System Warranty
1. The Contractor shall provide a five- (5) year warranty for both products and labor.
2. Service must be provided within twenty-four (24) hours of notification for emergency situations and within seventy-two (72) hours for routine service.

1.04 PRODUCT SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.

B. Product data for system components

1.05 QUALITY ASSURANCE

A. Comply as applicable with ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3 "Commercial Building Telecommunications Cabling Standard," February 2003.

B. Comply as applicable with ANSI/TIA/EIA-569-A, "Commercial Building Standards for Telecommunications Pathways and Spaces," February 1998.

C. Comply as applicable with ANSI/TIA/EIA-606, "The Administration Standard for Telecommunications Infrastructure of Commercial Buildings," May 2002.

D. Comply as applicable with J-STD-607, "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications," October 2002

E. Comply with NFPA 70, "National Electrical Code," 2002.

F. "Nationally Recognized Testing Laboratory" (NRTL) Listing: Provide materials that are listed and labeled.

G. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

H. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

I. FCC Regulations: Comply with FCC Part 68, Chapter 1, "US Code of Federal Regulations," Title 47 for all telephone system wire and cable connection components.

PART 2 PRODUCTS

2.01 HORIZONTAL STATION CABLE: CONTRACTOR SHALL PROVIDE ALL HORIZONTAL CABLES

A. CATEGORY CABLE (Cat 6)
   1. All cables shall conform to or exceed the TIA/EIA-568-B.2 "Commercial Building Telecommunications Cabling Standard" - Part 2: Balanced Twisted Pair Cabling Components
   2. Other standards supported include IEEE 802.3, 10BASE-T, and ANSI X3T9.5 TP-PMD requirements for UTP at 100 Ohms and 250 MHz.
   3. Cables shall be capable of supporting evolving high-end applications such as 1 Gbps. All cables shall be composed of 4-pair 24 AWG solid copper conductors.
   4. The cable shall be Underwriter's Laboratories Inc. (UL) listed type MPR, MPP, CMR, and CMP.
   5. Voice and data cables shall be distinguished by jacket color. Colors shall be gray for voice and blue for data cables.

2.02 TELECOMMUNICATIONS OUTLET (TCO)

A. Shall be modular, RJ45 type/8-position/8 conductor, Catagory CAT 6

B. Shall be universal application/multi-vendor supportive accepting most phone and data plugs.

C. Modular connectors shall be flush with outlet faceplate.

D. Cover shall match those indicated for power receptacle outlets in same spaces for materials and finish.

E. For wall telephone units, provide straight in type connection and include provision for support of unit.

F. Outlets shall be wired in a TIA/EIA-568B configuration.

G. All outlets shall utilize cross-over lead technology to address data circuit applications up to 250 MHz and conform to or exceed the TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard and the following:
   1. Electrical specifications:
      a. TIA/EIA Category (Cat6)
      b. Data Rate: Compatible with 100 Mbps Institute of Electrical and Electronics Engineers Inc, (IEEE) 802.3, 10BASE-T applications. Fully supports 1 Gbps TP-PMD at 328-ft (100m) over UTP per ANSI X3T9.5.
      c. Insulation resistance: 500-MΩ minimum

d. Dielectric withstands voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum to exposed conductive surface
e. Contact resistance: 20 mΩ maximum
f. Current rating: 1.5 A at 68° F (20°C) per IEC Publication 512-3, Test 5b.

2. UL Listed
3. CSA Certified
4. Comply with FCC Part 68
5. Mechanical Performance:
   a. Plug Insertion Life: 750 insertions
   b. Contact Force: 3.5-oz (99.2 g) minimum using FCC-approved modular plug
   c. Plug Retention Force: 30-LB (133 N) minimum between modular plug and jack
   d. Temperature Range: -40° to 150°F (-40° to 66°C)

2.03 PATCH PANEL - CATEGORY COPPER (CAT 6)

A. The panel shall support the Cat 6 applications and facilitate cross-connection and inter-connection using patch cords.

B. The wiring blocks shall be fire-retardant, molded plastic consisting of horizontal index strips for terminating conductors. These index strips shall be marked with four colors on the high teeth, separating the tip and ring of each pair, to establish pair location.

C. The panel shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10,000 connections.

D. Nineteen-inch (19") rack mountable patch panels shall be used. Patch panel installations shall contain a retaining trough between every 100 pair termination block.

E. The panel shall be able to accommodate 24 AWG cable conductors.

F. The panel shall be Underwriter's Laboratories Inc. (UL) listed.

G. Shall be wired in a TIA/EIA 568B configuration.

H. All Cat 6 patch panels shall support 100 Mbps TP-PMD and 155 Mbps ATM. All hardware shall meet or exceed the reliability, attenuation, and NEXT requirements of TIA/EIA 568-B.2.

2.04 110 COPPER TERMINATION BLOCK-TO-T568B JACK (VOICE ONLY) CATEGORY COPPER (CAT6)

A. The termination block shall support the Cat 6 applications and facilitate cross-connection and inter-connection using patch cords.

B. The wiring blocks shall be fire-retardant, molded plastic consisting of horizontal index strips for terminating twenty-five (25) or fifty (50) pairs of conductors each. These index strips shall be marked with four (4) colors on the high teeth, separating the tip and ring of each pair, to establish pair location.

C. The terminating block shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10,000 connections.

D. Shall be wired in a TIA/EIA-568-B configuration. Blocks shall have six (6) or twelve (12) jacks, as required.

E. The wiring block shall be able to accommodate 24 AWG cable conductors.

F. The block shall be Underwriter's Laboratories (UL) listed.

G. All Cat 6 blocks shall support 100 Mbps TP-PMD and 155 Mbps ATM. All hardware shall meet or exceed the reliability, attenuation, and NEXT requirements of TIA/EIA-568-B.2.

2.05 COMMUNICATIONS FLOOR-MOUNTED RACK

A. General: Racks shall be freestanding units designed for support of communications hardware and electronics. All racks shall be UL-listed.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Panduit Inc.
   2. Chatsworth Products, Inc.
   3. Homaco, Inc,
   4. Hubbell Inc., .

C. Floor-Mounted Rack (4-Post):
   1. Dimensions: 84-inches tall with a 26-inch base depth.
   2. Static weight capacity: 1000 lbs., minimum.
   3. Fabrication: Racks shall be fabricated from modular-steel, with bases pre-drilled for securing rack to the floor.
   4. Rack width shall be compatible with EIA 310-D standard, 19-inch panel mounting, utilizing 5/8-inch - 5/8-inch - 1/2-inch alternating hole pattern with #12-24 pre-tapped holes.
   5. Racks shall have U-shaped vertical channels, of EIA 310-D compliant thickness, that provide 45 rack spaces on both front and rear, and that have a universal side-drilling pattern to allow racks to be bolted together or for attachment of accessories.
   6. Finish: Racks shall receive manufacturer's standard baked-polyester powder coat (color: black) or clear mill finish.
   7. Accessories: All racks shall be provided with:
   8. #12-24 mounting screws, with not less than 24 screws per rack.
   9. Ground lug and #6 AWG, not less than 12-inches in length.

2.06 WIRE MANAGEMENT PANELS

A. Wire Management Panels – Dual sided horizontal and vertical wire management designed for proposed 4 post rack equivalent to Panduit's "Net Runner" cable manager system, or equal. Cable management units shall be installed in between all floor racks and on the outside of both end floor racks.

2.07 PRECAST HANDHOLE STRUCTURES

A. Handholes shall be equal to Quazite PG2436BA30. Handholes are 24 inches by 36 inches by 30 inches deep. Provide heavy-duty 2-bolt cover with "Communications" logo.

2.08 TERMINATION LABELS

A. Shall conform to ANSI/TIA/EIA-606. Labels will have pressure sensitive, permanent acrylic type adhesive, P-Touch type weather proof or equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contractor shall maintain conductor polarity (tip and ring) identification at the MDF, and station connecting blocks in accordance with industry practices.

B. The Contractor shall provide all cables. All communication cable installed by the Contractor shall be fully tested in accordance with TIA/EIA-568-B.2 (for UTP) and TIA/EIA 526-14-A-B.14 prior to acceptance.

C. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wiring , miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the System in a neat and orderly fashion.

D. It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the System. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment for cables, communication devices, jack stands for cable reels, or cable winches.

E. The Contractor shall be responsible for printed labels for all cables and cords, distribution frames, and outlet locations, according to the specifications. No labels are to be written by hand including numbers on boots.

F. The Contractor shall not place or attach any telecommunications cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

G. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

H. The Contractor shall be responsible for providing an approved ground at all newly installed distribution frames, and insuring proper bonding to any existing facilities. The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes and framework. All grounds and bonding shall consist of green #6 AWG solid copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground in compliance with J-STD-607 "Commercial Building Ground (Earthing) and Bonding Requirements for Telecommunications, Sections 2.1 and 5.3

I. Any data/voice cable that is not located in the same room as the IDF must have a full label on the cable at both ends.

3.02 INSTALLATION

A. Telephone Service: Comply with telephone utility organization requirements as to details of the telephone service.

B. Distribution System: Complete installation required. The system will be fully operational when instruments and electronic equipment are connected.

C. Raceway: Install service and distribution raceway for all cabling as indicated.

D. Conduit sleeves for Computer Network Infrastructure shall be installed not more than four inches (4") from wall and shall be stubbed at a maximum of four inches (4") above or below finished floor. Plastic bushings and pull wires shall be provided.

3.03 HORIZONTAL CABLE INSTALLATION

A. Obtain approval of all raceway system installation from engineer prior to installing any cable. Install cable without damaging conductors or jacket. Do not bend cable to a smaller radius than minimum recommended by manufacturer. Do not exceed manufacturers recommended pulling tensions. Pull cables simultaneously where more than one is being installed in the same raceway or at the same location. Use pulling compound or lubricant where necessary. Compound used must not damage conductor or insulation. Use pulling methods that will not damage cable or raceway, including fish tape, cable, rope and wire-cable grips.

B. Install outlet boxes with jack assemblies at outlets. Install cable in raceway in wall. Terminate raceway with a bushing in ceiling space above outlet except as otherwise indicated. Run cable concealed in accessible ceiling space except as otherwise indicated.

C. Provide bushings on all conduit stubbed to ceiling void.

D. Copper Cable above finished ceilings: Install parallel or perpendicular to surfaces or exposed structural members and follow surface contours where possible.

E. Cable Support: Secure cable to independent supports at intervals as required preventing sagging between supports. Use metallic supports with corrosion-resistant finish.

F. Splices: Do not splice cable between the normal terminations of runs.

G. No Dropped Ceiling: Route in conduit along structure.

H. Attach cable to building structure only as per NEC-800.

I. In suspended ceiling and raised floor areas where walker duct, cable trays or conduit are not available, the Contractor shall bundle horizontal Cat 6 wiring with wire ties at appropriate distances. The cable bundling shall be supported via CAT. 6 "J" hooks or CAT. 6 bridle rings with saddles attached to the existing building structure and framework. Use of Velcro straps is prohibited.

J. The 4-pair UTP cables shall be installed using a star topology format from the administration subsystem on each floor to every individual TCO.

K. The length of any horizontal Cat 6 cable shall not exceed 295-ft (90 m).

L. Conduit installed by the Contractor should not exceed one hundred feet (100') or contain more than two (2) 90-degree bends without utilizing appropriately sized pull boxes.

M. No Condulets may be used.

N. Cabling in Telecommunications Subclosets and Cabinets: Install conductors parallel to and at right angles to walls. Bundle, lace and train the conductors to terminal points with no excess. Use wire distribution spools at points where cables are fanned or conductors turned. Connect conductors that are terminated, spliced or interrupted to terminal blocks.

O. Conductor Terminations: Terminate conductors of cables on terminal block using tools recommended by terminal block manufacturer.

3.04 TELECOMMUNICATION OUTLET (TCO)

A. Unless otherwise noted on the floor plans, the TCO shall be flush mounted.

B. Outlet jacks shall be color keyed blue for data, green for cameras and gray for voice.

3.05 OUTSIDE CONDUIT

A. All buried cable shall be contained in a raceway system. When using PVC, a metallic locating tape shall be installed twelve inches (12") below grade.

B. Contractor shall obtain approval of all raceway system installation from the engineer prior to installing any cable.

C. Provide hand holes on all underground conduit runs that change direction.

3.06 GROUNDING

A. Communications Systems - In compliance with NEC 2002, Article 800, J-STD-607-A-2.1, J-STD-607-A-5.1, J-STD-607-Annex B
   1. Install a #6 AWG green insulated solid copper ground wire from the main building service entrance grounding system to the MDF Telecommunications Main Grounding Busbar (TMGB).
   2. Install a #6 AWG green insulated solid copper ground wire from the TMGB to each Telecommunications cabinet in the MDF.
   3. DO NOT GROUND OR BOND TO THE BUILDING STRUCTURE

B. Contractor shall install a copper busbar for grounding of communication systems.

3.07 IDENTIFICATION

A. Provide identification in accordance with the recommendations of ANSI/TIA/EIA-606, "Administration Standard for Telecommunications Infrastructure." Refer to labeling descriptions below.

3.08 TELECOMMUNICATIONS LABELING LEGEND

A. Copper Telecommunications Outlet (TCO) - *"X-RMNNN-BNN":*
   1. Where *"X"* equals "MDF" (Main Distribution Frame), "IDF" (Intermediate Distribution Facility), or "RB" (Rebox) indicating where the cable is terminated at the other end.
   2. Where *"NNN"* equals the room number where the MDF, IDF, or RB is located.
   3. Where *"B"* equals the outlet designation symbolized by "V" for voice, "D" for data, or "F" for fiber.
   4. Where *"NN"* equals the unique outlet/fiber number. This number shall be consecutive for each MDF, IDF, or RB and shall be numbered 01, 02, 03, etc.

B. Label all cables in each IDF with a corresponding TCO number.

C. Copper Patch Panels - Label each outlet at the MDF, IDF, or RB patch panels with a corresponding outlet number. Numbering shall be from left to right and from top to bottom with consecutive numbers. *Note: All labels shall be uniform in size using the same font size on letters and numbers (block style) through out.

D. Outlet numbers shall match exactly at both ends of all copper voice distribution feeder cables.

E. If the data cables and IDF are all contained within the same room, the data labels may read D1, D2, D3, etc. If not, they must have a full label at both ends.

3.09 FIELD QUALITY CONTROL

A. Test Notice: Provide at least 10 days' notice in writing when the system is ready for final acceptance testing.

B. Acceptance Tests: Include the following for each pair or conductor of each cable run.

C. 100 percent of the horizontal and riser wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.

D. Voice and data horizontal wiring pairs shall be tested from the TCO to the patch panel or block, the basic link test.

E. Data cables shall be tested for conformance to the specifications of TIA/EIA -568-B.2 for Cat 6 copper cable.

F. Wire Mapping shall be done to ensure proper wiring and connectivity. Test for:
   1. Continuity, end-to-end.
   2. Shorts between any two or more conductors.
   3. Crossed pairs
   4. Reversed pairs
   5. Split pairs
   6. Other mis-wirings

G. Document as Pass / Fail

H. Length shall be measured. Indicate the length of the cable as the pair with the shortest length and record it

I. Attenuation shall be tested with a remote signal injector and a reading made at the local end. Evaluate the worst pair attenuation and record result on test report.

J. Bi-Directional NEXT. Near-end crosstalk (NEXT) shall be tested on all six pair combinations in each four pair cable. Tests for NEXT shall be performed from both the work area outlet location and link origination point.

K. Fiber optic cables shall be tested in accordance with the requirements of TIA/EIA-526-14-A-B.1.4 Annex B (Bi-directional Testing). Maximum dB loss shall be 3.0. Show footage on test reports. Notify Architect of exceptions by cable ID number and give reasons for the exceptions.

L. Computer generated test results must be submitted to the Architect.

M. Re-testing: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify that the total system meets the Specifications and complies with applicable standards.

N. Report of Tests and Inspections: Prepare a written record of inspections, tests, and detailed test results in the form of a test log and format the log in cable ID number order.

3.10 ENTRANCE FACILITIES:

A. An entrance raceway (conduit) meeting the following specifications shall be provided by the Contractor for the use of the local telephone service provider.

B. General - (Conduit)
   1. Contractor shall install a quantity of two (2) 2-inch conduits from the Owners' property line, as specified by the local telephone service provider, to the main telecommunications room.
   2. Conduits to be intermediate metal, rigid metal or rigid non-metallic conduit installed in accordance with Articles 345, 346, or 347, respectively, of the National Electric Code.

3. Contractor shall bury conduit to a depth between twenty-four inches (24") and thirty-six inches (36") below final grade.
4. Contractor shall equip conduit with no more than the equivalent of two-quarter bends (a total of 180 degrees) between cable pulling points.
5. All conduit bends shall have a minimum radius of ten (10) times the inside diameter of the conduit. LBs will not be acceptable.
6. Contractor shall equip conduits with a mule tape with footage on tape.

C. Field Side - (Conduit at Right of Way)
1. Contractor shall cap conduit to prevent debris and water from entering before cable placement.
2. Contractor shall install conduits to a hand hole (30" x 48" x 36") and the hand hole in locations designated by the Owner.

D. Building side - (At Main Telecommunications Room)
1. The responsibility to seal entrance conduits to protect against water damage is left entirely with the Contractor.
2. All fire rated structures that are penetrated during conduit or cable placement must be fire-stopped by the Contractor.

E. The telephone service provider shall terminate its entrance cables inside the building in the Main Telecommunications Distribution Room. This area will be provided by the Contractor with the following requirements met:
1. Contractor shall equip area with an 8' wide x 4' high x ¾" fire retardant plywood backboard, with visible fire rating, and securely fastened to the wall.
2. Contractor shall equip backboard with a standard duplex convenience outlet.
3. Contractor shall maintain clear path to this area and a 3' maintenance area directly in front of terminal area.
4. Contractor shall equip area with direct lighting sufficient for a uniform light intensity of 30-foot candles measured at floor level.

END OF SECTION

APPENDIX A:

Reverse Osmosis Equipment Procurement Project Manual

PROJECT MANUAL

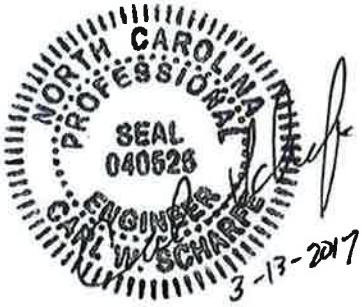
FOR

Reverse Osmosis Equipment Procurement

Brunswick Regional Water and Sewer H2GO
Leland, North Carolina

3081-AB

MARCH 2017



Carl Scharfe P.E.

THE **WOOTEN** COMPANY
120 North Boylan Avenue Raleigh NC 27603-1423
919.828.0531 fax 919.834.3589
License Number: F-0115

CERTIFICATION PAGE

A. Civil Engineering Design

I, Carl W. Scharfe, P.E., hereby certify that the Bidding Requirements, Contract Requirements, and Division 11, 13 and 15 of the Brunswick Regional H2GO Reverse Osmosis (RO) Equipment Procurement Project Manual were prepared by me or under my direct supervision.

SEAL



B. Civil Engineering Design

I, Charles W. Davis, P.E., hereby certify that the P&ID portion of the Brunswick Regional H2GO Reverse Osmosis (RO) Equipment Procurement Project Manual were prepared by me or under my direct supervision.



END OF DOCUMENT

REVERSE OSMOSIS EQUIPMENT PROCUMENT

BRUNSWICK REGIONAL WATER AND SEWER H2GO
LELAND, NORTH CAROLINA

SUBJECT: ADDENDUM NO. 1 **03/31/17**

To: PROSPECTIVE BIDDERS AND OTHER CONCERNED PARTIES

This ADDENDUM forms a part of the Contract Documents and modifies the original Bidding Documents as noted below. Bidders shall acknowledge receipt of the ADDENDUM in the space provided on the Bid Form. Failure to do so may subject the Bidder to Disqualification.

A. Bidding Requirements
   1. Section 00100 Add for Bid, Pages 1 and 2.
      a. Replace Add for Bid with the attached **Ad for Bid** as advertised.
      b. Also see attached Affidavit of Publication in Star-News showing the official Ad for Bid advertised for this project.

B. Technical Specifications
   1. Section 03510 Page 7, Part 2.02.I. Add the following at the end of the paragraph:

      "The 10-year present worth cost calculation shall be determined at a permeate flow rate of 1.75 mgd"

Bids will be received until 2:00 pm, Tuesday, April 18, 2017.

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHARFE

FOR THE OWNER
THE WOOTEN COMPANY
120 N. Boylan Avenue
Raleigh, NC 27603
919.828.0531
License No. F-0115

BY: Carl Scharfe 3/31/17
Carl Scharfe, P.E.

END OF DOCUMENT

ADVERTISEMENT FOR BIDS

Project: Reverse Osmosis Equipment Procurement

Buyer: Brunswick Regional Water and Sewer H2GO

Brunswick Regional Water and Sewer H2GO
PO Box 2230 / 516 Village Road, NE
Leland, NC 28451

Engineer: The Wooten Company
120 N. Boylan Avenue
Raleigh, NC 27603
(919) 828-0531

Separate sealed Bids will be received until 2:00 pm, Tuesday, April 18, 2017, in the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C, at which time and place bids will be publicly opened and read aloud at the time noted above for the furnishing of new Reverse Osmosis Equipment for a new Water Treatment Plant.

After Bids are opened, the Owner shall evaluate them in accordance with the methods and criteria set forth in the Instructions to Bidders. The Owner reserves the right to waive any informality or to reject any or all Bids. Unless all Bids are rejected, Award will be made to the lowest responsible Bidder, taking into consideration quality, performance and the time specified in the proposals for the performance of the Contract.

The Project consists of the following major items:

- Supply of two (2) Reverse Osmosis (RO) Feed Pumps to feed brackish groundwater at high pressure to two reverse osmosis treatment trains (skids). Pumps to be supplied as an integrated package with the RO treatment trains.
- Fabricate and supply two (2) Reverse Osmosis (RO) Treatment Trains complete to be delivered to the WTP site. Each treatment train shall consist of 33 x 15 vessel two stage array, membrane elements, pressure vessels, integral second stage energy recover device (ERD), permeate and concentrate collection piping, cleaning delivery and return piping, flow meters, automated and manual valves, instrumentation, treatment train control panel, sampling board, and other necessary appurtenances as described in the contract documents.
- Supply RO flush system components including one (1) flush tank, water level probe, flush tank fill control valve and two (2) flush water feed pumps.
- Supply RO cleaning system components including one (1) cleaning tank, one (1) waste tanks, one (1) cleaning pump (with variable speed motor), one (1) waste tank mixer, one (1) submerged heating coil for the cleaning tank and miscellaneous instrumentation.
- Supply two (2) chemical feed pumps, one (1) chemical flow meter, and one (1) floor mounted skid assembly for feed of scale inhibitor to the raw water prior to the Reverse Osmosis Treatment Trains.
- Scope of work will include fabrication, shipping, RO Treatment Train assembly at the site, installation assistance services, start-up testing, performance testing, and operator training for all equipment supplied.

A pre-bid meeting will be held on Wednesday, March 22, 2017 at 10:00 am at the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C. Pre-bid meeting attendance is not mandatory, but is highly encouraged for prospective bidders.

Bidding Documents may be examined at Engineer's and Owner's office and at:

Construction Journal (online)
McGraw Hill Dodge Company (online)
Construct Connect (online)

Complete Bidding Documents may also be obtained at the Issuing Office of the Engineer upon submitting a non-refundable fee in the amount of $100 for each set of documents which includes all contracts. With request for Bidding Documents supply the following information: Company name, contact person, street address, and phone and fax numbers for Bidding office.

Bid Security in the amount of five percent of the Bid must accompany each Bid and shall be subject to the conditions provided in the Instructions to Bidders.

No Bidder may withdraw his bid within 60 days after the actual date of the opening thereof.

END OF DOCUMENT

Star-News
STARNEWSONLINE.COM
CLASSIFIED ADVERTISING
1003 South 17th Street • Wilmington, NC 28401 • Classified ph: 910-343-2323 • Legal ads ph: 910-343-2342

Order:	W002554086	Pubs:	1,15	Rate:	L9
Phone:	(919)828-0531	Class:	0001	Charges:	$ 0.00
Account:	H9957043	Start	03/12/2017	List Price:	$ 404.82
Name:	SMITH, ADRIENNE	Stop	03/12/2017	Pay-	$ 0.00
Caller:	ADRIENNE.eMAIL.h	Inser-	2	Balance:	$ 404.82
Taken By:	17	Columns:	1	Lines:	156
Schedule:	3/12 1x, 3/12 1x, , ,			Taken On:	03/09/2017

ADVERTISEMENT FOR BIDS
Project: Reverse Osmosis Equipment Procurement
Buyer: Brunswick Regional Water and Sewer H2GO
Brunswick Regional Water and Sewer H2GO
PO Box 2230 / 516 Village Road, NE
Leland, NC 28451
Engineer: The Wooten Company
120 N. Boylan Avenue
Raleigh, NC 27603
(919) 828-0531
Separate sealed Bids will be received until 2:00 pm, Tuesday, April 18, 2017, in the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C, at which time and place bids will be publicly opened and read aloud at the time noted above for the furnishing of new Reverse Osmosis Equipment for a new Water Treatment Plant.
After Bids are opened, the Owner shall evaluate them in accordance with the methods and criteria set forth in the Instructions to Bidders. The Owner reserves the right to waive any informality or to reject any or all Bids. Unless all Bids are rejected, Award will be made to the lowest responsible Bidder, taking into consideration quality, performance and the time specified in the proposals for the performance of the Contract.
The Project consists of the following major items:
•Supply of two (2) Reverse Osmosis (RO) Feed Pumps to feed brackish groundwater at high pressure to two reverse osmosis treatment trains (skids). Pumps to be supplied as an integrated package with the RO treatment trains.
•Fabricate and supply two (2) Reverse Osmosis (RO) Treatment Trains complete to be delivered to the WTP site. Each treatment train shall consist of 33 x 15 vessel two stage array, membrane elements, pressure vessels, integral second stage energy recover device (ERD), permeate and concentrate collection piping, cleaning delivery and return piping, flow meters, automated and manual valves, instrumentation, treatment train control panel, sampling board, and other necessary appurtenances as described in the contract documents.
•Supply RO flush system components including one (1) flush tank, water level probe, flush tank fill control valve and two (2) flush water feed pumps.
•Supply RO cleaning system components including one (1) cleaning tank, one (1) waste tanks, one (1) cleaning pump (with variable speed motor), one (1) waste tank mixer, one (1) submerged heating coil for the cleaning tank and miscellaneous instrumentation.
•Supply two (2) chemical feed pumps, one (1) chemical flow meter, and one (1) floor mounted skid assembly for feed of scale inhibitor to the raw water prior to the Reverse Osmosis Treatment Trains.
•Scope of work will include fabrication, shipping, RO Treatment Train assembly at the site, installation assistance services, start-up testing, performance testing, and operator training for all equipment supplied.
A pre-bid meeting will be held on Wednesday, March 22, 2017 at 10:00 am at the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C. Pre-bid meeting attendance is not mandatory, but is highly encouraged for prospective bidders.
Bidding Documents may be examined at Engineer's and Owner's office and at:
Construction Journal (online)
McGraw Hill Dodge Company (online)
Construct Connect (online)
Complete Bidding Documents may also be obtained at the Issuing Office of the Engineer upon submitting a non-refundable fee in the amount of $100 for each set of documents which includes all contracts. With request for Bidding Documents supply the following information: Company name, contact person, street address, and phone and fax numbers for Bidding office.
Bid Security in the amount of five percent of the Bid must accompany each Bid and shall be subject to the conditions provided in the Instructions to Bidders.
No Bidder may withdraw his bid within 60 days after the actual date of the opening thereof.

Attention:_____ Fax:_____

This is a final proof. If any information is incorrect, please contact your sales representative prior to the deadline of the first insertion. Otherwise your order is accepted as having been approved.

REVERSE OSMOSIS EQUIPMENT PROCUMENT

BRUNSWICK REGIONAL WATER AND SEWER H2GO
LELAND, NORTH CAROLINA

SUBJECT: ADDENDUM NO. 2 **04/07/17**

To: PROSPECTIVE BIDDERS AND OTHER CONCERNED PARTIES

This ADDENDUM forms a part of the Contract Documents and modifies the original Bidding Documents as noted below. Bidders shall acknowledge receipt of the ADDENDUM in the space provided on the Bid Form. Failure to do so may subject the Bidder to Disqualification.

A. General
1. A pilot test report (Wooten, April 2016) for this project was conducted and is available in pdf format on the Wooten Company project share file directory (http:wootencompany.sharefile.com) and has been sent via e-mail to all plan holders.

B. Bidding
1. Bid Form, Bid Item 5.d.

Delete **"waste tank mixer"** from the item list in Bid Item 5.d. This item is already covered in Bid Item 2 Waste Tank Mixer.

C. Contracting
1. Section 00800 Supplementary Conditions
Add the following:

Article SC-11 Cancellation , Suspension, and Termination.

SC-11.01.A **Delete this paragraph in its entirety**.

SC-11.02. A **Change** right to suspend performance of the Contract from **"a maximum of ninety days,.."** to **"a maximum of thirty days,.."**

D. Technical Specifications
1. Section 11214, Page 3, Part 1.05.A3. Add Weir Floway, Inc to the Engineer approved RO Feed Pump manufacturer's per the following:

1.05.A..3 "..., , Flow Serve, Weir Floway Inc, ..."

2. Section 13510, Page 2, Part 1.03.A. In this table under the column "Maximum Permeate Quality, mg/l", **Change** the chloride value from "<100.0" to "**<150.0**" and **Change** the TDS (as sum of ions) value from "<250" to **"<300**".

3. Section 13510, Page 3, Part 1.04.B. In this table under the column "Future", **Change** the "Proposed membrane array, 1stage/2nd stage" from "33/15" to " **Note 1** ". At the bottom of the table add Note 1 as follows:

"**Note 1: ROEM can adjust array while meeting Maximum Permeate Quality, mg/l, as listed in Part 1.03.A. The ROEM shall maintain the RO Feed Pump motor size at 400 HP or below for the future condition. Membrane projections will be performed as indicated in Section 2.02.H to show compliance**".

4. Section 13510, Page 3, Part 1.04.B. In this table under the columns "Initial" and "Future", **Change** the "Design flux" from "15 gfd" to **"<15** gfd" in both columns. Also Change the "Turn down flux" from "13 gfd" to **"<13** gfd" in both columns.

5. Section 13510 Page 4, Part 1.06.A.2. Add the following part g:

   1.06.A.2.g "Biwater, Inc, San Dimas, California.

6. Section 13510 Page 6, Part 2.02.A. In the first sentence **change**

   "...400 square feet of active membrane area..." to "...**up to 440** square feet of active membrane area...."

7. Section 13510 Page 6, Part 2.02.G. At the end of the sentence, **Change** "...after 1, 2, and 3 years." to **"...after 1, 2, and 4 years."**

8. Section 13510 Page 6, Part 2.02.H. At the end of the sentence, **Change** "...after 1, 2, and 3 years." to **"...after 1, 2, and 4 years."**

9. Section 13510, Page 19, Part 2.15.C.4.f. Change to the following:

   "Pump Speed type **Variable"**

10. Section 13510, Page 20, Part 2.18.B.1.a. **Change** beginning of first sentence

    "UV System Manufacturer" to "**ROEM**"

11. Section 13510, Page 21, Part 2.18.B.1.e. **Delete** the first two sentences.

12. Section 13510, Page 22, Part 2.18.B.4.b. **Delete** the following sentence:

    "Refer to Section 17060 – Signal Coordination Requirements for further details of discrete signal type and voltage requirements"

    ROEM standard signals and voltages are acceptable.

13. Section 13510, Page 22, Part 2.18.B.4.b. **Delete** the following sentence:

    "Interposing relays shall be as specified in Section 17550."

    Relays are to meet the requirements in Section 2.18.A or 2.18.I.10

14. Section 13510, Page 22, Part 2.18.B.4.c. **Delete** and **Replace** the following sentence:

    "Lightning/surge protection shall be provided as specified in Section 17560 - Transient Voltage Surge Suppression Devices."

    "ROEM standard lightning/surge protection is acceptable. AC input surge protection shall be provided at a minimum per 2.18.E.7.e.6."

15. Section 13510, Page 22, Part 2.18.B.5.a. **Delete** the first sentence.

16. Section 13510, Page 22, Part 2.18.B.5.a End of third sentence, **Change** "...Subsection 2.04, Input/Output Subsystems." to **"...Part 2.18.B.4."**

17. Section 13510, Page 23, Part 2.18.B.5. **Add** as Part 2.18.B.5.c the following sentence **"Remote I/O to be as shown on P&IDs."**

18. Section 13510, Page 26, Part 2.18.H. **Delete** Part H in its entirety. Newport Electronics as specified in Section 13550 Part 2.06 are to be used.

19. Section 13530, Page 1, Part 1.02.A.2. **Delete** this line.

20. Section 13550, Page 5, Part 2.05.E. **Change** Rosemont Model 1054A to Rosemount Model 1056.

Bids will be received until 2:00 pm, Tuesday, April 18, 2017.

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHARFE 4/7/17

FOR THE OWNER
THE WOOTEN COMPANY
120 N. Boylan Avenue
Raleigh, NC 27603
919.828.0531
License No. F-0115

BY: _____
Carl Scharfe, P.E.

END OF DOCUMENT

TABLE OF CONTENTS

Document	Title	Pages
00005	Certification Page	1-1
00010	Table of Contents	1-1
	Bidding Requirements	
00100	Advertisement for Bids	1-2
00200	Instruction to Bidders	1-7
00410	Bid Form	1-8
00415	Equipment Manufacturer	1-2
00430	Bid Bond	1-2
00490	Addenda	
	Contract Requirements	
00510	Notice of Award	1-1
00520	Agreement	1-8
00550	Notice to Proceed	1-1
00610	Performance Bond	1-4
00615	Payment Bond	1-3
00616	Page for Attaching Power of Attorney (P & P Bonds)	1-1
00618	Page for Attaching Certificate of Insurance	1-1
00620	Contractor's Application for Payment	1-4
	NC County Sales and Use Tax Report	1-1
00634	Certificate of Owner's Attorney & Pre-Audit Statement (Exhibit GC-A)	1-1
00700	General Conditions (EJCDC, 2007)	1-30
00800	Supplementary Conditions	1-5
	Rules Implementing Settlement Conferences	1-9
00941	Change Order(s)	1-2
	Technical Specifications	
	Division 11 – Equipment	
11214	Reverse Osmosis Feed Pumps	1-8
11220	Waste Tank Mixer	1-5
11245	Scale Inhibitor Feed System	1-9
	Division 13 – Specialty Construction	
13228	Horizontal Cartridge Filter	1-4
13510	Reverse Osmosis Treatment Train Units	1-41
13530	Reverse Osmosis Treatment Train Process Control Logic	1-7
13540	Reverse Osmosis Treatment Train System Training	1-4
13550	Reverse Osmosis Field-Mounted Instruments	1-8
	Division 15 – Mechanical	
15132	Reverse Osmosis System Pressure Gauges	1-3

END OF DOCUMENT

ADVERTISEMENT FOR BIDS

Project: Reverse Osmosis Equipment Procurement

Buyer: Brunswick Regional Water and Sewer H2GO

Brunswick Regional Water and Sewer H2GO
PO Box 2230 / 516 Village Road, NE
Leland, NC 28451

Engineer: The Wooten Company
120 N. Boylan Avenue
Raleigh, NC 27603
(919) 828-0531

Separate sealed Bids will be received until 2:00 pm, Tuesday, April 18, 2017, in the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C, at which time and place bids will be publicly opened and read aloud at the time noted above for the furnishing of new Reverse Osmosis Equipment for a new Water Treatment Plant.

After Bids are opened, the Owner shall evaluate them in accordance with the methods and criteria set forth in the Instructions to Bidders. The Owner reserves the right to waive any informality or to reject any or all Bids. Unless all Bids are rejected, Award will be made to the lowest responsible Bidder, taking into consideration quality, performance and the time specified in the proposals for the performance of the Contract.

The Project consists of the following major items:

- Supply of two (2) Reverse Osmosis (RO) Feed Pumps to feed brackish groundwater at high pressure to two reverse osmosis treatment trains (skids). Pumps to be supplied as an integrated package with the RO treatment trains.
- Fabricate and supply two (2) Reverse Osmosis (RO) Treatment Trains complete to be delivered to the WTP site. Each treatment train shall consist of 33 x 15 vessel two stage array, membrane elements, pressure vessels, integral second stage energy recover device (ERD), permeate and concentrate collection piping, cleaning delivery and return piping, flow meters, automated and manual valves, instrumentation, treatment train control panel, sampling board, and other necessary appurtenances as described in the contract documents.
- Supply RO flush system components including one (1) flush tank, water level probe, flush tank fill control valve and two (2) flush water feed pumps.
- Supply RO cleaning system components including one (1) cleaning tank, one (1) waste tanks, one (1) cleaning pump (with variable speed motor), one (1) waste tank mixer, one (1) submerged heating coil for the cleaning tank and local on/off and cleaning pump speed control panel.
- Supply two (2) chemical feed pumps, one (1) chemical flow meter, and one (1) floor mounted skid assembly for feed of scale inhibitor to the raw water prior to the Reverse Osmosis Treatment Trains.
- Scope of work will include fabrication, shipping, RO Treatment Train assembly at the site, installation assistance services, start-up testing, performance testing, and operator training for all equipment supplied.

A pre-bid meeting will be held on Wednesday, March 22, 2017 at 10:00 am at the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C. Pre-bid meeting attendance is mandatory in order to bid the project.

Bidding Documents may be examined at Engineer's and Owner's office and at:

Construction Journal (online)
McGraw Hill Dodge Company (online)
Construct Connect (online)

Complete Bidding Documents may also be obtained at the Issuing Office of the Engineer upon submitting a non-refundable fee in the amount of $100 for each set of documents which includes all contracts. With request for Bidding Documents supply the following information: Company name, contact person, street address, and phone and fax numbers for Bidding office.

Bidders that are not pre-approved will be required to show evidence that they have fabricated and supplied at least five (5) reverse osmosis units treating similar feed water with a minimum train size of 1 million gallons per day (mgd). Bidder will also have at least ten (10) years of experience in the fabrication and supply of the type, design, function and quality as required by the Instructions to Bidders. Buyer will have sole discretion in determining if a Bidder meets the necessary requirements.

Bid Security in the amount of five percent of the Bid must accompany each Bid and shall be subject to the conditions provided in the Instructions to Bidders.

No Bidder may withdraw his bid within 60 days after the actual date of the opening thereof.

END OF DOCUMENT

INSTRUCTIONS TO BIDDERS

Table of Contents

Article 1 - DEFINED TERMS 1
Article 2 - BIDS RECEIVED 1
Article 3 - COPIES OF BIDDING DOCUMENTS 1
Article 4 - QUALIFICATIONS OF BIDDERS 1
Article 5 - EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND POINT OF DESTINATION 2
Article 6 - PRE-BID CONFERENCE 3
Article 7 - INTERPRETATIONS AND ADDENDA 3
Article 8 - BID SECURITY 3
Article 9 - CONTRACT TIMES 4
Article 10 - LIQUIDATED DAMAGES 4
Article 11 - "OR-EQUAL" ITEMS 4
Article 12 - PREPARATION OF BID 4
Article 13 - BASIS OF BID; COMPARISON OF BIDS 5
Article 14 - SUBMITTAL OF BID 5
Article 15 - MODIFICATION OR WITHDRAWAL OF BID 6
Article 16 - OPENING OF BIDS 6
Article 17 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE 6
Article 18 - EVALUATION OF BIDS AND AWARD OF CONTRACT 6
Article 19 - CONTRACT SECURITY AND INSURANCE 7
Article 20 - SIGNING OF AGREEMENT 7
Article 21 - SALES AND USE TAXES 7
Article 22 - RETAINAGE 7
Article 23 - CONTRACT TO BE ASSIGNED 7

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers, American Council of Engineering Companies, and Associated General Contractors of America. **All rights reserved.**

INSTRUCTIONS TO BIDDERS

ARTICLE 1 - DEFINED TERMS

1.01 Terms used in these Instructions to Bidders will have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below.

A. *Issuing Office* – The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered. The Issuing Office is The Wooten Company, 120 North Boylan Avenue, Raleigh, NC 27603.

ARTICLE 2 - BIDS RECEIVED

2.01 Refer to advertisement for information on receipt of Bids.

ARTICLE 3 - COPIES OF BIDDING DOCUMENTS

3.01 Complete sets of the Bidding Documents in the number and for the deposit sum, if any, stated in the advertisement or invitation to bid may be obtained from the Issuing Office. The deposit will be refunded to each document holder of record who returns a complete set of Bidding Documents in good condition within 30 days after opening of Bids.

3.02 Complete sets of the Bidding Documents shall be used in preparing Bids; neither Buyer nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

3.03 Buyer and Engineer have made copies of Bidding Documents available on the above terms only for the purpose of obtaining Bids for furnishing Goods and Special Services and do not authorize or confer a license for any other use.

ARTICLE 4 - QUALIFICATIONS OF BIDDERS

4.01 To demonstrate Bidder's qualifications to furnish Goods and Special Services, within five days of Buyer's request Bidder shall submit written evidence, such as financial data and previous experience, if requested by Buyer.

EJCDC P-200, Suggested Instructions to Bidders for Procurement Contracts.
Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers,
American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

4.02 Bidder is advised to carefully review those portions of the Bid Form requiring Bidder's representations and certifications.

ARTICLE 5 - EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND POINT OF DESTINATION

5.01 Upon request Buyer will provide Bidder access to the Point of Destination and the site where Goods are to be installed or Special Services are to be provided so that Bidder may conduct such investigations, examinations, tests, and studies as Bidder deems necessary for submission of a Bid.

5.02 It is the responsibility of each Bidder before submitting a Bid to:

A. examine and carefully study the Bidding Documents, including any Addenda, and the related data identified in the Bidding Documents;

B. visit the Point of Destination and the site where the Goods are to be installed and Special Services are to be provided to become familiar with the local conditions if required by the Bidding Documents to do so, or if, in Bidder's judgment, any local condition may affect cost, progress, or the furnishing of Goods and Special Services;

C. become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, or the furnishing of the Goods and Special Services;

D. carefully study, consider, and correlate the information known to Bidder; information commonly known to sellers of similar goods doing business in the locality of the Point of Destination and the site where the Goods will be installed or where Special Services will be provided; information and observations obtained from Bidder's visits, if any, to the Point of Destination and the site where the Goods are to be installed or Special Services are to be provided; and any reports and drawings identified in the Bidding Documents regarding the Point of Destination and the site where the Goods will be installed or where Special Services will be provided, with respect to the effect of such information, observations, and documents on the cost, progress, and performance of Seller's obligations under the Contract Documents;

E. promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution (if any) thereof by Engineer is acceptable to Bidder; and

F. determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing Goods and Special Services.

5.03 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 5, that without exception the Bid is premised upon furnishing Goods and Special Services required by the Bidding Documents, that Bidder has given Engineer written notice of all conflicts, errors, ambiguities and discrepancies that Bidder has discovered in the Bidding Documents and the written resolutions (if any) thereof by Engineer are acceptable to Bidder, and that the

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers,
American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing Goods and Special Services.

ARTICLE 6 - PRE-BID CONFERENCE

6.01 A pre-bid conference will be held at 10:00 a.m. on March 22, 2017 at the offices of Brunswick Regional Water and Sewer H2GO at 516 Village Road NE, Leland, N.C. Representatives of Buyer and Engineer will be present to discuss the Goods and Special Services to be furnished. Bidders are highly encouraged to attend and participate in the conference. Engineer will transmit to all prospective Bidders of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by Engineer as having received the Bidding Documents. Questions received less than ten days prior to the date for opening of Bids will not be answered. Only answers in the Addenda will be binding. Oral statements, interpretations, and clarifications may not be relied upon and will not be binding or legally effective.

7.02 Addenda may be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Buyer or Engineer.

ARTICLE 8 - BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Buyer in an amount of five (5) percent of Bidder's maximum Bid price and in the form of a certified check, bank money order, or a Bid Bond (on form attached) issued by a surety meeting the requirements of Paragraph 4.01.B of the General Conditions.

8.02 The Bid security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within 15 days after the Notice of Award, Buyer may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited. The Bid security of other Bidders that Buyer believes to have a reasonable chance of receiving the award may be retained by Buyer until the earlier of 7 days after the Effective Date of the Agreement or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be returned.

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers,
American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

8.03 Bid security of other Bidders that Buyer believes do not have a reasonable chance of receiving the award will be returned within seven days after the Bid opening.

ARTICLE 9 - CONTRACT TIMES

9.01 See applicable provisions in the Agreement.

ARTICLE 10 - LIQUIDATED DAMAGES

10.01 Any provisions for liquidated damages, such as those for *Seller's* failure to attain a Milestone, or to deliver the Goods *or furnish Special Services within the Contract Times*, are set forth in the Agreement.

ARTICLE 11 - "OR-EQUAL" ITEMS

11.01 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, including the Addenda. Bidders may propose "or equal" materials and equipment, which if approved by Engineer will be identified by Addendum. The materials and equipment described in the Bidding Documents establish a standard of required type, function, and quality to be met by any proposed "or-equal" item. No item of material or equipment will be considered by Engineer as an "or-equal" unless written request for approval has been submitted by Bidder and has been received by Engineer at least 15 days prior to the date for receipt of Bids. Each such request shall conform to the requirements of Paragraph 5.04 of the General Conditions. The burden of proof of the merit of the proposed item is upon Bidder. Engineer's decision of approval or disapproval of a proposed item will be final. Bidders shall not rely upon approvals unless set forth in an Addendum.

ARTICLE 12 - PREPARATION OF BID

12.01 The Bid Form is included with the Bidding Documents. Additional copies of Bidding Documents may be obtained from the Issuing Office.

12.02 All blanks on the Bid Form shall be completed in ink and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each item listed therein. In the case of optional alternates the words "No Bid," "No Change," or "Not Applicable" may be entered.

12.03 A Bid by a corporation shall be executed in the corporate name by the president or a vice-president or other corporate officer accompanied by evidence of authority to sign. The corporate seal shall be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be shown.

12.04 A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be shown.

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers, American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

12.05 A Bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown.

12.06 A Bid by an individual shall show the Bidder's name and official address.

12.07 A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown.

12.08 All names must be typed or printed in ink below the signature.

12.09 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid Form.

12.10 Each Bidder shall list the postal address, e-mail address, and telephone number for communications regarding the Bid.

ARTICLE 13 - BASIS OF BID; COMPARISON OF BIDS

13.01 Lump Sum

A. Bidder shall submit a Bid on a lump sum basis as set forth in the Bid Form.

B. For determination of the apparent low Bidder, Bids will be compared on the basis of the Total Lump Sum Bid.

ARTICLE 14 - SUBMITTAL OF BID

14.01 With each copy of the Bidding Documents, a Bidder is furnished one separate unbound copy of the Bid Form, and, if required, the Bid Bond. The unbound copy of the Bid Form is to be completed and submitted with the Bid security. Also submit the following documents:

List of Proposed Major Suppliers (00430 Equipment Manufacturer's List)

14.02 A Bid shall be submitted no later than the date and time prescribed and at the place indicated in the advertisement or invitation to bid, and shall be enclosed in a plainly marked envelope with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted) and the name and address of Bidder, and shall be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED". A mailed Bid shall be addressed to **Mr. Bob Walker, Executive Director, Brunswick Regional Water and Sewer H2GO, P.O. Box 2230 / 516 Village Road, NE, Leland, NC 28451.**

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers,
American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

ARTICLE 15 - MODIFICATION OR WITHDRAWAL OF BID

15.01 A Bid may be modified or withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids.

15.02 If, within 24 hours after Bids are opened, any Bidder files a duly signed written notice with Buyer and promptly thereafter demonstrates to the reasonable satisfaction of Buyer that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Goods and Special Services are rebid, that Bidder will be disqualified from further bidding on the Goods and Special Services.

ARTICLE 16 - OPENING OF BIDS

16.01 Bids will be opened at the time and place indicated in the advertisement or invitation to bid and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the Base Bids and Alternate Bids, if any, will be made available to Bidders after the opening of Bids.

ARTICLE 17 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE

17.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Buyer may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 18 - EVALUATION OF BIDS AND AWARD OF CONTRACT

18.01 Buyer reserves the right to reject any and all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Buyer further reserves the right to reject the Bid of any Bidder that Buyer finds, after reasonable inquiry and evaluation, to be nonresponsible. Buyer may also reject the Bid of any Bidder if Buyer believes that it would not be in the best interest of the Project to make an award to that Bidder. Buyer also reserves the right to waive all informalities not involving price, time, or changes in the Goods and Special Services, and to negotiate contract terms with the Successful Bidder.

18.02 More than one Bid for the same Goods and Special Services from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Goods and Special Services shall be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

18.03 In evaluating Bids, Buyer will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data as may be requested in the Bid Form or may be requested from Bidders prior to a Notice of Award.

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers,
American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

18.04 Buyer may conduct such investigations as Buyer deems necessary to establish the responsibility, qualifications, and financial ability of Bidder.

18.05 If the Contract is to be awarded, Buyer will award the Contract to the Bidder whose Bid is in the best interest of the Project.

ARTICLE 19 - CONTRACT SECURITY AND INSURANCE

19.01 Article 4 of the General Conditions and Article 4 of the Supplementary Conditions set forth Buyer's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the executed Agreement to Buyer, it must be accompanied by such bonds.

ARTICLE 20 - SIGNING OF AGREEMENT

20.01 When Buyer issues a Notice of Award to the Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents that are to be identified in the Agreement and attached thereto. Within 15 days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Buyer. Within 10 days thereafter, Buyer shall deliver one fully signed counterpart to Successful Bidder with a complete set of Drawings with appropriate identification.

ARTICLE 21 - SALES AND USE TAXES

21.01 Buyer is NOT exempt from North Carolina state sales and use taxes on materials and equipment to be incorporated in the Project. Said taxes shall be included in the Bid. Refer to Paragraph 5.05 of the Supplementary Conditions for additional information.

ARTICLE 22 - RETAINAGE

22.01 Provisions concerning Seller's rights to deposit securities in lieu of retainage are set forth in the Agreement.

ARTICLE 23 - CONTRACT TO BE ASSIGNED

23.01 Bidder's attention is directed to the provisions of Paragraph 11.02 of the Agreement which provide for the assignment of the Contract to a installation contractor designated by the Buyer to construct the Reverse Osmosis Water Treatment Plant. Bidder should consider the application of the terms and conditions of the Contract Documents after assignment, and is advised of the duty to continue to perform the Contract after it has been assigned to the installation contractor. Timing of the assignment is set forth in the Agreement. Forms documenting the assignment of the Contract and for the agreement of the Seller's surety to such assignment are included as attachments to the Agreement.

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers, American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

BID FORM

TABLE OF CONTENTS

Article 1 - BID RECIPIENT 2

Article 2 - BIDDER'S ACKNOWLEDGMENTS 2

Article 3 - BIDDER'S REPRESENTATIONS 2

Article 4 - BIDDER'S CERTIFICATIONS 3

Article 5 - BASIS OF BID 4

Article 6 - TIME OF COMPLETION 5

Article 7 - ATTACHMENTS TO THIS BID 5

Article 8 - DEFINED TERMS 5

Article 9 - BID SUBMITTAL 6

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

BID FORM

ARTICLE 1 - BID RECIPIENT

1.01 This Bid is submitted to:

Brunswick Regional Water and Sewer H2GO
P.O. Box 2230 / 516 Village Road, NE
Leland, NC 28451

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into a Contract with Buyer in the form included in the Bidding Documents to furnish the Goods and Special Services as specified or indicated in the Bidding Documents, for the prices and within the times indicated in this Bid, and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 - BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Buyer.

ARTICLE 3 - BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, the related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date

B. Bidder has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided and become familiar with and is satisfied as to the observable local conditions that may affect cost, progress, or the furnishing of Goods and Special Services, if required to do so by the Bidding Documents, or if, in Bidder's judgment, any local condition may affect cost, progress, or the furnishing of Goods and Special Services.

C. Bidder is familiar with and is satisfied as to all Laws and Regulations in effect as of the date of the Bid that may affect cost, progress, and the furnishing of Goods and Special Services.

D. Bidder has carefully studied, considered, and correlated the information known to Bidder; information commonly known to sellers of similar goods doing business in the locality of the Point of Destination and the site where the Goods will be installed or

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

where Special Services will be provided; information and observations obtained from Bidder's visits, if any, to the Point of Destination and the site where the Goods will be installed or Special Services will be provided; and any reports and drawings identified in the Bidding Documents regarding the Point of Destination and the site where the Goods will be installed or where Special Services will be provided, with respect to the effect of such information, observations, and documents on the cost, progress, and performance of Seller's obligations under the Bidding Documents.

E. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution (if any) thereof by Engineer is acceptable to Bidder.

F. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing the Goods and Special Services for which this Bid is submitted.

ARTICLE 4 - BIDDER'S CERTIFICATIONS

4.01 Bidder certifies that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Buyer, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

ARTICLE 5 - BASIS OF BID

5.01 Bidder will furnish the Goods and Special Services in accordance with the Contract Documents for the following lump sum price(s):

Bid Item	Description	Lump Sum Amount in Figures
1	SUBMITTALS Including process information submittal, schedules, shop drawings, P & IDS, etc, excepting O&M Manuals.	$
2	WASTE TANK MIXER Including waste tank mixer and all accessories as indicated in Specification Section 11220.	$
3	SCALE INBITOR FEED SYSTEM Including chemical metering pump, pump skid and all accessories as indicated in Specification Section 11245.	$
4	HORIZONTAL CARTRIDGE FILTER Including horizontal cartridge filter and all accessories as indicated in Specification Section 13328.	$
5	RO TRAIN AND FLUSH AND CLEANING EQUIPMENT a. RO Feed Pumps Including two RO Feed Pumps, all accessories and testing per Specification Section 11214. b. RO Treatment Trains Including energy recovery devices, 48 pressure vessels per train, support structures, train process piping and valving, flow meters, pressure gauges, train control valves/actuators, process control system including hardware, software, train instrument panel, train PLC enclosure sampling board, and field mounted instruments as described in Specification Sections 13510 and referenced specifications. c. RO Membrane Elements Including 336 membranes per train and all other requirements as specified in Specification Section 13510, Part 2.02.	$_____ $_____ $_____

EJCDC P-400, Suggested Bid Form for Procurement Contracts.
Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

	d. Flush and Clean System Equipment Including flush, clean and waste tanks, tank heater, flush pumps, cleaning pump, waste tank mixer, valves, and piping per Specification Section 13510, Part 2.14 and Part 2.15. e. Other required equipment, not included above.	$_____ $_____
6	INSTALLATION AND ADVISEMENT SERVICES Including final layout design and Installation Contractor advisement and site supervision and start-up testing (Section 13510, Part 3.01, 3.02, 3.03, and 3.04)	$_____
7	TESTING AND TRAINING RO Train Performance testing (Section 13510, Part 3.05, 3.06) O&M Manuals and Training (Section 13510, Part 1.05.E and Section 13540)	$_____ $_____

TOTAL CONTRACT LUMP SUM PRICE $_____
(Items 1 through 7)

_____

_____

(Written)

ARTICLE 6 - TIME OF COMPLETION

6.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedule set forth in Article 5 of the Agreement.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 - ATTACHMENTS TO THIS BID

7.01 The following documents are attached to and made a condition of this Bid:

A. Required Bid security in the form of five (5) percent of the bid amount.

B. List of Proposed Major Suppliers (00415 Equipment Manufacturer's List)

ARTICLE 8 - DEFINED TERMS

8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

ARTICLE 9 - BID SUBMITTAL

9.01 This Bid submitted by:

If Bidder is:

An Individual

Name (typed or printed): _____

By: _____
(Individual's signature)

Doing business as: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

A Partnership

Partnership Name: _____

(SEAL)

By: _____
(Signature of general partner - attach evidence of authority to sign)

Name (typed or printed): _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

A Corporation

Corporation Name: _____

State of Incorporation: _____

Type (General Business, Professional, Service, other): _____

By: _____
(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(CORPORATE SEAL)

Attest _____
(Signature of Corporate Secretary)

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

A Limited Liability Company (LLC)

LLC Name: _____

State in which organized: _____

By: _____

(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

A Joint Venture

First Joint Venturer Name: _____ (SEAL)

By: _____

(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

Second Joint Venturer Name: _____ (SEAL)

By: _____

(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

Phone and Facsimile Number, and Address for receipt of official communications to Joint Venture:_____

_____

(Each joint venturer must sign. The manner of signing for each individual, partnership, corporation, and limited liability company that is a party to the joint venture should be in the manner indicated above.)

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

SECTION 00415

EQUIPMENT MANUFACTURERS LIST

PART 1 GENERAL

1.01 SCOPE

A. Bidder shall be required to attach the Equipment Manufacturers List with the Bid Form to indicate the selected manufacturers for the requested major pieces of equipment.

1.02 REQUIREMENTS

A. The requirements as they apply to the submitted list are as follows:

1. Each Bidder shall enter in the space provided the names of the manufacturers of equipment which Bidder proposes to furnish. Not more than one manufacturer's name shall be listed for each item of equipment.
2. Failure to completely and accurately fill out the list shall disqualify the Bid as non-responsive.
3. Named manufacturers listed in the specific Specification Sections are acceptable provided the supplied equipment meets or exceeds the requirements of the Project Specifications.
4. "Or Equal" manufacturers may be listed in the blank provided for each item of equipment. The Bidder shall be required to follow the provisions for the approval of "Or Equal" pieces of equipment as outlined in the instructions to Bidders, Article 11.
5. Upon award of a contract, the named equipment shall be furnished. Substitutions will be permitted only if the named equipment does not meet the requirements of the Contract Documents, the manufacturer is unable to meet the delivery requirements of the construction schedule, or the manufacturer is dilatory in complying with the requirements of the Contract Documents. Substitutions shall be subject to concurrence of the Owner and shall be confirmed by Change Order.
6. Preliminary acceptance of equipment listed by manufacturer's name shall not in any way constitute a waiver of the specifications covering such equipment and final acceptance will be based on full conformity with the Contract Documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

BRUNSWICK REGIONAL WATER AND SEWER H2GO
REVERSE OSMOSIS EQUIPMENT PROCUREMENT

EQUIPMENT MANUFACTURERS LIST

A.	Section 11214 Reverse Osmosis (RO) Feed Pumps	_____
B.	Section 11245 Scale Inhibitor Metering Pump/Skid System	_____
B.	Section 13228 Horizontal Cartridge Filter	_____
C.	Section 13510 RO Membrane Element Manufacturer	_____
D.	Section 13510 RO Pressure Vessels Manufacturer	_____
E.	Section 13510 Energy Recovery Device Manufacturer	_____
G.	Section 13510 Butterfly Valves (>150 psi service) Manufacturer	_____
I.	Section 13510 V-ball Control Valve Manufacturer	_____
K.	Section 13510 Flow Meter Manufacturer	_____
L.	Section 13510 Flush Pumps Manufacturer	_____
M.	Section 13510 Cleaning Pump Manufacturer	_____
N.	Section 13510 Flush Tank Manufacturer	_____
O.	Section 13510 Clean and Waste Tank Manufacturer	_____

Respectfully submitted:

(Type or Print Name)

_____

(Signature)

_____

(Title)

License Number: _____

Date: _____

(SEAL - if bid is by a Corporation)

BID BOND

Any singular reference to Bidder, Surety, Owner or other party shall be considered plural where applicable.

BIDDER *(Name and Address)*:

SURETY *(Name and Address of Principal Place of Business)*:

OWNER *(Name and Address)*:
Brunswick Regional Water and Sewer H2GO
PO Box 2230 / 516 Village Road, NE
Leland, NC 28451

BID
Bid Due Date: April 18, 2017
Description *(Project Name and Include Location)*:
Reverse Osmosis Equipment Procurement for Water Treatment Plant (WTP), Belville, NC

BOND
Bond Number:
Date *(Not earlier than Bid due date)*:
Penal sum _____ $ _____
(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER	**SURETY**
_____ (Seal)	_____ (Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
_____	_____
Title	Title

Note: Above addresses are to be used for giving required notice.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1 Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2 All Bids are rejected by Owner, or

3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

Notice of Award

Project::	Date:
Owner: **Brunswick Regional Water and Sewer H2GO**	Owner's Contract No.: N/A
Contract: N/A	Engineer's Project No.:

Bidder:

Bidder's Address: (send Certified Mail, Return Receipt Requested)

You are notified that your Bid dated **DATE** for the above Contract has been considered. You are the Successful Bidder and are awarded a Contract for the following:

Procurement

The Contract Price of your Contract is _____ Dollars & **($_____).**

Four (4) copies of the proposed Contract Documents (except Drawings) accompany this Notice of Award.

Three (3) sets of the Procurement Documents will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within 10 days of the date you receive this Notice of Award.

1. Deliver to the Owner four (4) fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract Bonds as specified in the Instructions to Bidders, General Conditions Paragraph 5.01, and Supplementary Conditions Paragraph SC-5.01.

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award and declare your Bid security forfeited.

Within 10 days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

_____
Owner

By: _____
Authorized Signature

_____
Title

Copy to Engineer

Acceptance of Notice

Receipt of the above Notice of Award is hereby acknowledged by _____

this the _____ day of _____, 20___.

By:_____

Title:_____

EJCDC No. C-510 (2007 Edition) Prepared by the Engineers' Joint Contract Documents Committee and endorsed by the Associated General Contractors of America and the Construction Specifications Institute.

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

AGREEMENT BETWEEN BUYER AND SELLER FOR PROCUREMENT CONTRACTS

Prepared by

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

ACEC
American Council of Engineering Companies

AGC of America
The Associated General Contractors of America
Quality People. Quality Projects.

ASCE American Society of Civil Engineers

National Society of Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

AMERICAN SOCIETY OF CIVIL ENGINEERS

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A Practice Division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

This Agreement Between Buyer and Seller for Procurement Contracts has been prepared for use with the Standard General Conditions for Procurement Contracts (EJCDC P-700, 2010 Edition). Their provisions are interrelated, and a change in one may necessitate a change in the others. The suggested wording contained in the Suggested Instructions to Bidders for Procurement Contracts (EJCDC P-200, 2010 Edition), the Suggested Bid Form for Procurement Contracts (EJCDC P-400, 2010 Edition), and the Guide to the Preparation of Supplementary Conditions for Procurement Contracts (EJCDC P-800, 2010 Edition) is also carefully interrelated with the wording of this Agreement.

Copyright © 2010:

National Society of Professional Engineers
1420 King Street, Alexandria, VA 22314-2794
(703) 684-2882
www.nspe.org

American Council of Engineering Companies
1015 15th Street, N.W., Washington, DC 20005
(202) 347-7474
www.acec.org

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400
(800) 548-2723
www.asce.org

Associated General Contractors of America
2300 Wilson Boulevard, Suite 400, Arlington, VA 22201-3308
(703) 548-3118
www.agc.org

The copyright for EJCDC P-520 is owned jointly by the four EJCDC sponsoring organizations listed above. The National Society of Professional Engineers (NSPE) is the Copyright Administrator for the EJCDC documents; please direct all inquiries and requests regarding EJCDC copyrights to NSPE.

NOTE: EJCDC publications may be purchased at www.ejcdc.org, or from any of the four sponsoring organizations above.

This document contains a suggested format and suggested terms and conditions that will be applicable in most situations. Additional information concerning the use of *this and other* EJCDC Procurement Documents may be found in the Commentary on the EJCDC Procurement Documents (EJCDC P-001, 2010 Edition).

For brevity in the text, the Standard General Conditions for Procurement Contracts (EJCDC P-700, 2010 Edition) will be referred to as "General Conditions."

For brevity in the "Notes to Users" referenced paragraphs of the Suggested Instruction to Bidders (EJCDC P-200, 2010 Edition) are referred to with the prefix "I", those of the Bid Form (EJCDC P-400, 2010 Edition) with the prefix "BF", and those of the General Conditions (P-700, 2010 Edition) or Supplementary Conditions (EJCDC P-800, 2010 Edition) with the prefix "GC" or "SC".

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

TABLE OF CONTENTS

Article 1 – GOODS AND SPECIAL SERVICES 1

Article 2 – THE PROJECT 1

Article 3 – ENGINEER 1

Article 4 – POINT OF DESTINATION 1

Article 5 – CONTRACT TIMES 1

Article 6 – CONTRACT PRICE 2

Article 7 – PAYMENT PROCEDURES 2

Article 8 – INTEREST 3

Article 9 – SELLER'S REPRESENTATIONS 3

Article 10 – CONTRACT DOCUMENTS 4

Article 11 – MISCELLANEOUS 5

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

AGREEMENT

THIS AGREEMENT is by and between Brunswick Regional Water and Sewer H2GO ("Buyer") and _____ ("Seller").

Buyer and Seller hereby agree as follows:

ARTICLE 1 – GOODS AND SPECIAL SERVICES

1.01 Seller shall furnish the Goods and Special Services as specified or indicated in the Contract Documents.

ARTICLE 2 – THE PROJECT

2.01 The Project, of which the Goods and Special Services may be the whole or only a part, is identified as follows:

Reverse Osmosis Equipment Procurement

ARTICLE 3 – ENGINEER

3.01 The Contract Documents for the Goods and Special Services have been prepared by **The Wooten Company** ("Engineer"), which is to act as Buyer's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with Seller's furnishing of Goods and Special Services.

ARTICLE 4 – POINT OF DESTINATION

4.01 The Point of Destination is designated as: 148 Gregory Road in Bellville NC

ARTICLE 5 – CONTRACT TIMES

5.01 *Time of the Essence*

A. All time limits for Milestones, if any, including the submittal of Shop Drawings and Samples, the delivery of Goods, and the furnishing of Special Services as stated in the Contract Documents, are of the essence of the Contract.

5.02 *Milestones*

A. Days for Submittal of Shop Drawings and Samples: Seller shall submit all Shop Drawings and Samples required by the Contract Documents to Buyer for Engineer's review and approval within **45** days after the date when the Contract Times commence to run as provided in Paragraph 2.04 of the General Conditions. It is the intent of the parties that (1) Engineer conduct such review and issue its approval, or a denial accompanied by substantive comments regarding information needed to gain approval, within 21 days of Seller's submittal of such Shop Drawings and Samples; and (2) resubmittals be limited whenever possible. If more than one resubmittal is necessary for reasons not the fault

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

and beyond the control of Seller, then Seller shall be entitled to seek appropriate relief under Paragraph 7.02.B of the General Conditions.

B. *Days to Achieve Delivery of Goods:* The Goods are to be delivered to the Point of Destination and ready for Installation Contractor's receipt of delivery **255** days after the date when the Contract Times commence to run as provided in Paragraph 2.04 of the General Conditions.

A. *Days for Furnishing Special Services:* The furnishing of Special Services to Buyer by Seller will commence within **14** days after the Installation Contractor's notification that the Goods delivered are ready to be installed, started, tested, and operated (for 1 month) shall be completed within **120** days thereafter.

5.03 *Buyer's Final Inspection*

A. Final Inspection: Buyer shall make its final inspection of the Goods pursuant to Paragraph 8.01.C of the General Conditions within **14** days after Buyer's receipt of notification from the Installation Contractor confirming Seller's completion of furnishing Special Services.

5.04 *Liquidated Damages*

A. Buyer and Seller recognize that Buyer will suffer financial loss if the Goods are not delivered at the Point of Destination and ready for receipt of delivery by Buyer within the times specified in Paragraph 5.02 above, plus any extensions thereof allowed in accordance with Article 7 of the General Conditions. The parties also recognize that the timely performance of services by others involved in the Project is materially dependent upon Seller's specific compliance with the requirements of Paragraph 5.02. Further, they recognize the delays, expense, and difficulties involved in proving the actual loss suffered by Buyer if complete acceptable Goods are not delivered on time. Accordingly, instead of requiring such proof, Buyer and Seller agree that as liquidated damages for delay (but not as a penalty) Seller shall pay Buyer $ 1,000 for each day that expires after the time specified in Paragraph 5.02.B for delivery of acceptable Goods.

ARTICLE 6 – CONTRACT PRICE

6.01 Buyer shall pay Seller for furnishing the Goods and Special Services in accordance with the Contract Documents as follows:

A. A Total Lump Sum Price of $_____.

ARTICLE 7 – PAYMENT PROCEDURES

7.01 *Submittal and Processing of Payment*

A. Seller shall submit Applications for Payment in accordance with Article 10 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

7.02 *Progress Payments; Retainage*

A. Buyer shall make progress payments on account of the Contract Price on the basis of Seller's Applications for Payment as follows:

1. Upon receipt of the first Application for Payment submitted in accordance with Paragraph 10.01.A.1 of the General Conditions and accompanied by Engineer's recommendation of payment in accordance with Paragraph 10.02.A of the General Conditions, an amount equal to 15 percent of the Contract Price, less such amounts as Engineer may determine in accordance with Paragraph 10.02.A.3 of the General Conditions.

2. Upon receipt of the second such Application for Payment accompanied by Engineer's recommendation of payment in accordance with Paragraph 10.01.A.2 of the General Conditions, an amount sufficient to increase total payments to Seller to 85 percent of the Contract Price, less such amounts as Engineer may determine in accordance with Paragraph 10.02.A.3 of the General Conditions.

B. Upon receipt of the final Application for Payment accompanied by Engineer's recommendation of payment, Buyer shall pay Seller the amount recommended by Engineer, less any sum Buyer is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages.

ARTICLE 8 – INTEREST

8.01 All monies not paid when due as provided in Article 10 of the General Conditions shall bear interest at the statutory rate.

ARTICLE 9 – SELLER'S REPRESENTATIONS

9.01 In order to induce Buyer to enter into this Agreement, Seller makes the following representations:

A. Seller has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents, as applicable to Seller's obligations identified in Article 1 above.

B. If required by the Bidding Documents to visit the Point of Destination and site where the Goods are to be installed or Special Services will be provided, or if, in Seller's judgment, any local condition may affect cost, progress, or the furnishing of the Goods and Special Services, Seller has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided and become familiar with and is satisfied as to the observable local conditions that may affect cost, progress, and the furnishing of the Goods and Special Services.

C. Seller is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and the furnishing of the Goods and Special Services.

D. Seller has carefully studied, considered, and correlated the information known to Seller; information commonly known to sellers of similar goods doing business in the locality of

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

the Point of Destination and the site where the Goods will be installed or where Special Services will be provided; information and observations obtained from Seller's visits, if any, to the Point of Destination and site where the Goods are to be installed or Services will be provided; and any reports and drawings identified in the Bidding Documents regarding the Point of Destination and the site where the Goods will be installed or where Special Services will be provided, with respect to the effect of such information, observations, and documents on the cost, progress, and performance of Seller's obligations under the Contract Documents.

E. Seller has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Seller has discovered in the Contract Documents, and the written resolution (if any) thereof by Engineer is acceptable to Seller.

F. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing Goods and Special Services.

ARTICLE 10 – CONTRACT DOCUMENTS

10.01 *Contents*

A. The Contract Documents consist of the following:

1. This Agreement (pages __ to __, inclusive);
2. Performance Bond (pages __ to __, inclusive);
3. Payment Bond (pages ____ to ____, inclusive);
4. General Conditions (pages ___ to ___, inclusive);
5. Supplementary Conditions (pages ___ to ___, inclusive);
6. Specifications as listed in table of contents of the Project Manual;
7. Procurement Drawings, consisting of a cover sheet and sheets numbered PR-1 through PR-12 and numbered I-0 to I-3, inclusive, with each sheet bearing the following general title: Reverse Osmosis Equipment Procurement
8. Addenda (Numbers ___ to ___, inclusive);
9. Exhibits to this Agreement (enumerated as follows):
    a. Exhibit A-1 to Agreement between Buyer and Seller dated _____, Assignment of Contract; Consent to Assignment; and Acceptance of Assignment.
    b. Exhibit A-2 to Agreement between Buyer and Seller dated _____, Agreement to Assignment by Seller's Surety.
    c. Seller's Bid, solely as to the prices set forth therein (pages ___ to ___, inclusive);

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

d. Documentation submitted by Seller prior to Notice of Award (pages ___ to ___, inclusive);

e. _____;

10. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:

a. Notice to Proceed;

b. Change Order(s);

c. Work Change Directive(s).

B. The documents listed in Paragraph 10.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 10.

D. The Contract Documents may only be amended, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 11 – MISCELLANEOUS

11.01 *Terms*

A. Terms used in this Agreement will have the meanings indicated in the General Conditions and the Supplementary Conditions.

11.02 *Assignment of Contract*

A. Buyer has the right to assign this Contract for furnishing Goods and Special Services, but only to a person or entity with sufficient ability to satisfy all of Buyer's obligations under this Contract, and Seller hereby consents to such assignment. Forms documenting the assignment of the Contract, and consent of Seller's surety to the assignment, have been executed by Buyer, Seller, and Seller's surety, and are attached as exhibits to this Agreement.

1. The Contract will be executed in the name of Buyer initially, and will be assigned to a construction contractor designated by Buyer. Such construction contractor's responsibilities will include the installation of the Goods. The assignment will occur on the effective date of the agreement between Buyer and the construction contractor, which is expected to occur on or about September 19, 2017. As of the date of acceptance of assignment by the construction contractor, all references in the Contract Documents to Buyer shall mean the designated construction contractor.

2. The assignment of the Contract shall relieve the assignor from all further obligations and liabilities under this Contract. After assignment, Seller shall become a subcontractor or supplier to the assignee and, except as noted herein, all rights, duties,

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

and obligations of Buyer under the Contract shall become the rights, duties, and obligations of the assignee.

3. After assignment:

   a. All performance warranties, guarantees, and indemnifications required by the Contract Documents will continue to run for the benefit of assignor and, in addition, for the benefit of the assignee. However, if assignor and assignee make the same warranty or guarantee claim, then Seller shall only be liable once for such claim.

   b. Except as provided in this Paragraph 11.02.A.3.b, all rights, duties, and obligations of Engineer to assignee and Seller under this Contract will cease.

      1) Engineer will review Seller's Applications for Payment and make recommendations to assignee for payments as provided in Paragraphs 10.02 and 10.06 of the General Conditions.

      2) Upon the written request of either the assignee or Seller, Engineer will issue with reasonable promptness clarifications or interpretations of the Contract Documents pursuant to the terms of Paragraph 9.02.A of the General Conditions.

B. No other assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound. Specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by Laws and Regulations). Unless specifically stated to the contrary in any written consent to such an assignment, such an assignment will not release or discharge the assignor from any duty or responsibility under the Contract Documents.

11.03 *Successors and Assigns*

A. Buyer and Seller each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

11.04 *Severability*

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Buyer and Seller. The Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

11.05 *Seller's Certifications*

A. Seller certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 11.05:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process or in the Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Buyer, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

11.06 *Limitations*

A. Buyer and Seller waive against each other, and against the other's officers, directors, members, partners, employees, agents, consultants, and subcontractors, any and all claims for or entitlement to incidental, indirect, or consequential damages arising out of, resulting from, or related to the Contract. Upon assignment the terms of this Paragraph 11.06.A shall be binding upon the assignee with respect to Seller and assignor. The terms of this mutual waiver do not apply to or limit any claim by either Buyer or Seller against the other based on any of the following: (a) contribution or indemnification, (b) costs, losses, or damages attributable to personal or bodily injury, sickness, disease, or death, or to injury to or destruction of the tangible property of others, (c) intentional or reckless wrongful conduct, or (d) rights conferred by any bond provided by Seller under this Contract.

B. Upon assignment the terms of this Paragraph 11.06.B shall be binding upon both the assignor and assignee with respect to Seller's liability, and upon Seller with respect to both assignor's and assignee's liabilities. The terms of this mutual limitation do not apply to or limit any claim by either Buyer or Seller against the other based on any of the following: (a) contribution or indemnification with respect to third-party claims, losses, and damages; (b) costs, losses, or damages attributable to personal or bodily injury, sickness, disease, or death, or to injury to or destruction of the tangible property of others, (c) intentional or reckless wrongful conduct, or (d) rights conferred by any bond provided by Seller under this Contract.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

IN WITNESS WHEREOF, Buyer and Seller have signed this Agreement. Counterparts have been delivered to Buyer and Seller. All portions of the Contract Documents have been signed or identified by Buyer and Seller or on their behalf.

This Agreement will be effective on ***[insert date]*** (which is the Effective Date of the Agreement).

Buyer: _____	Seller: _____
By: _____	By: _____
[Corporate Seal]	[Corporate Seal]
Attest: _____	Attest: _____
Address for giving notice:	Address for giving notice:
_____	_____
_____	_____
_____	_____
(If Buyer is a corporation, attach evidence of authority to sign. If Buyer is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Buyer-Seller Agreement.)	Agent for service of process:
	_____
	_____
	_____
	_____
	(If Seller is a corporation or a partnership, attach evidence of authority to sign.)
Designated Representative:	Designated Representative:
Name: _____	Name: _____
Title: _____	Title: _____
Address: _____	Address: _____
Phone: _____	Phone: _____
Facsimile: _____	Facsimile: _____

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

EXHIBIT A-1 to Agreement Between Buyer and Seller dated ____

ASSIGNMENT OF CONTRACT; CONSENT TO ASSIGNMENT; AND ACCEPTANCE OF ASSIGNMENT

This assignment will be effective on ***[insert date]***.

[or]

This assignment will be effective on the Effective Date of the Agreement between Buyer and Construction Contractor.

The Contract between Brunswick Regional Water and Sewer H2GO ("Buyer") and _____("Seller")
for furnishing Goods and Special Services under the Contract Documents entitled
Reverse Osmosis Equipment Procurement
is hereby assigned, transferred, and set over to _____
("Construction Contractor"). Construction Contractor shall be totally responsible for the performance of Seller and for the duties, rights and obligations of Buyer, not otherwise retained by Buyer, under the terms of the Contract between Buyer and Seller.

ASSIGNMENT DIRECTED BY: Bob Walker, Executive Director
Buyer

(If Buyer is a corporation, attach evidence of authority to sign. If Buyer is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Buyer-Seller Agreement.)

By: _____
(Signature) (Title)

ASSIGNMENT ACKNOWLEDGED AND ACCEPTED BY: _____
Seller

(If Seller is a corporation, attach evidence of authority to sign.)

By: _____
(Signature) (Title)

ASSIGNMENT ACCEPTED BY: _____
Construction Contractor

(If Construction Contractor is a corporation, attach evidence of authority to sign.)

By: _____

EJCDC P-520, Agreement Between Buyer and Seller for Procurement Contracts.
Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

EXHIBIT A-2 to Agreement Between Buyer and Seller dated _____

AGREEMENT TO ASSIGNMENT BY SELLER'S SURETY

Surety hereby acknowledges and agrees that the Contract for furnishing Goods and Special Services under the Contract Documents entitled Reverse Osmosis Equipment Procurement by and between Brunswick Regional Water and Sewer H2GO ("Buyer") and _____ ("Seller") may be assigned, transferred, and set over to _____ ("Construction Contractor"), in accordance with Paragraph 11.02 of Agreement between Buyer and Seller.

Surety further agrees that, upon assignment of the Contract, the Construction Contractor shall have all the rights of the Buyer under the Performance Bond.

(Corporate Seal)

Surety

Company: _____

By: _____
Signature and Title
(Attach Power of Attorney)

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

Notice to Proceed

Project::	Date:
Owner: Brunswick Regional Water and Sewer H2GO	Owner's Contract No.:
Contract: **Reverse Osmosis Equipment Procurement**	Engineer's Project No.:

Contractor:

Contractor's Address: (send Certified Mail, Return Receipt Requested)

You are notified that the Contract Times under the above contract will commence to run on Date. On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 5 of the Agreement, the number of days to achieve Substantial Completion is Date and the number of days to achieve readiness for final payment DAYS. The date of completion of all work is therefore Date.

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you must deliver to the Owner (with copies to Engineer and other identified additional insureds) certificates of insurance which you are required to purchase and maintain in accordance with the Contract Documents.

Also, before you may start any Work at the Site, you must :

Owner
Given by:
Authorized Signature

Title

Date

Copy to Engineer

Acceptance of Notice

Receipt of the Notice of Proceed is hereby acknowledged by _____

this the _____ day of _____, 20___.

By:_____

Title:_____

EJCDC No. C-550 (2007 Edition) Prepared by the Engineers' Joint Contract Documents Committee and endorsed by the Associated General Contractors of America and the Construction Specifications Institute.

PERFORMANCE BOND
FOR PROCUREMENT CONTRACTS

Any singular reference to Seller, Surety, Buyer, or other party shall be considered plural where applicable.

SELLER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

BUYER (Name and Address): Brunswick Regional Water and Sewer H2GO

CONTRACT
Date:
Amount:
Description (Name and Location):

BOND
Date (Not earlier than Contract Date):
Bond Number:
Amount:
Modifications to this Bond Form:

Surety and Seller, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

Seller as Principal
Company: (Corp. Seal)

Signature:
Name and Title:

Surety
Company: (Corp. Seal)

Signature:
Name and Title:
(Attach Power of Attorney)
Address:

Telephone Number:

(Space is provided below for signatures of additional parties, if required.)

Seller as Principal
Company: (Corp. Seal)

Signature:
Name and Title:

Surety
Company: (Corp. Seal)

Signature:
Name and Title:
Address:
Telephone Number:

Published jointly by National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. 2010. All rights reserved.

1. Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to Buyer for the performance of the Contract, which is incorporated herein by reference. For purposes of this bond, Buyer means Buyer's assigns, if and when Buyer has assigned the Contract.

2. If Seller performs the Contract, Surety and Seller have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no Buyer Default, Surety's obligation under this Bond shall arise after:

   3.1. Buyer has notified Seller and Surety pursuant to Paragraph 10 that Buyer is considering declaring a Seller Default and has requested and attempted to arrange a conference with Seller and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. (If Buyer, Seller, and Surety agree, Seller shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Buyer's right, if any, subsequently to declare a Seller Default); and

   3.2. Buyer has declared a Seller Default and formally terminated Seller's right to complete the Contract. Such Seller Default shall not be declared earlier than 20 days after Seller and Surety have received notice as provided in Paragraph 3.1; and

   3.3. Buyer has agreed to pay the Balance of the Contract Price to:

      a. Surety in accordance with the terms of the Contract;

      b. Another seller selected pursuant to Paragraph 4.3 to perform the Contract.

4. When Buyer has satisfied the conditions of Paragraph 3, Surety shall promptly and at Surety's expense take one of the following actions:

   4.1. Arrange for Seller, with consent of Buyer, to perform and complete the Contract; or

   4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

   4.3. Obtain bids or negotiated proposals from qualified sellers acceptable to Buyer for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Buyer and a seller selected with Buyer's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the Bonds issued on the Contract, and pay to Buyer the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by Buyer resulting from Seller Default; or

   4.4. Waive its right to perform and complete, arrange for completion, or obtain a new seller, and with reasonable promptness under the circumstances, either:

      a. determine the amount for which it may be liable to Buyer and, as soon as practicable after the amount is determined, tender payment therefor to Buyer; or

Published jointly by National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. 2010. All rights reserved.

b. deny liability in whole or in part and notify Buyer citing reasons therefor.

5. If Surety does not proceed as provided in Paragraph 4 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Buyer to Surety demanding that Surety perform its obligations under this Bond, and Buyer shall be entitled to enforce any remedy available to Buyer. If Surety proceeds as provided in paragraph 4.4, and Buyer refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Buyer shall be entitled to enforce any remedy available to Buyer.

6. After Buyer has terminated Seller's right to complete the Contract, and if Surety elects to act under Paragraph 4.1, 4.2, or 4.3, then the responsibilities of Surety to Buyer shall not be greater than those of Seller under the Contract, and the responsibilities of Buyer to Surety shall not be greater than those of Buyer under the Contract. To a limit of the amount of this Bond, but subject to commitment by Buyer of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

   6.1. the responsibilities of Seller for correction or replacement of defective Goods and Special Services and completion of the Contract;

   6.2. Additional legal, design professional, and delay costs resulting from Seller's Default, and resulting from the actions of or failure to act of Surety under Paragraph 4; and

   6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Seller.

7. Surety shall not be liable to Buyer or others for obligations of Seller that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Buyer or its heirs, executors, administrators, successors, or assigns.

8. Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location of the Point of Destination, and shall be instituted within two years after Seller Default or within two years after Seller ceased working or within two years after Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to Surety, Buyer or Seller shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Point of Destination, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

Published jointly by National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. 2010. All rights reserved.

12. Definitions.

12.1. *Balance of the Contract Price:* The total amount payable by Buyer to Seller under the Contract after all proper adjustments have been made, including allowance to Seller of any amounts received or to be received by Buyer in settlement of insurance or other Claims for damages to which Seller is entitled, reduced by all valid and proper payments made to or on behalf of Seller under the Contract.

12.2. *Contract:* The agreement between Buyer and Seller identified on the signature page, including all Contract Documents and changes thereto.

12.3. *Seller Default:* Failure of Seller, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

12.4. *Buyer Default:* Failure of Buyer, which has neither been remedied nor waived, to pay Seller as required by the Contract or to perform and complete or comply with the other terms thereof.

Published jointly by National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. 2010. All rights reserved.

PAYMENT BOND
FOR PROCUREMENT CONTRACTS

Any singular reference to Seller, Surety, Buyer or other party shall be considered plural where applicable.

SELLER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

BUYER (Name and Address): Brunswick Regional Water and Sewer H2GO

CONTRACT
Date:
Amount:
Description (Name and Location):

BOND
Date (Not earlier than Contract Date):
Bond Number:
Amount:
Modifications to this Bond Form:

Surety and Seller, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

Seller as Principal
Company: (Corp. Seal)

Signature:
Name and Title:

Surety
Company: (Corp. Seal)

Signature:
Name and Title:
(Attach Power of Attorney)
Address:
Telephone Number:

(Space is provided below for signatures of additional parties, if required.)

Seller as Principal
Company: (Corp. Seal)

Signature:
Name and Title:

Surety
Company: (Corp. Seal)

Signature:
Name and Title:
Address:
Telephone Number:

Published jointly by National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. 2010. All rights reserved.

1. Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to Buyer to pay for labor, materials and equipment furnished for use in the performance of the Contract, which is incorporated herein by reference. For purposes of this bond, Buyer means Buyer's assigns, if and when Buyer has assigned the Contract.

2. With respect to Buyer, this obligation shall be null and void if Seller:

   2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

   2.2. Defends, indemnifies and holds harmless Buyer from all claims, demands, liens or suits by any person or entity who furnished labor, materials or equipment for use in the performance of the Contract, provided Buyer has promptly notified Seller and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens or suits and tendered defense of such claims, demands, liens or suits to Seller and Surety, and provided there is no Buyer Default.

3. With respect to Claimants, this obligation shall be null and void if Seller promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

   4.1. Claimants who are employed by or have a direct contract with Seller have given notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Buyer stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

   4.2. Claimants who do not have a direct contract with Seller:

      a. Have furnished written notice to Seller and sent a copy, or notice thereof, to Buyer, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was done or performed; and

      b. Have either received a rejection in whole or in part from Seller or not received within 30 days of furnishing the above notice any communication from Seller by which Seller had indicated the claim will be paid directly or indirectly; and

      c. Not having been paid within the above 30 days, have sent a written notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Buyer stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Seller.

5. If a notice required by Paragraph 4 is given by Buyer to Seller or to Surety, that is sufficient compliance.

6. Reserved.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Buyer to Seller under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any Performance Bond. By Seller furnishing and Buyer

Published jointly by National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. 2010. All rights reserved.

accepting this Bond, they agree that all funds earned by Seller in the performance of the Contract are dedicated to satisfy obligations of Seller and Surety under this Bond, subject to Buyer's priority to use the funds for the completion of the furnishing the Goods and Special Services.

9. Surety shall not be liable to Buyer, Claimants or others for obligations of Seller that are unrelated to the Contract. Buyer shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders, and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Goods relevant to the claim are located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Buyer or Seller shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Buyer or Seller, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Seller shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. Definitions

    15.1 *Claimant:* An individual or entity having a direct contract with Seller or with a Subcontractor of Seller to furnish labor, materials or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Contract, architectural and engineering services required for furnishing the Goods and Special Services by Seller and Seller's Subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.

    15.2. *Contract:* The agreement between Buyer and Seller identified on the signature page, including all Contract Documents and changes thereto.

    15.3. *Buyer Default:* Failure of Buyer, which has neither been remedied nor waived, to pay Seller as required by the Contract or to perform and complete or comply with the other terms thereof.

Published jointly by National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. 2010. All rights reserved.

PAGE FOR ATTACHING

POWER OF ATTORNEY

PAGE FOR ATTACHING

CERTIFICATE OF INSURANCE

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

Contractor's Application for Payment No. _____

	Application Period:	Application Date:
To (Owner):	From (Contractor):	Via (Engineer):
Project:	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.:

Application For Payment

Change Order Summary

Approved Change Orders		
Number	Additions	Deductions
TOTALS		
NET CHANGE BY CHANGE ORDERS		

1. **ORIGINAL CONTRACT PRICE** ..... $ _____
2. **Net change by Change Orders** ..... $ _____
3. **Current Contract Price (Line 1 ± 2)** ..... $ _____
4. **TOTAL COMPLETED AND STORED TO DATE (Column F on Progress Estimate)** ..... $ _____
5. **RETAINAGE:**
   - a. X _____ **Work Completed** ..... $ _____
   - b. X _____ **Stored Material** ..... $ _____
   - c. **Total Retainage (Line 5a + Line 5b)** ..... $ _____
6. **AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c)** ..... $ _____
7. **LESS PREVIOUS PAYMENTS (Line 6 from prior Application)** ..... $ _____
8. **AMOUNT DUE THIS APPLICATION** ..... $ _____
9. **BALANCE TO FINISH, PLUS RETAINAGE (Column G on Progress Estimate + Line 5 above)** ..... $ _____

Contractor's Certification

The undersigned Contractor certifies that to the best of its knowledge: (1) all previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with Work covered by prior Applications for Payment; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to Owner indemnifying Owner against any such Liens, security interest or encumbrances); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

By:	Date:

Payment of: $ _____
(Line 8 or other - attach explanation of the other amount)

is recommended by: _____ _____
(Engineer) (Date)

Payment of: $ _____
(Line 8 or other - attach explanation of the other amount)

is approved by: _____ _____
(Owner) (Date)

Approved by: _____ _____
Funding Agency (if applicable) (Date)

© 2010 National Society of Professional Engineers for EJCDC. All rights reserved.

Progress Estimate - Lump Sum Work

Contractor's Application

For (Contract):	Application Number:
Application Period:	Application Date:

			Work Completed		E	F		G
A		B	C	D	Materials Presently Stored (not in C or D)	Total Completed and Stored to Date (C + D + E)	% (F / B)	Balance to Finish (B - F)
Specification Section No.	Description	Scheduled Value ($)	From Previous Application (C+D)	This Period				

Progress Estimate - Unit Price Work

Contractor's Application

For (Contract):							Application Number:			
Application Period:							Application Date:			
A				B	C	D	E	F		
Item		Bid Item Quantity	Unit Price	Bid Item Value ($)	Estimated Quantity Installed	Value of Work Installed to Date	Materials Presently Stored (not in C)	Total Completed and Stored to Date (D + E)	% (F / B)	Balance to Finish (B - F)
Bid Item No.	Description									

Stored Material Summary

Contractor's Application

For (Contract):								Application Number:			
Application Period:								Application Date:			
A		B	C		D		E		F		G
					Stored Previously				Incorporated in Work		
Bid Item No.	Supplier Invoice No.	Submittal No. (with Specification Section No.)	Storage Location	Description of Materials or Equipment Stored	Date Placed into Storage (Month/Year)	Amount ($)	Amount Stored this Month ($)	Subtotal Amount Completed and Stored to Date (D + E)	Date (Month/ Year)	Amount ($)	Materials Remaining in Storage ($) (D + E - F)

NORTH CAROLINA SALES TAX AND USE REPORT

(Paid During This Estimate Period)

PAGE____ of ____

PROJECT _____ _____ COUNTY ESTIMATE NO. _____

CONTRACTOR _____ PERIOD ENDING _____

DATE	VENDOR NAME	INVOICE NUMBER	INVOICE AMOUNT	TYPE OF PROPERTY	STATE TAX	COUNTY TAX	TOTAL TAX	COUNTY OF SALE*

I certify that the above-listed vendors were paid sales tax upon purchase of building materials during the period covered by the construction estimate, and the property upon which such taxes were paid with or will be used in the performance of this contract. No tax on purchases or rentals of supplies, tools and/or equipment is included in the above list. All of the material above became a part of or is annexed to the building(s) or structure(s) being erected, altered or repaired. I certify that, to the best of my knowledge, the information provided here is true, correct, and complete

Sworn to and subscribed to before me this _____ day of _____, 20____.

_____
Notary Public

My commission expires: _____

Seal

_____
Contractor's Signature

_____
Print or Type Name of Above

*If this is an out-of-state vendor, the County of Sale should be the county to which the merchandise was shipped.

EXHIBIT GC-A

CERTIFICATE OF OWNER'S ATTORNEY

I, the undersigned, _____,
the duly authorized and acting legal representative of _____
_____, do hereby certify as follows:

I have examined the attached Contract(s) and Performance and Payment Bonds and the manner of execution thereof, and I am of the opinion that each of the aforesaid agreements is adequate and has been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties named thereon; and that the foregoing agreements constitute valid and legally binding obligations upon the parties executing the same in accordance with terms, conditions, and provisions thereof.

Date _____

_____

PRE-AUDIT STATEMENT

This instrument has been pre-audited in the manner required by the Local Government Budget and Fiscal Control Act.

Brunswick Regional Water and Sewer H2GO, NC
Date:_____

By:_____

Title:_____

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS FOR PROCUREMENT CONTRACTS

Prepared by

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

ACEC
American Council of Engineering Companies

AGC of America
The Associated General Contractors of America
Quality People. Quality Projects.

ASCE American Society of Civil Engineers

National Society of Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

AMERICAN SOCIETY OF CIVIL ENGINEERS

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A Practice Division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

These Standard General Conditions for Procurement Contracts have been prepared for use with the Suggested Instructions to Bidders for Procurement Contracts (EJCDC P-200, 2010 Edition), the Agreement Between Buyer and Seller for Procurement Contracts (EJCDC P-520, 2010 Edition), and the Guide to Preparation of Supplementary Conditions for Procurement Contracts (EJCDC P-800, 2010 Edition). Their provisions are interrelated and a change in one may necessitate a change in the others. Additional information concerning the use of the EJCDC Procurement Documents may be found in the Commentary on Procurement Documents (EJCDC P-001, 2010 Edition).

Copyright © 2010:

National Society of Professional Engineers
1420 King Street, Alexandria, VA 22314-2794
(703) 684-2882
http://www.nspe.org

American Council of Engineering Companies
1015 15th Street N.W., Washington, DC 20005
(202) 347-7474
http://www.acec.org

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400
(800) 548-2723
http://www.asce.org

Associated General Contractors of America
2300 Wilson Boulevard, Suite 400, Arlington, VA 22201-3308
(703) 548-3118
www.agc.org

The copyright for EJCDC P-700 is owned jointly by the four EJCDC sponsoring organizations listed above. The National Society of Professional Engineers (NSPE) is the Copyright Administrator for the EJCDC documents; please direct all inquiries and requests regarding EJCDC copyrights to NSPE.

NOTE: EJCDC publications may be purchased at www.ejcdc.org, or from any of the four sponsoring organizations above.

TABLE OF CONTENTS

Page

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY 1
1.01 Defined Terms 1
1.02 Terminology 4

ARTICLE 2 - PRELIMINARY MATTERS 5
2.01 Delivery of Bonds 5
2.02 Evidence of Insurance 5
2.03 Copies of Documents 5
2.04 Commencement of Contract Times; Notice to Proceed 5
2.05 Designated Representatives 5
2.06 Progress Schedule 5
2.07 Preliminary Conference 6
2.08 Safety 6

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT AND AMENDING 6
3.01 Intent 6
3.02 Standards, Specifications, Codes, Laws and Regulations 6
3.03 Reporting and Resolving Discrepancies 7
3.04 Amending and Clarifying Contract Documents 8

ARTICLE 4 - BONDS AND INSURANCE 8
4.01 Bonds 8
4.02 Insurance 9
4.03 Licensed Sureties and Insurers 9

ARTICLE 5 - SELLER'S RESPONSIBILITIES 9
5.01 Supervision and Superintendence 9
5.02 Labor, Materials and Equipment 9
5.03 Laws and Regulations 10
5.04 Or Equals 10
5.05 Taxes 11
5.06 Shop Drawings and Samples 11
5.07 Continuing Performance 13
5.08 Seller's Warranties and Guarantees 13
5.09 Indemnification 14
5.10 Delegation of Professional Design Services 15

ARTICLE 6 - SHIPPING AND DELIVERY 15
6.01 Shipping 15
6.02 Delivery 15
6.03 Risk of Loss 16
6.04 Progress Schedule 16

ARTICLE 7 - CHANGES: SCHEDULE AND DELAY 16
7.01 Changes in the Goods and Special Services 16
7.02 Changing Contract Price or Contract Times 17

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

ARTICLE 8 - BUYER'S RIGHTS 17
8.01 Inspections and Testing 17
8.02 Non-Conforming Goods or Special Services 19
8.03 Correction Period 20

ARTICLE 9 - ROLE OF ENGINEER 20
9.01 Duties and Responsibilities 20
9.02 Clarifications and Interpretations 20
9.03 Authorized Variations 21
9.04 Rejecting Non-Conforming Goods and Special Services 21
9.05 Decisions on Requirements of Contract Documents 21
9.06 Claims and Disputes 21

ARTICLE 10 - PAYMENT 22
10.01 Applications for Progress Payments 22
10.02 Review of Applications for Progress Payments 23
10.03 Amount and Timing of Progress Payments 23
10.04 Suspension of or Reduction in Payment 24
10.05 Final Application for Payment 24
10.06 Final Payment 24
10.07 Waiver of Claims 25

ARTICLE 11 - CANCELLATION, SUSPENSION, AND TERMINATION 25
11.01 Cancellation 25
11.02 Suspension of Performance by Buyer 25
11.03 Suspension of Performance by Seller 25
11.04 Breach and Termination 26

ARTICLE 12 - LICENSES AND FEES 27
12.01 Intellectual Property and License Fees 27
12.02 Seller's Infringement 27
12.03 Buyer's Infringement 28
12.04 Reuse of Documents 28
12.05 Electronic Data 28

ARTICLE 13 - DISPUTE RESOLUTION 29
13.01 Dispute Resolution Method 29

ARTICLE 14 - MISCELLANEOUS 29
14.01 Giving Notice 29
14.02 Controlling Law 30
14.03 Computation of Time 30
14.04 Cumulative Remedies 30
14.05 Survival of Obligations 30
14.06 Entire Agreement 30

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

STANDARD GENERAL CONDITIONS FOR PROCUREMENT CONTRACTS

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Whenever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to the singular or plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument signed by both Buyer and Seller covering the Goods and Special Services and which lists the Contract Documents in existence on the Effective Date of the Agreement.

3. *Application for Payment*—The form acceptable to Buyer which is used by Seller in requesting progress and final payments and which is accompanied by such supporting documentation as is required by the Contract Documents.

4. *Bid*— The offer or proposal of a Seller submitted on the prescribed form setting forth the prices for the Goods and Special Services to be provided.

5. *Bidder*—The individual or entity that submits a Bid directly to Buyer.

6. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).

7. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and Bid Form with any supplements.

8. *Buyer*—The individual or entity purchasing the Goods and Special Services.

9. *Change Order*—A document which is signed by Seller and Buyer and authorizes an addition, deletion, or revision to the Contract Documents or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement. Change Orders may be the result of mutual agreement by Buyer and Seller, or of resolution of a Claim.

Copyright © 2010 National Society of Professional Engineers, American Society of Civil Engineers,
American Council of Engineering Companies, and Associated General Contractors of America. All rights reserved.

10. *Claim*—A demand or assertion by Buyer or Seller seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*—The entire and integrated written agreement between Buyer and Seller concerning the Goods and Special Services. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*—Those items so designated in the Agreement. Shop Drawings and other Seller submittals are not Contract Documents, even if accepted, reviewed, or approved by Engineer or Buyer.

13. *Contract Price*—The moneys payable by Buyer to Seller for furnishing the Goods and Special Services in accordance with the Contract Documents as stated in the Agreement.

14. *Contract Times*—The times stated in the Agreement by which the Goods must be delivered and Special Services must be furnished.

15. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Goods and Special Services to be furnished by Seller. Shop Drawings and other Seller submittals are not Drawings as so defined.

16. *Effective Date of the Agreement*—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

17. *Engineer*—The individual or entity designated as such in the Agreement.

18. *Field Order*—A written order issued by Engineer which requires minor changes in the Goods or Special Services but which does not involve a change in the Contract Price or Contract Times.

19. *General Requirements*—Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

20. *Goods*—The tangible and movable personal property that is described in the Contract Documents, regardless of whether the property is to be later attached to realty.

21. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, including Goods, as defined herein, and Special Services, if any, as defined herein. This term refers to both the Goods and the Special Services, or to either the Goods or the Special Services, and to any portion of the Goods or the Special Services, as the context requires.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

22. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

23. *Milestone*—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to the Contract Times.

24. *Notice of Award*—The written notice by Buyer to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Buyer will sign and deliver the Agreement.

25. *Notice to Proceed*—A written notice given by Buyer to Seller fixing the date on which the Contract Times commence to run and on which Seller shall start to perform under the Contract.

26. *Point of Destination*—The specific address of the location where delivery of the Goods shall be made, as stated in the Agreement.

27. *Project*—The total undertaking of which the Goods and Special Services may be the whole, or only a part.

28. *Project Manual*—The documentary information prepared for bidding and furnishing the Goods and Special Services. A listing of the contents of the Project Manual is contained in its table of contents.

29. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Goods and Special Services and which establish the standards by which such portion of the Goods and Special Services will be judged.

30. *Seller*—The individual or entity furnishing the Goods and Special Services.

31. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Seller and submitted by Seller to illustrate some portion of the Goods and Special Services.

32. *Special Services*—Services associated with the Goods to be furnished by Seller as required by the Contract Documents.

33. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the furnishing of the Goods and Special Services, and certain administrative requirements and procedural matters applicable thereto.

34. *Successful Bidder*—The Bidder submitting a responsive Bid, to whom Buyer makes an award.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

35. *Supplementary Conditions*—That part of the Contract Documents which amends or supplements these General Conditions.

36. *Work Change Directive*—A written statement to Seller issued on or after the Effective Date of the Agreement and signed by Buyer ordering an addition, deletion, or other revision in the Contract Documents with respect to the Goods and Special Services. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B and 1.02.C are not defined, but have the indicated meanings when used in the Bidding Requirements or Contract Documents.

B. *Intent of Certain Terms or Adjectives:*

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Goods and Special Services. It is intended that such exercise of professional judgment, action, or determination will be commercially reasonable and will be solely to evaluate, in general, the Goods and Special Services for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to Engineer any duty or authority to supervise or direct the furnishing of Goods or Special Services or any duty or authority to undertake responsibility contrary to any other provision of the Contract Documents.

2. The word "non-conforming" when modifying the words "Goods and Special Services," "Goods," or "Special Services," refers to Goods and Special Services that fail to conform to the Contract Documents.

3. The word "receipt" when referring to the Goods, shall mean the physical taking and possession by the Buyer under the conditions specified in Paragraph 8.01.B.3.

4. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

5. The word "furnish," when used in connection with the Goods and Special Services shall mean to supply and deliver said Goods to the Point of Destination (or some other

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

specified location) and to perform said Special Services fully, all in accordance with the Contract Documents.

C. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 *Delivery of Bonds*

A. When Seller delivers the executed counterparts of the Agreement to Buyer, Seller also shall deliver such bonds as Seller may be required to furnish.

2.02 *Evidence of Insurance*

A. When Seller delivers the executed counterparts of the Agreement to Buyer, Seller shall deliver to Buyer, with copies to each additional insured identified by name in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Seller is required to purchase and maintain in accordance with Article 4.

2.03 *Copies of Documents*

A. Buyer shall furnish Seller up to five printed or hard copies of the Contract Documents. Additional copies will be furnished upon request at the cost of reproduction.

2.04 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.05 *Designated Representatives*

A. Buyer and Seller shall each designate its representative at the time the Agreement is signed. Each representative shall have full authority to act on behalf of and make binding decisions in any matter arising out of or relating to the Contract.

2.06 *Progress Schedule*

A. Within 15 days after the Contract Times start to run, Seller shall submit to Buyer and Engineer an acceptable progress schedule of activities, including at a minimum, Shop Drawing and Sample submittals, tests, and deliveries as required by the Contract Documents. No progress payment will be made to Seller until an acceptable schedule is submitted to Buyer and Engineer.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

B. The progress schedule will be acceptable to Buyer and Engineer if it provides an orderly progression of the submittals, tests, and deliveries to completion within the specified Milestones and the Contract Times. Such acceptance will not impose on Buyer or Engineer responsibility for the progress schedule, for sequencing, scheduling, or progress of the work nor interfere with or relieve Seller from Seller's full responsibility therefor. Such acceptance shall not be deemed to acknowledge the reasonableness and attainability of the schedule.

2.07 *Preliminary Conference*

A. Within 20 days after the Contract Times start to run, a conference attended by Seller, Buyer, Engineer and others as appropriate will be held to establish a working understanding among the parties as to the Goods and Special Services and to discuss the schedule referred to in Paragraph 2.06.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

2.08 *Safety*

A. Buyer and Seller shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss. When Seller's personnel, or the personnel of any subcontractor to Seller, are present at the Point of Destination or any work area or site controlled by Buyer, the Seller shall be responsible for the compliance by such personnel with any applicable requirements of Buyer's safety programs that are made known to Seller.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT AND AMENDING

3.01 *Intent*

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce or furnish the indicated Goods and Special Services will be provided, whether or not specifically called for, at no additional cost to Buyer.

C. Clarifications and interpretations of, or notifications of minor variations and deviations in, the Contract Documents, will be issued by Engineer as provided in Article 9.

3.02 *Standards, Specifications, Codes, Laws and Regulations*

A. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws and Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws and Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

B. No provision of any such standard, specification, manual or code, or any instruction of a supplier shall be effective to change the duties or responsibilities of Buyer or Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall any such provision or instruction be effective to assign to Buyer or Engineer, or any of their consultants, agents, or employees any duty or authority to supervise or direct the performance of Seller's obligations or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

1. *Seller's Review of Contract Documents Before the Performance of the Contract*: Before performance of the Contract, Seller shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Seller shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Seller discovers or has actual knowledge of and shall obtain a written interpretation or clarification from Engineer before proceeding with the furnishing of any Goods and Special Services affected thereby.

2. *Seller's Review of Contract Documents During the Performance of the Contract:* If, during the performance of the Contract, Seller discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Contract, any standard, specification, manual or code, or of any instruction of any Supplier, Seller shall promptly report it to Engineer in writing. Seller shall not proceed with the furnishing of the Goods and Special Services affected thereby until an amendment to or clarification of the Contract Documents has been issued.

3. Seller shall not be liable to Buyer or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Seller had actual knowledge thereof.

B. *Resolving Discrepancies:* Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

1. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

2. the provisions of any Laws or Regulations applicable to the furnishing of the Goods and Special Services (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

3.04 *Amending and Clarifying Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions to the Goods and Special Services or to modify contractual terms and conditions by a Change Order.

B. Buyer may issue a Work Change Directive providing for additions, deletions, or revisions to the Goods and Special Services, in which case (1) the Contract Price shall be equitably adjusted to account for any reasonable and necessary credits to Buyer for any such deletion, or for costs (including reasonable overhead and profit) incurred by Seller to accommodate such an addition or revision and (2) the Contract Times shall be equitably adjusted to account for any impact on progress and completion of performance. Such adjustments subsequently shall be duly set forth in a Change Order.

C. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Goods and Special Services may be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 5.06.D.3); or

3. Engineer's written interpretation or clarification.

ARTICLE 4 - BONDS AND INSURANCE

4.01 *Bonds*

A. Seller shall furnish to Buyer performance and payment bonds, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Seller's obligations under the Contract Documents. These bonds shall remain in effect until 1) one year after the date when final payment becomes due or 2) completion of the correction period specified in Paragraph 8.03, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Seller shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.

C. If the surety on any bond furnished by Seller is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

to meet the requirements of Paragraph 4.01.B, Seller shall promptly notify Buyer and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 4.01.B and 4.02.

4.02 *Insurance*

A. Seller shall provide insurance of the types and coverages and in the amounts stipulated in the Supplementary Conditions.

B. Failure of Buyer to demand certificates of insurance or other evidence of Seller's full compliance with these insurance requirements or failure of Buyer to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Seller's obligation to maintain such insurance.

C. Upon assignment of this Contract, Seller shall comply with the written request of assignee to provide certificates of insurance to assignee.

D. Buyer does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Seller.

E. The insurance and insurance limits required herein shall not be deemed as a limitation on Seller's liability under the indemnities granted to Buyer in the Contract Documents.

4.03 *Licensed Sureties and Insurers*

A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Buyer or Seller shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

ARTICLE 5 - SELLER'S RESPONSIBILITIES

5.01 *Supervision and Superintendence*

A. Seller shall supervise, inspect, and direct the furnishing of the Goods and Special Services competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform its obligations in accordance with the Contract Documents. Seller shall be solely responsible for the means, methods, techniques, sequences, and procedures necessary to perform its obligations in accordance with the Contract Documents. Seller shall not be responsible for the negligence of Buyer or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure that is shown or indicated in and expressly required by the Contract Documents.

5.02 *Labor, Materials and Equipment*

A. Seller shall provide competent, qualified and trained personnel in all aspects of its performance of the Contract.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

B. All Goods, and all equipment and material incorporated into the Goods, shall be as specified, and unless specified otherwise in the Contract Documents, shall be:

1. new, and of good quality;

2. protected, assembled, connected, cleaned, and conditioned in accordance with the original manufacturer's instructions; and

3. shop assembled to the greatest extent practicable.

5.03 *Laws and Regulations*

A. Seller shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of its obligations in accordance with the Contract Documents. Except where otherwise expressly required by such Laws and Regulations, neither Buyer nor Engineer shall be responsible for monitoring Seller's compliance with any Laws or Regulations.

B. If Seller furnishes Goods and Special Services knowing or having reason to know that such furnishing is contrary to Laws or Regulations, Seller shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such performance. It shall not be Seller's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this provision shall not relieve Seller of Seller's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance shall be the subject of an adjustment in Contract Price or Contract Times. If Buyer and Seller are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 9.06.

5.04 *Or Equals*

A. Whenever the Goods, or an item of material or equipment to be incorporated into the Goods, are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular supplier or manufacturer, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item is permitted, other items of material or equipment or material or equipment of other suppliers or manufacturers may be submitted to Buyer for Engineer's review.

1. If in Engineer's sole discretion, such an item of material or equipment proposed by Seller is functionally equal to that named and sufficiently similar so that no change in related work will be required, it may be considered by Engineer as an "or-equal" item.

2. For the purposes of this paragraph, a proposed item of material or equipment may be considered functionally equal to an item so named only if:

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

a. in the exercise of reasonable judgment, Engineer determines that: 1) it is at least equal in quality, durability, appearance, strength, and design characteristics; 2) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole; 3) it has an acceptable record of performance and availability of responsive service; and

b. Seller certifies that if approved: 1) there will be no increase in any cost, including capital, installation or operating costs, to Buyer; and 2) the proposed item will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraph 5.04.A. Engineer will be the sole judge of whether to accept or reject such a proposal or submittal. No "or-equal" will be ordered, manufactured or utilized until Engineer's review is complete, which will be evidenced by an approved Shop Drawing. Engineer will advise Buyer and Seller in writing of any negative determination. Notwithstanding Engineer's approval of an "or-equal" item, Seller shall remain obligated to comply with the requirements of the Contract Documents.

C. *Special Guarantee:* Buyer may require Seller to furnish at Seller's expense a special performance guarantee or other surety with respect to any such proposed "or-equal."

D. *Data:* Seller shall provide all data in support of any such proposed "or-equal" at Seller's expense.

5.05 *Taxes*

A. Seller shall be responsible for all taxes and duties arising out of the sale of the Goods and the furnishing of Special Services. All taxes are included in the Contract Price, except as noted in the Supplementary Conditions.

5.06 *Shop Drawings and Samples*

A. Seller shall submit Shop Drawings and Samples to Buyer for Engineer's review and approval in accordance with the schedule required in Paragraph 2.06.A. All submittals will be identified as required and furnished in the number of copies specified in the Contract Documents. The data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Seller proposes to provide.

B. Where a Shop Drawing or Sample is required by the Contract Documents, any related work performed prior to Engineer's approval of the pertinent submittal will be at the sole expense and responsibility of Seller.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

C. *Submittal Procedures:*

1. Before submitting each Shop Drawing or Sample, Seller shall have determined and verified:

   a. all field measurements (if required), quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto; and

   b. that all materials are suitable with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the furnishing of Goods and Special Services.

2. Seller shall also have reviewed and coordinated each Shop Drawing or Sample with the Contract Documents.

3. Each submittal shall bear a stamp or include a written certification from Seller that Seller has reviewed the subject submittal and confirmed that it is in compliance with the requirements of the Contract Documents. Both Buyer and Engineer shall be entitled to rely on such certification from Seller.

4. With each submittal, Seller shall give Buyer and Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both in a written communication separate from the submittal and by specific notation on each Shop Drawing or Sample.

D. *Engineer's Review:*

1. Engineer will provide timely review of Shop Drawings and Samples.

2. Engineer's review and approval will be only to determine if the Goods and Special Services covered by the submittals will, after installation or incorporation in the Project, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole.

3. Engineer's review and approval shall not relieve Seller from responsibility for any variation from the requirements of the Contract Documents unless Seller has complied with the requirements of Paragraph 5.06.C.4 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Seller from responsibility for complying with the requirements of Paragraph 5.06.C.1.

E. *Resubmittal Procedures:*

1. Seller shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Seller shall direct specific attention in writing to any revisions other than the corrections called for by Engineer on previous submittals.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

5.07 *Continuing Performance*

A. Seller shall adhere to the progress schedule established in accordance with Paragraph 2.06.A., and the Goods shall be delivered and the Special Services furnished within the Contract Times specified in the Agreement.

B. Seller shall carry on furnishing of the Goods and Special Services and adhere to the progress schedule during all disputes or disagreements with Buyer. No furnishing of Goods and Special Services shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraphs 11.03 or 11.04, or as Buyer and Seller may otherwise agree in writing.

5.08 *Seller's Warranties and Guarantees*

A. Seller warrants and guarantees to Buyer that the title to the Goods conveyed shall be proper, its transfer rightful, and free from any security interest, lien, or other encumbrance. Seller shall defend, indemnify, and hold Buyer harmless against any liens, claims, or demands contesting or affecting title of the Goods conveyed.

B. Seller warrants and guarantees to Buyer that all Goods and Special Services will conform with the Contract Documents, and with the standards established by any Samples approved by Engineer. Engineer shall be entitled to rely on Seller's warranty and guarantee. If the Contract Documents do not otherwise specify the characteristics or the quality of the Goods, the Goods shall comply with the requirements of Paragraph 5.02.B.

C. Seller's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, improper modification, improper maintenance, or improper operation by persons other than Seller; or

2. corrosion or chemical attack, unless corrosive or chemically-damaging conditions were disclosed by Buyer in the Contract Documents and the Contract Documents required the Goods to withstand such conditions;

3. use in a manner contrary to Seller's written instructions for installation, operation, and maintenance; or

4. normal wear and tear under normal usage.

D. Seller's obligation to furnish the Goods and Special Services in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Goods and Special Services that are non-conforming, or a release of Seller's obligation to furnish the Goods and Special Services in accordance with the Contract Documents:

1. observations by Buyer or Engineer;

2. recommendation by Engineer or payment by Buyer of any progress or final payment;

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

3. use of the Goods by Buyer;

4. any acceptance by Buyer (subject to the provisions of Paragraph 8.02.D.1) or any failure to do so;

5. the issuance of a notice of acceptance by Buyer pursuant to the provisions of Article 8;

6. any inspection, test or approval by others; or

7. any correction of non-conforming Goods and Special Services by Buyer.

E. Buyer shall promptly notify Seller of any breach of Seller's warranties or guarantees.

F. Seller makes no implied warranties under this Contract.

5.09 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Seller shall indemnify and hold harmless Buyer and Engineer, and the officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of Seller's obligations under the Contract Documents, provided that any such claim, cost, loss, or damages attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Goods themselves), including the loss of use resulting therefrom, but only to the extent cause by any negligent act or omission of Seller, or any individual or entity directly or indirectly employed by Seller or anyone for whose acts Seller may be liable.

B. In any and all claims against Buyer or Engineer or any of their respective assignees, consultants, agents, officers, directors, members, partners, employees, agents, consultants, contractors, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Seller, any subcontractor, any supplier, or any individual or entity directly or indirectly employed by any of them to furnish any of the Goods and Special Services, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 5.09.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for seller or any such subcontractor, supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Seller under Paragraph 5.09.A shall not extend to the liability of Engineer and Engineer's officers, directors, partners, employees, agents, and consultants arising out of:

1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

5.10 *Delegation of Professional Design Services*

A. Seller will not be required to provide professional design services unless such services are specifically required by the Contract Documents or unless such services are required to carry out Seller's responsibilities for furnishing the Goods and Special Services. Seller shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to the Goods and Special Services are specifically required of Seller by the Contract Documents, Buyer and Engineer will specify all performance and design criteria that such services must satisfy. Seller shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Goods and Special Services designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Buyer and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Buyer and Engineer have specified to Seller all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 5.10, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 5.06.D.2.

E. Seller shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 6 - SHIPPING AND DELIVERY

6.01 *Shipping*

A. Seller shall select the carrier and bear all costs of packaging, transportation, insurance, special handling and any other costs associated with shipment and delivery.

6.02 *Delivery*

A. Seller shall deliver the Goods F.O.B. the Point of Destination in accordance with the Contract Times set forth in the Agreement, or other date agreed to by Buyer and Seller.

B. Seller shall provide written notice to Buyer at least 10 days before shipment of the manner of shipment and the anticipated delivery date. The notice shall also include any instructions concerning special equipment or services required at the Point of Destination to unload and care

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

for the Goods. Seller shall also require the carrier to give Buyer at least 24 hours notice by telephone prior to the anticipated time of delivery.

C. Buyer will be responsible and bear all costs for unloading the Goods from carrier.

D. Buyer will assure that adequate facilities are available to receive delivery of the Goods during the Contract Times for delivery set forth in the Agreement, or another date agreed by Buyer and Seller.

E. No partial deliveries shall be allowed, unless permitted or required by the Contract Documents or agreed to in writing by Buyer.

6.03 *Risk of Loss*

A. Risk of loss and insurable interests transfer from Seller to Buyer upon Buyer's receipt of the Goods.

B. Notwithstanding the provisions of Paragraph 6.03.A, if Buyer rejects the Goods as non-conforming, the risk of loss on such Goods shall remain with Seller until Seller corrects the non-conformity or Buyer accepts the Goods. If rejected Goods remain at the Point of Destination pending modification and acceptance, then Seller shall be responsible for arranging adequate protection and maintenance of the Goods at Seller's expense.

6.04 *Progress Schedule*

A. Seller shall adhere to the progress schedule established in accordance with Paragraph 2.06 as it may be adjusted from time to time as provided below.

1. Seller shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.06) proposed adjustments in the progress schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the progress schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 7. Adjustments in Contract Times may only be made by a Change Order.

ARTICLE 7 - CHANGES: SCHEDULE AND DELAY

7.01 *Changes in the Goods and Special Services*

A. Buyer may at any time, without notice to any surety, make an addition, deletion, or other revision to the Contract Documents with respect to the Goods and Services, within the general scope of the Contract, by a Change Order or Work Change Directive. Upon receipt of any such document, Seller shall promptly proceed with performance pursuant to the revised Contract Documents (except as otherwise specifically provided).

B. If Seller concludes that a Work Change Directive issued by Buyer affects the Contract Price or Contract Times, then Seller shall notify Buyer within 15 days after Seller has received the Work

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

Change Directive, and submit written supporting data to Buyer within 45 days after such receipt. If Seller fails to notify Buyer within 15 days, Seller waives any Claim for such adjustment. If Buyer and Seller are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 9.06.

C. Seller shall not suspend performance while Buyer and Seller are in the process of making such changes and any related adjustments to Contract Price or Contract Times.

7.02 *Changing Contract Price or Contract Times*

A. The Contract Price or Contract Times may only be changed by a Change Order.

B. Any Claim for an adjustment in the Contract Price or Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 9.06.

C. If Seller is prevented from delivering the Goods or performing the Special Services within the Contract Times for any unforeseen reason beyond its control and not attributable to its actions or inactions, then Seller shall be entitled to an adjustment of the Contract Times to the extent attributable to such reason. Such reasons include but are not limited to acts or neglect by Buyer, inspection delays, fires, floods, epidemics, abnormal weather conditions, acts of God, and other like matters. If such an event occurs and delays Seller's performance, Seller shall notify Buyer in writing within 15 days of knowing or having reason to know of the beginning of the event causing the delay, stating the reason therefor.

D. Seller shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Seller. Delays attributable to and within the control of Seller's subcontractors or suppliers shall be deemed to be delays within the control of Seller.

E. If Seller is prevented from delivering the Goods or furnishing the Special Services within the Contract Times due to the actions or inactions of Buyer, Seller shall be entitled to any reasonable and necessary additional costs arising out of such delay to the extent directly attributable to Buyer.

F. Neither Buyer nor Seller shall be entitled to any damages arising from delays which are beyond the control of both Buyer and Seller, including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God, and other like matters.

ARTICLE 8 - BUYER'S RIGHTS

8.01 *Inspections and Testing*

A. *General:*

1. The Contract Documents specify required inspections and tests. Buyer shall have the right to perform, or cause to be performed, reasonable inspections and require reasonable

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

tests of the Goods at Seller's facility, and at the Point of Destination. Seller shall allow Buyer a reasonable time to perform such inspections or tests.

2. Seller shall reimburse Buyer for all expenses, except for travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, for inspections and tests specified in the Contract Documents. If as the result of any such specified testing the Goods are determined to be non-conforming, then Seller shall also bear the travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, and all expenses of re-inspection or retesting.

3. Buyer shall bear all expenses of inspections and tests that are not specified in the Contract Documents (other than any re-inspection or retesting resulting from a determination of non-conformity, as set forth in Paragraph 8.01.A.2 immediately above); provided, however, that if as the result of any such non-specified inspections or testing the Goods are determined to be non-conforming, then Seller shall bear all expenses of such inspections and testing, and of any necessary re-inspection and retesting.

4. Seller shall provide Buyer timely written notice of the readiness of the Goods for all inspections, tests, or approvals which the Contract Documents specify are to be observed by Buyer prior to shipment.

5. Buyer will give Seller timely notice of all specified tests, inspections, and approvals of the Goods which are to be conducted at the Point of Destination.

6. If, on the basis of any inspections or testing, the Goods appear to be conforming, Buyer will give Seller prompt notice thereof. If on the basis of said inspections or testing, the Goods appear to be non-conforming, Buyer will give Seller prompt notice thereof and will advise Seller of the remedy Buyer elects under the provisions of Paragraph 8.02.

7. Neither payments made by Buyer to Seller prior to any tests or inspections, nor any tests or inspections shall constitute acceptance of non-conforming Goods, or prejudice Buyer's rights under the Contract.

B. Inspection on Delivery:

1. Buyer or Engineer will visually inspect the Goods upon delivery solely for purposes of identifying the Goods and general verification of quantities and observation of apparent condition in order to provide a basis for a progress payment. Such visual inspection will not be construed as final or as receipt of any Goods and Special Services that, as a result of subsequent inspections and tests, are determined to be non-conforming.

2. Within ten days of such visual inspection, Buyer shall provide Seller with written notice of Buyer's determination regarding conformity of the Goods. In the event Buyer does not provide such notice, it will be presumed that the Goods appear to be conforming and that Buyer has acknowledged their receipt upon delivery.

3. If, on the basis of the visual inspection specified in Paragraph 8.01.B.1, the Goods appear to be conforming, Buyer's notice thereof to Seller will acknowledge receipt of the Goods.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

C. Final Inspection:

1. After all of the Goods have been incorporated into the Project, tested in accordance with such testing requirements as are specified, and are functioning as indicated, Buyer or Engineer will make a final inspection.

2. If, on the basis of the final inspection, the Goods are conforming, Buyer's notice thereof will constitute Buyer's acceptance of the Goods.

3. If, on the basis of the final inspection, the Goods are non-conforming, Buyer will identify the non-conformity in writing.

8.02 *Non-Conforming Goods and Special Services*

A. If, on the basis of inspections and testing prior to delivery, the Goods and Special Services are found to be non-conforming, or if at any time after Buyer has acknowledged receipt of delivery and before the expiration of the correction period described in Paragraph 8.03, Buyer determines that the Goods and Special Services are non-conforming, then Seller shall promptly, without cost to Buyer and in response to written instructions from Buyer, either correct such non-conforming Goods and Special Services, or, if Goods are rejected by Buyer, remove and replace the non-conforming Goods with conforming Goods, including all work required for reinstallation.

B. Buyer's Rejection of Non-Conforming Goods:

1. If Buyer elects to reject the Goods in whole or in part, Buyer's notice to Seller will describe in sufficient detail the non-conforming aspect of the Goods. If Goods have been delivered to Buyer, Seller shall promptly, and within the Contract Times, remove and replace the rejected Goods.

2. Seller shall bear all costs, losses and damages attributable to the removal and replacement of the non-conforming Goods as provided in Paragraph 8.02.E.

3. Upon rejection of the Goods, Buyer retains a security interest in the Goods to the extent of any payments made and expenses incurred in their testing and inspection.

C. Remedying Non-Conforming Goods and Special Services:

1. If Buyer elects to permit the Seller to modify the Goods to correct the non-comformance, then Seller shall promptly provide a schedule for such modifications and shall make the Goods conforming within a reasonable time.

2. If Buyer notifies Seller in writing that any of the Special Services are non-conforming, Seller shall promptly provide conforming services acceptable to Buyer. If Seller fails to do so, Buyer may delete the Special Services and reduce the Contract Price a commensurate amount.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

D. Buyer's Acceptance of Non-Conforming Goods:

Instead of requiring correction or removal and replacement of non-conforming Goods discovered either before or after final payment, Buyer may accept the non-conforming Goods. Seller shall bear all reasonable costs, losses, and damages attributable to Buyer's evaluation of and determination to accept such non-conforming Goods as provided in Paragraph 8.02.E.

E. Seller shall pay all claims, costs, losses, and damages, including but not limited to all fees and charges for re-inspection, retesting and for any engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs arising out of or relating to the non-conforming Goods and Special Services. Seller's obligations shall include the costs of the correction or removal and replacement of the non-conforming Goods and the replacement of property of Buyer and others destroyed by the correction or removal and replacement of the non-conforming Goods, and obtaining conforming Special Services from others.

F. *Buyer's Rejection of Conforming Goods:*

If Buyer asserts that Goods and Special Services are non-conforming and such Goods and Special Services are determined to be conforming, or if Buyer rejects as non-conforming Goods and Special Services that are later determined to be conforming, then Seller shall be entitled to reimbursement from Buyer of costs incurred by Seller in inspecting, testing, correcting, removing, or replacing the conforming Goods and Special Services, including but not limited to fees and charges of engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs associated with the incorrect assertion of non-conformance or rejection of conforming Goods and Special Services.

8.03 *Correction Period*

A. Seller's responsibility for correcting all non-conformities in the Goods and Special Services will extend for a period of one year after the earlier of the date on which Buyer has placed the Goods in continuous service or the date of final payment, or for such longer period of time as may be prescribed by Laws or Regulations or by the terms of any specific provisions of the Contract Documents.

ARTICLE 9 - ROLE OF ENGINEER

9.01 *Duties and Responsibilities*

A. The duties and responsibilities and the limitations of authority of Engineer are set forth in the Contract Documents.

9.02 *Clarifications and Interpretations*

A. Engineer will issue with reasonable promptness such written clarifications or interpretations of the Contract Documents as Engineer may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents. Such written

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

clarifications and interpretations will be binding on Buyer and Seller. If either Buyer or Seller believes that a written clarification or interpretation justifies an adjustment in the Contract Price or Contract Times, either may make a Claim therefor.

9.03 *Authorized Variations*

A. Engineer may authorize minor deviations or variations in the Contract Documents by: 1) written approval of specific variations set forth in Shop Drawings when Seller has duly noted such variations as required in Paragraph 5.06.C.4, or 2) a Field Order.

9.04 *Rejecting Non-Conforming Goods and Special Services*

A. Engineer will have the authority to disapprove or reject Goods and Special Services that Engineer believes to be non-conforming. Engineer will also have authority to require special inspection or testing of the Goods or Special Services as provided in Paragraph 8.01 whether or not the Goods are fabricated or installed, or the Special Services are completed.

9.05 *Decisions on Requirements of Contract Documents*

A. Engineer will be the initial interpreter of the Contract Documents and judge of the acceptability of the Goods and Special Services. Claims, disputes and other matters relating to the acceptability of the Goods and Special Services or the interpretation of the requirements of the Contract Documents pertaining to Seller's performance will be referred initially to Engineer in writing with a request for a formal decision in accordance with this paragraph.

B. When functioning as interpreter and judge under this Paragraph 9.05, Engineer will not show partiality to Buyer or Seller and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity. The rendering of a decision by Engineer pursuant to this Paragraph 9.05 with respect to any such Claim, dispute, or other matter (except any which have been waived by the making or acceptance of final payment as provided in Paragraph 10.07) will be a condition precedent to any exercise by Buyer or Seller of such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any such Claim, dispute, or other matter.

9.06 *Claims and Disputes*

A. *Notice*: Written notice of each Claim relating to the acceptability of the Goods and Special Services or the interpretation of the requirements of the Contract Documents pertaining to either party's performance shall be delivered by the claimant to Engineer and the other party to the Agreement within 15 days after the occurrence of the event giving rise thereto, and written supporting data shall be submitted to Engineer and the other party within 45 days after such occurrence unless Engineer allows an additional period of time to ascertain more accurate data.

B. *Engineer's Decision*: Engineer will review each such Claim and render a decision in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

C. If Engineer does not render a formal written decision on a Claim within the time stated in Paragraph 9.06.B., Engineer shall be deemed to have issued a decision denying the Claim in its entirety 31 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

D. Engineer's written decision on such Claim or a decision denying the Claim in its entirety that is deemed to have been issued pursuant to Paragraph 9.06.C, will be final and binding upon Buyer and Seller 30 days after it is issued unless within 30 days of issuance Buyer or Seller appeals Engineer's decision by initiating the mediation of such Claim in accordance with the dispute resolution procedures set forth in Article 13.

E. If Article 13 has been amended to delete the mediation requirement, then Buyer or Seller may appeal Engineer's decision within 30 days of issuance by following the alternative dispute resolution process set forth in Article 13, as amended; or if no such alternative dispute resolution process has been set forth, Buyer or Seller may appeal Engineer's decision by 1) delivering to the other party within 30 days of the date of such decision a written notice of intent to submit the Claim to a court of competent jurisdiction, and 2) within 60 days after the date of such decision instituting a formal proceeding in a court of competent jurisdiction.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 9.06.

G. The parties agree to endeavor to avoid or resolve Claims through direct, good faith discussions and negotiations whenever practicable. Such discussions and negotiations should at the outset address whether the parties mutually agree to suspend the time periods established in this Paragraph 9.06; if so, a written record of such mutual agreement should be made and jointly executed.

ARTICLE 10 - PAYMENT

10.01 *Applications for Progress Payments*

A. Seller shall submit to Buyer for Engineer's review Applications for Payment filled out and signed by Seller and accompanied by such supporting documentation as is required by the Contract Documents and also as Buyer or Engineer may reasonably require. The timing and amounts of progress payments shall be as stipulated in the Agreement.

1. The first application for Payment will be submitted after review and approval by Engineer of all Shop Drawings and of all Samples required by the Contract Documents.

2. The second Application for Payment will be submitted after receipt of the Goods has been acknowledged in accordance with Paragraph 8.01.B and will be accompanied by a bill of sale, invoice, or other documentation reasonably satisfactory to Buyer warranting that Buyer has rightfully received good title to the Goods from Seller and that, upon payment, the Goods will be free and clear of all liens. Such documentation will include releases and waivers from all parties with viable lien rights. In the case of multiple deliveries of Goods, additional Applications for Payment accompanied by the required

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

documentation will be submitted as Buyer acknowledges receipt of additional items of the Goods.

10.02 *Review of Applications for Progress Payments*

A. Engineer will, within ten days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Buyer, or return the Application to Seller indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Seller may make the necessary corrections and resubmit the Application.

1. Engineer's recommendation of payment requested in the first Application for Payment will constitute a representation by Engineer, based on Engineer's review of the Application for Payment and the accompanying data, that the Shop Drawings and Samples have been reviewed and approved as required by the Contract Documents and Seller is entitled to payment of the amount recommended.

2. Engineer's recommendation of payment requested in the Application for Payment submitted upon Buyer's acknowledgment of receipt of the Goods will constitute a representation by Engineer, based on Engineer's review of the Application for Payment and the accompanying data Seller is entitled to payment of the amount recommended. Such recommendation will not constitute a representation that Engineer has made a final inspection of the Goods, that the Goods are free from non-conformities, acceptable or in conformance with the Contract Documents, that Engineer has made any investigation as to Buyer's title to the Goods, that exhaustive or continuous inspections have been made to check the quality or the quantity of the Goods beyond the responsibilities specifically assigned to Engineer in the Contract Documents or that there may not be other matters or issues between the parties that might entitle Seller to additional payments by Buyer or Buyer to withhold payment to Seller.

3. Engineer may refuse to recommend that all or any part of a progress payment be made, or Engineer may nullify all or any part of any payment previously recommended if, in Engineer's opinion, such recommendation would be incorrect or if on the basis of subsequently discovered evidence or subsequent inspections or tests Engineer considers such refusal or nullification necessary to protect Buyer from loss because the Contract Price has been reduced, Goods are found to be non-conforming, or Seller has failed to furnish acceptable Special Services.

10.03 *Amount and Timing of Progress Payments*

A. Subject to Paragraph 10.02.A., the amounts of the progress payments will be as provided in the Agreement. Buyer shall within 30 days after receipt of each Application for Payment with Engineer's recommendation pay Seller the amount recommended; but, in the case of the Application for Payment upon Buyer's acknowledgment of receipt of the Goods, said 30-day period may be extended for so long as is necessary (but in no event more than 60 days) for Buyer to examine the bill of sale and other documentation submitted therewith. Buyer shall notify Seller promptly of any deficiency in the documentation and shall not unreasonably withhold payment.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

10.04 *Suspension of or Reduction in Payment*

A. Buyer may suspend or reduce the amount of progress payments, even though recommended for payment by Engineer, under the following circumstances:

1. Buyer has reasonable grounds to conclude that Seller will not furnish the Goods or the Special Services in accordance with the Contract Documents, and

2. Buyer has requested in writing assurances from Seller that the Goods and Special Services will be delivered or furnished in accordance with the Contract Documents, and Seller has failed to provide adequate assurances within ten days of Buyer's written request.

B. If Buyer refuses to make payment of the full amount recommended by Engineer, Buyer will provide Seller and Engineer immediate written notice stating the reason for such action and promptly pay Seller any amount remaining after deduction of the amount withheld. Buyer shall promptly pay Seller the amount withheld when Seller corrects the reason for such action to Buyer's satisfaction.

10.05 *Final Application for Payment*

A. After Seller has corrected all non-conformities to the reasonable satisfaction of Buyer and Engineer, furnished all Special Services, and delivered all documents required by the Contract Documents, Engineer will issue to Buyer and Seller a notice of acceptance. Seller may then make application for final payment following the procedure for progress payments. The final Application for Payment will be accompanied by all documentation called for in the Contract Documents, a list of all unsettled Claims, and such other data and information as Buyer or Engineer may reasonably require.

10.06 *Final Payment*

A. If, on the basis of final inspection and the review of the final Application for Payment and accompanying documentation, Engineer is reasonably satisfied that Seller has furnished the Goods and Special Services in accordance with the Contract Documents, and that Seller's has fulfilled all other obligations under the Contract Documents, then Engineer will, within ten days after receipt of the final Application for Payment, recommend in writing final payment subject to the provisions of Paragraph 10.07 and present the Application to Buyer. Otherwise, Engineer will return the Application to Seller, indicating the reasons for refusing to recommend final payment, in which case Seller shall make the necessary corrections and resubmit the Application for payment. If the Application and accompanying documentation are appropriate as to form and substance, Buyer shall, within 30 days after receipt thereof, pay Seller the amount recommended by Engineer, less any sum Buyer is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages to which Buyer is entitled.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

10.07 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Buyer against Seller, except Claims arising from unsettled liens from non-conformities in the Goods or Special Services appearing after final payment, from Seller's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Seller's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Seller against Buyer (other than those previously made in accordance with the requirements herein and listed by Seller as unsettled as required in Paragraph 10.05.A, and not resolved in writing).

ARTICLE 11 - CANCELLATION, SUSPENSION, AND TERMINATION

11.01 *Cancellation*

A. Buyer has the right to cancel the Contract, without cause, at any time prior to delivery of the Goods by written notice. Cancellation pursuant to the terms of this paragraph shall not constitute a breach of contract by Buyer. Upon cancellation:

1. Buyer shall pay Seller for the direct costs incurred in producing any Goods that Seller has specially manufactured for the Project, plus a fair and reasonable amount for overhead and profit.

2. For Goods that are not specially manufactured for the Project, Seller shall be entitled to a restocking charge of 10 percent of the unpaid Contract Price of such Goods.

11.02 *Suspension of Performance by Buyer*

A. Buyer has the right to suspend performance of the Contract for up to a maximum of ninety days, without cause, by written notice. Upon suspension under this paragraph, Seller shall be entitled to an increase in the Contract Times and Contract Price caused by the suspension, provided that performance would not have been suspended or delayed for causes attributable to Seller.

11.03 *Suspension of Performance by Seller*

A. Subject to the provisions of Paragraph 5.07.B, Seller may suspend the furnishing of the Goods and Special Services only under the following circumstance:

1. Seller has reasonable grounds to conclude that Buyer will not perform its future payment obligations under the Contract; and,

2. Seller has requested in writing assurances from Buyer that future payments will be made in accordance with the Contract, and Buyer has failed to provide such assurances within ten days of Seller's written request.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

11.04 *Breach and Termination*

A. Buyer's Breach:

1. Buyer shall be deemed in breach of the Contract if it fails to comply with any material provision of the Contract Documents, including but not limited to:

   a. wrongful rejection or revocation of Buyer's acceptance of the Goods,

   b. failure to make payments in accordance with the Contract Documents, or

   c. wrongful repudiation of the Contract.

2. Seller shall have the right to terminate the Contract for cause by declaring a breach should Buyer fail to comply with any material provisions of the Contract. Upon termination, Seller shall be entitled to all remedies provided by Laws and Regulations.

   a. In the event Seller believes Buyer is in breach of its obligations under the Contract, Seller shall provide Buyer with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Buyer shall have seven days from receipt of the written notice declaring the breach (or such longer period of time as Seller may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

B. Seller's Breach:

1. Seller shall be deemed in breach of the Contract if it fails to comply with any material provision of the Contract Documents, including, but not limited to:

   a. failure to deliver the Goods or perform the Special Services in accordance with the Contract Documents,

   b. wrongful repudiation of the Contract, or

   c. delivery or furnishing of non-conforming Goods and Special Services.

2. Buyer may terminate Seller's right to perform the Contract for cause by declaring a breach should Seller fail to comply with any material provision of the Contract Documents. Upon termination, Buyer shall be entitled to all remedies provided by Laws and Regulations.

   a. In the event Buyer believes Seller is in breach of its obligations under the Contract, and except as provided in Paragraph 11.04.B.2.b, Buyer shall provide Seller with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Seller shall have seven days from receipt of the written notice declaring the breach (or such longer period of time as Buyer may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

b. If and to the extent that Seller has provided a performance bond under the provisions of Paragraph 4.01, the notice and cure procedures of that bond, if any, shall supersede the notice and cure procedures of Paragraph 11.04.B.2.a.

ARTICLE 12 - LICENSES AND FEES

12.01 *Intellectual Property and License Fees*

A. Unless specifically stated elsewhere in the Contract Documents, Seller is not transferring any intellectual property rights, patent rights, or licenses for the Goods delivered. However, in the event the Seller is manufacturing to Buyer's design, Buyer retains all intellectual property rights in such design.

B. Seller shall pay all license fees and royalties and assume all costs incident to the use or the furnishing of the Goods, unless specified otherwise by the Contract Documents.

12.02 *Seller's Infringement*

A. Subject to Paragraph 12.01.A, Seller shall indemnify and hold harmless Buyer, Engineer and their officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors from and against all claims, costs, losses, damages, and judgments (including but not limited to all reasonable fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement or alleged infringement of any United States or foreign patent or copyright by any of the Goods as delivered hereunder.

B. In the event of suit or threat of suit for intellectual property infringement, Buyer will promptly notify Seller of receiving notice thereof.

C. Seller shall promptly defend the claim or suit, including negotiating a settlement. Seller shall have control over such claim or suit, provided that Seller agrees to bear all expenses and to satisfy any adverse judgment thereof.

1. If Seller fails to defend such suit or claim after written notice by Buyer, Seller will be bound in any subsequent suit or claim against Seller by Buyer by any factual determination in the prior suit or claim.

2. If Buyer fails to provide Seller the opportunity to defend such suit or claim after written notice by Seller, Buyer shall be barred from any remedy against Seller for such suit or claim.

D. If a determination is made that Seller has infringed upon intellectual property rights of another, Seller may obtain the necessary licenses for Buyer's benefit, or replace the Goods and provide related design and construction as necessary to avoid the infringement at Seller's own expense.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

12.03 *Buyer's Infringement*

A. Buyer shall indemnify and hold harmless Seller, and its officers, directors, partners, employees, agents, consultants, contractors, and subcontractors from and against all claims, costs, losses, damages, and judgments (including but not limited to all reasonable fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement or alleged infringement of any United States or foreign patent or copyright caused by Seller's compliance with Buyer's design of the Goods or Buyer's use of the Goods in combination with other materials or equipment in any process (unless intent of such use was known to Seller and Seller had reason to know such infringement would result).

B. In the event of suit or threat of suit for intellectual property infringement, Seller must after receiving notice thereof promptly notify Buyer.

C. Upon written notice from Seller, Buyer shall be given the opportunity to defend the claim or suit, including negotiating a settlement. Buyer shall have control over such claim or suit, provided that Buyer agrees to bear all expenses and to satisfy any adverse judgment thereof.

1. If Buyer fails to defend such suit or claim after written notice by Seller, Buyer will be bound in any subsequent suit or claim against Buyer by Seller by any factual determination in the prior suit or claim.

2. If Seller fails to provide Buyer the opportunity to defend such suit or claim after written notice by Buyer, Seller shall be barred from any remedy against Buyer for such suit or claim.

12.04 *Reuse of Documents*

A. Neither Seller nor any other person furnishing any of the Goods and Special Services under a direct or indirect contract with Seller shall: (1) acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions; or (2) reuse any of such Drawings, Specifications, other documents, or copies thereof on any other project without written consent of Buyer and Engineer and specific written verification or adaptation by Engineer. This prohibition will survive termination or completion of the Contract. Nothing herein shall preclude Seller from retaining copies of the Contract Documents for record purposes.

12.05 *Electronic Data*

A. Unless otherwise stated in the Supplementary Conditions, copies of data furnished by Buyer or Engineer to Seller, or by Seller to Buyer or Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. The transferring party will correct any errors detected within the 60-day acceptance period.

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 13 - DISPUTE RESOLUTION

13.01 *Dispute Resolution Method*

A. Either Buyer or Seller may initiate the mediation of any Claim decided in writing by Engineer under Paragraph 9.06.B or 9.06.C before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the Engineer's decision from becoming final and binding.

B. Buyer and Seller shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the mediation process does not result in resolution of the Claim, then Engineer's written decision under Paragraph 9.06.B or a denial pursuant to Paragraph 9.06.C shall become final and binding 30 days after termination of the mediation unless, within that time period, Buyer or Seller:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions, or

2. agrees with the other party to submit the Claim to another dispute resolution process, or

3. if no dispute resolution process has been provided for in the Supplementary Conditions, delivers to the other party written notice of the intent to submit the Claim to a court of competent jurisdiction, and within 60 days of the termination of the mediation institutes such formal proceeding.

ARTICLE 14 - MISCELLANEOUS

14.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if: 1) delivered in person to the individual or to a member

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

of the firm or to an officer of the corporation for whom it is intended, or 2) if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

14.02 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Point of Destination is located.

B. In the case of any conflict between the express terms of this Contract and the Uniform Commercial Code, as adopted in the state whose law governs, it is the intent of the parties that the express terms of this Contract shall apply.

14.03 *Computation of Time*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day shall be omitted from the computation.

14.04 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents, and the provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

14.05 *Survival of Obligations*

A. All representations, indemnifications, warranties and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Goods and Special Services and termination or completion of the Agreement.

14.06 *Entire Agreement*

A. Buyer and Seller agree that this Agreement is the complete and final agreement between them, and supersedes all prior negotiations, representations, or agreements, either written or oral. This Agreement may not be altered, modified, or amended except in writing signed by an authorized representative of both parties.

Copyright © 2010 National Society of Professional Engineers, American Council of Engineering Companies, American Society of Civil Engineers, and Associated General Contractors of America. All rights reserved.

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Procurement Contract (P-700, 2010) and other provisions of the Contract Documents as indicated below. All provisions, which are not so amended or supplemented, remain in full force and effect.

The terms used in these Supplementary Conditions will have the meanings indicated in the General Conditions with the following additional explanation as defined in Article 1. Additional terms used in these Supplementary Conditions have the meanings indicated below, which are applicable to both the singular and plural thereof.

TABLE OF CONTENTS

		Page
Article SC-1	Definition and Terminology	1
Article SC-2	Preliminary Matters	1
Article SC-4	Bonds and Insurance	2
Article SC-6	Shipping and Delivery	4
Article SC-13	Dispute Resolution	4

ARTICLE SC-1, DEFINITIONS AND TERMINOLOGY

The Specifications are written in imperative mood and streamlined form. This imperative language is directed to the Seller, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

SC-1.01.A.3. Add the following language to the end of Paragraph 1.01.A.3:

The Application for Payment form to be used on this Project is EJCDC No. C-620. Seller may use their standard computerized forms for providing detail payment breakdown as an attachment to summary sheet.

SC-1.01.A.9. Add the following language to the end of Paragraph 1.01.A.9:

The Change Order form to be used on this Project is EJCDC No. C-941.

ARTICLE SC-2, PRELIMINARY MATTERS

SC-2.04 Delete paragraph 2.03 in its entirety and insert the following in its place:

2.04.A The Contract Times will commence to run on the day indicated in the Notice to Proceed. A Notice to Proceed will be issued at any time within 30 days after the Effective Date of the Agreement or a date agreed to by the Owner and Seller.

ARTICLE SC-4, BONDS AND INSURANCE

SC-4.02 Add the following new paragraphs immediately after paragraph 4.02.E:

F. Seller shall purchase and maintain such liability and other insurance as is appropriate for the furnishing of Goods and Special Services and as will provide protection from claims set forth below which may arise out of or result from Seller's furnishing of the Goods or

Special Services and Seller's other obligations under the Contract Documents, whether the furnishing of Goods or Special Services, or other obligations are to be performed by Seller, any subcontractor or supplier, or by anyone directly or indirectly employed by any of them to furnish the Goods or Special Services, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Seller's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other that Seller's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained: (i) by any person as a result of an offense directly or indirectly related to the employment of such person by Seller, or (ii) by any other person for any other reason;

5. claims for damages, other than to the Goods, because of injury or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

G. The policies of insurance so required by this Paragraph 4.02 to be purchased and maintained shall:

1. with respect to insurance required by Paragraphs SC-4.02.F.3 through SC-4.02.F.6 inclusive, include as additional insureds (subject to any customary exclusion in respect of professional liability) Buyer, Engineer, their consultants, and all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided below or required by Laws or Regulations, whichever is greater;

3. include completed operations insurance;

4. include contractual liability insurance covering Seller's indemnity obligations under Paragraphs 5.09 and 12.02.

5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Buyer and Seller and to each other additional insured identified in these Supplementary Conditions to whom a certificate of insurance

has been issued (and the certificates of insurance furnished by the Seller pursuant to Paragraph SC-4.02.I will so provide);

6. remain in effect at least until final payment and at all times thereafter when Seller may be correcting, removing, or replacing non-comforming Goods in accordance with paragraph 8.03; and

7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment (and Seller shall furnish Buyer and each other additional insured identified in these Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Buyer and any such additional insured of continuation of such insurance at final payment and one year thereafter).

8. with respect to any delegation of professional design services to Seller pursuant to paragraph 5.10 of the General Conditions, include professional liability coverage by endorsement or otherwise.

H. The limits of liability for the insurance required by paragraph SC-4.02.B shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Worker's Compensation, and related coverages under paragraphs SC-4.02.B.1 and B.2:

a.	Worker's Compensation:	Per the Workers' Compensation Laws of the State of North Carolina.
c.	Employers Liability:	$500,000

2. Seller's General Liability under paragraphs SC-4.02.B.3 through B.6 which shall include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of the Seller:

a.	General Aggregate	$2,000,000.00
b.	Products & Completed Operations Aggregate	$1,000,000.00
c.	Personal & Advertising Injury	$1,000,000.00
d.	Each Occurrence (Bodily Injury & Property Damage)	$1,000,000.00
e.	Property Damage liability insurance will provide Explosion, Collapse, and Under-ground coverages where applicable.	
f.	Excess or Umbrella Liability	
	1) General Aggregate	$5,000,000.00
	2) Each Occurrence	$5,000,000.00

3. Automobile Liability under Paragraph SC-4.02.B.6 of the General Conditions:

a.	Bodily Injury:	
	Each person	$1,000,000.00
	Each Accident	$1,000,000.00
b.	Property Damage:	
	Each Accident	$1,000,000.00

OR (i.e., either a. and b. or c.)

c. Combined Single Limit of $1,000,000.00

4. The Contractual Liability coverage required by Paragraph 5.04.B.4 of the General Conditions shall provide coverage for not less than the following amounts:

a. Bodily Injury:	
Each person	$2,000,000.00
Each Accident	$2,000,000.00
b. Property Damage:	
Each Accident	$2,000,000.00
Annual Aggregate	$2,000,000.00

E. Seller shall deliver to Buyer, with copies to each additional insured identified in these Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Buyer or any other additional insured) which Seller is required to purchase and maintain.

F. If Buyer has any objection to the coverage afforded by or other provisions of the insurance required to be purchased and maintained on the basis of non-conformance with the Contract Documents, Buyer shall notify Seller in writing within 10 days after receipt of the certificates or other evidence required by Paragraph SC-4.02.E. Seller shall provide such additional information in respect to insurance as Buyer shall reasonably request.

ARTICLE SC-6, SHIPPING AND DELIVERY

SC-6.02.A, Delete this Paragraph in its entirety and replace with the following:

SC-6.02.A. Seller shall deliver the Goods F.O.B. to the Point of Destination in accordance with the Contract Times set forth in the Agreement, or other date agreed to and coordinated between the Seller and the Installation Contractor.

SC-6.02.C. Change the word "Buyer" to read as "Installation Contractor".

SC-6.02.D, Delete this Paragraph in its entirety and replace with the following:

SC-6.02.D. Buyer will assure that adequate facilities are available to receive delivery of the Goods during the Contract Times for delivery set forth in the Agreement, or another date agreed by the Seller and Installation Contractor.

ARTICLE SC-13, DISPUTE RESOLUTION

SC-13.01.A, Delete the second and third sentence in Paragraph 13.01 A.

SC-13.01.B, Delete Paragraph 13.01.B in its entirety and replace with the following:

B. Disputes shall be resolved in accordance with the dispute resolution process adopted on February 26, 2002 by the N. C. State Building Commission. The "Rules Implementing Mediated Settlement Conferences in North Carolina Construction Projects" are attached to this section.

SC-13.01.C, Delete Paragraph 13.01.C in its entirety and replace it with the following:

C. All parties agree that only the North Carolina courts shall have jurisdiction over the Contract and any controversies arising out of this Contract and this agreement shall be governed by and construed in accordance with the laws of the State of North Carolina.

END OF DOCUMENT

RULES IMPLEMENTING MEDIATED SETTLEMENT CONFERENCES IN NORTH CAROLINA PUBLIC CONSTRUCTION PROJECTS

Adopted
February 26, 2002

Table of Rules

Rule

1. Initiating Mediated Settlement Conferences
   A. Purpose of Mandatory Settlement Conferences.
   B. Initiating the Dispute Resolution Process.

2. Selection of Mediator
   A. Selection of Certified Mediator by Agreement of the Parties.
   B. Nomination and Court Approval of a Non-Certified Mediator.
   C. Appointment of Mediator by the SCO.
   D. Mediator Information Directory.
   E. Disqualification of Mediator.

3. The Mediated Settlement Conference
   A. Where Conference is to be Held.
   B. When Conference is to be Held.
   C. Request to Extend Deadline for Completion.
   D. Recesses.
   E. The Mediated Settlement Conference shall not be cause for the Delay of the Construction Project which is the focus of the Dispute.

4. Duties of Parties and Other Participants in Formal Dispute Resolution Process
   A. Attendance.
   B. Finalizing Agreement.
   C. The Mediation Fee shall be paid in accordance with G.S. 143-128(g).
   D. Failure to Compensate Mediator.

5. Authority and Duties of Mediators
   A. Authority of Mediator.
   B. Duties of Mediator.

6. Compensation of the Mediator
   A. By Agreement.
   B. By Appointment.

7. Mediator Certification

8. Rule Making

9. Definitions

10. Time Limits

RULE 1. INITIATING MEDIATED SETTLEMENT CONFERENCES

A. **Purpose of Mandatory Settlement Conferences**. Pursuant to G.S. 143-128(g) 143-135.26(11), these Rules are promulgated to implement a system of settlement events which are designated to focus the parties' attention on settlement rather than on claim preparation and to provide a structured opportunity for settlement negotiations to take place. Nothing herein is intended to limit or prevent the parties from engaging in settlement procedures voluntarily at any time prior to or during commencement of the dispute resolution process.

B. **Initiating the Dispute Resolution Process**
   1) Any party to a public construction contract governed by Article 8. Ch. 143 of the General Statutes and identified in G.S. 143-128(g) and who is a party to a dispute arising out of the construction process in which the amount in controversy is at least $15,000 may submit a written request to the public owner for mediation of the dispute.
   2) Prior to submission of a written request for mediation to the public owner, the parties requesting mediation,
      a) If a prime contractor, must have first submitted its claim to the Project Designer for review as set forth in Exhibit A. If the dispute is not resolved through the Project Designer's instructions, then the dispute becomes ripe for mediation in the Formal Dispute Resolution Process, and the party may submit his written request for mediation to the public owner.
      b) If the party requesting mediation is a subcontractor, it must first have submitted its claim for mediation to the prime contractor with whom it has a contract. If the dispute is not resolved through the Prime Contractor's involvement, then the dispute becomes ripe for mediation in the Formal Dispute Resolution Process, and the party may submit its written request for mediation to the public owner.
      c) If the party requesting mediation is the Project Designer, then it must first submit its claim to the public owner to resolve. If the dispute is not resolved with the public owner's involvement, then the Project Designers' dispute is ripe for mediation in the Formal Dispute Resolution Process, and the Project Designer may submit its written request to the public owner for mediation.

RULE 2. SELECTION OF MEDIATOR

A. **Selection of Certified Mediator by Agreement of the Parties**. The parties may select a mediator certified pursuant to the Rules by agreement within 21 days of requesting mediation. The requesting party shall file with the State Construction Office (hereinafter collectively referred to as the "SCO") or public owner if a non-State project a Notice of Selection of Mediator by Agreement within 10 days of the request; however, any party may file the notice. Such notice shall state the name, address and telephone number of the mediator selected; state the rate of compensation of the mediator; state that the mediator and opposing counsel have agreed upon the selection and rate of compensation; and state that the mediator is certified pursuant to these Rules.

B. **Nomination and Public Owner Approval of a Non-Certified Mediator.** The parties may select a mediator who does not meet the certification requirements of these rules but who, in the opinion of the parties and the SCO or public owner, is otherwise qualified by training or experience to mediate the action.

If the parties select a non-certified mediator, the requesting party shall file with the SCO a Nomination of Non-Certified Mediator within 10 days of the request. Such nomination shall state the name, address and telephone number of the mediator; state the training, experience or other qualifications of the mediator; state the rate of compensation of the mediator; and state that the mediator and opposing counsel have agreed upon the selection and rate of compensation.

The SCO or public owner shall rule on said nomination, shall approve or disapprove of the parties' nomination and shall notify the parties of its decision.

C. **Appointment of Mediator by the SCO**. If the parties cannot agree upon the selection of a mediator, the party or party's attorney shall so notify the SCO or public owner and request, on behalf of the parties, that the SCO or public owner appoint a mediator. The request for appointment must be filed within 10 days after request to mediate and shall state that the parties have had a full and frank discussion concerning the selection of a mediator and have been unable to agree. The request shall state whether any party prefers a certified attorney mediator, and if so, the SCO or public owner shall appoint a certified attorney mediator. If no preference is expressed, the SCO or public owner may appoint a certified attorney mediator or a certified non-attorney mediator.

D. **Mediator Information Directory**. To assist the parties in the selection of a mediator by agreement, the parties are free to utilize the list of certified mediators maintained in any county participating in the Superior Court Mediation Settlement Conference Program.

E. **Disqualification of Mediator**. Any party may request replacement of the mediator by the SCO or public owner for good cause. Nothing in this provision shall preclude mediators from disqualifying themselves.

RULE 3. THE MEDIATED SETTLEMENT CONFERENCE

A. **Where Conference is to be Held**. Unless all parties and the mediator otherwise agree, the mediated settlement conference shall be held in the county where the project is located. The mediator shall be responsible for reserving a place and making arrangements for the conference and for giving timely notice of the time and location of the conference to all attorneys, unrepresented parties and other persons and entities required to attend.

B. **When Conference is to be Held**. The deadline for completion of the mediation shall be not less than 30 days nor more than 60 days after the naming of the mediator.

C. **Request to Extend Deadline for Completion**. A party, or the mediator, may request the SCO or public owner to extend the deadline for completion of the conference. Such request shall state the reasons the extension is sought and

shall be served by the moving party upon the other parties and the mediator. If any party does not consent to the request, said party shall promptly communicate its objection to the SCO or public owner.

The SCO or public owner may grant the request by setting a new deadline for completion of the conference.

D. **Recesses.** The mediator may recess the conference at any time and may set times for reconvening. If the time for reconvening is set before the conference is recessed, no further notification is required for persons present at the conference.

E. The mediated settlement conference shall not be cause for the delay of the construction project which is the focus of the dispute.

RULE 4. DUTIES OF PARTIES AND OTHER PARTICIPANTS IN FORMAL DISPUTE RESOLUTION PROCESS

A. **Attendance.**
1) All parties to the dispute originally presented to the Designer or Prime Contractor for initial resolution must attend the mediation. Failure of a party to a construction contract to attend the mediation will result in the public owner's withholding of monthly payment to that party until such party attends the mediation.
2) Attendance shall constitute physical attendance, not by telephone or other electronic means. Any attendee on behalf of a party must have authority from that party to bind it to any agreement reached as a result of the mediation.
3) Attorneys on behalf of parties may attend the mediation but are not required to do so.
4) Sureties or insurance company representatives are not required to attend the mediation unless any monies paid or to be paid as a result of any agreement reached as a result of mediation require their presence or acquiescence. If such agreement or presence is required, then authorized representatives of the surety or insurance company must attend the mediation.

B. **Finalizing Agreement.** If an agreement is reached in the conference, parties to the agreement shall reduce its terms to writing and sign it along with their counsel.

C. **The mediation fee shall be paid in accordance with G.S. 143-128(g).**

D. **Failure to compensate mediator.** Any party's failure to compensate the mediators in accordance with G.S. 143-128(g) shall subject that party to a withholding of said amount of money from the party's monthly payment by the public owner.

Should the public owner fail to compensate the mediator, it shall hereby be subject to a civil cause of action from the mediator for the 1/3 portion of the mediator's total fee as required by G.S. 143-128(g).

RULE 5. AUTHORITY AND DUTIES OF MEDIATORS

A. **Authority of Mediator.**

1) *Control of Conference.* The mediator shall at all times be in control of the conference and the procedures to be followed.
2) *Private Consultation.* The mediator may communicate privately with any participant or counsel prior to and during the conference. The fact that private communications have occurred with a participant shall be disclosed to all other participants at the beginning of the conference.
3) *Scheduling the Conference.* The mediator shall make a good faith effort to schedule the conference at a time that is convenient with the participants, attorneys and mediator. In the absence of agreement, the mediator shall select the date for the conference.

B. **Duties of Mediator.**

1) The mediator shall define and describe the following at the beginning of the conference:
   a) The process of mediation;
   b) The difference between mediation and other forms of conflict resolution;
   c) The costs of the mediated settlement conference;
   d) That the mediated settlement conference is not a trial, the mediator is not a judge, and the parties retain their legal rights if they do not reach settlement;
   e) The circumstances under which the mediator may meet and communicate privately with any of the parties or with any other person;
   f) Whether and under what conditions communications with the mediator will be held in confidence during the conference;
   g) The inadmissibility of conduct and statements as provided by G.S. 7A-38.1(1);
   h) The duties and responsibilities of the mediator and the participants; and
   i) That any agreement reached will be reached by mutual consent.
2) *Disclosure.* The mediator has a duty to be impartial and to advise all participants of any circumstance bearing on possible bias, prejudice or partiality.
3) *Declaring Impasse.* It is the duty of the mediator timely to determine that an impasse exists and that the conference should end.
4) *Reporting Results of Conference.* The mediator shall report to the SCO or public owner within 10 days of the conference whether or not an agreement was reached by the parties. If an agreement was reached, the report shall state the nature of said agreement. The mediator's report shall inform the SCO or public owner of the absence of any party known to the mediator to have been absent from the mediated settlement conference without permission. The SCO or public owner may require the mediator to provide statistical data for evaluation of the mediated settlement conference program.
5) *Scheduling and Holding the Conference.* It is the duty of the mediator to schedule the conference and conduct it prior to the deadline of completion set by the rules. Deadlines for completion of the conference shall be strictly observed by the mediator unless said time limit is changed by a written order of the SCO or public owner.

RULE 6. COMPENSATION OF THE MEDIATOR

A. **By Agreement.** When the mediator is stipulated by the parties, compensation shall be as agreed upon between the parties and the mediator provided that the provision of G.S. 143-128(g) are observed.
B. **By Appointment.** When the mediator is appointed by the SCO or public owner, the parties shall compensate the mediator for mediation services at the rate in accordance with the rate charged for Superior Court mediation. The parties shall also pay to the mediator a one-time per case administrative rate in accordance with the rate charged for Superior Court mediation, which is due upon appointment.

RULE 7. MEDIATOR CERTIFICATION.

All mediators certified in the Formal Dispute Resolution Program shall be properly certified in accordance with the rules certifying mediators in Superior Court in North Carolina. * When selecting mediators, the parties may designate a preference for mediators with a background in construction law or public construction contracting. Such requirements, while preferred, are not mandatory under these rules.

All mediators chosen must either demonstrate they are certified in accordance with the Rules Implementing Scheduled Mediated Settlement Conference in Superior Court or must gain the consent of the SCO or public owner to mediate any dispute in accordance with these rules.

* Except when otherwise allowed by the SCO or public owner upon the request of the parties to the mediation.

RULE 8. RULE MAKING

These Rules are subject to amendment by rule making by the State Building Commission.

These Rules are mandated for State projects when the contracting state entity has not otherwise adopted its own dispute resolution provision. These rules are optional for all other projects subject to Article 8, Ch. 143 of the General Statutes.

RULE 9. DEFINITIONS

When the phrase "SCO or public owner" is used in these rules, "SCO" shall apply to state projects, "public owner" shall apply to non-state public projects.

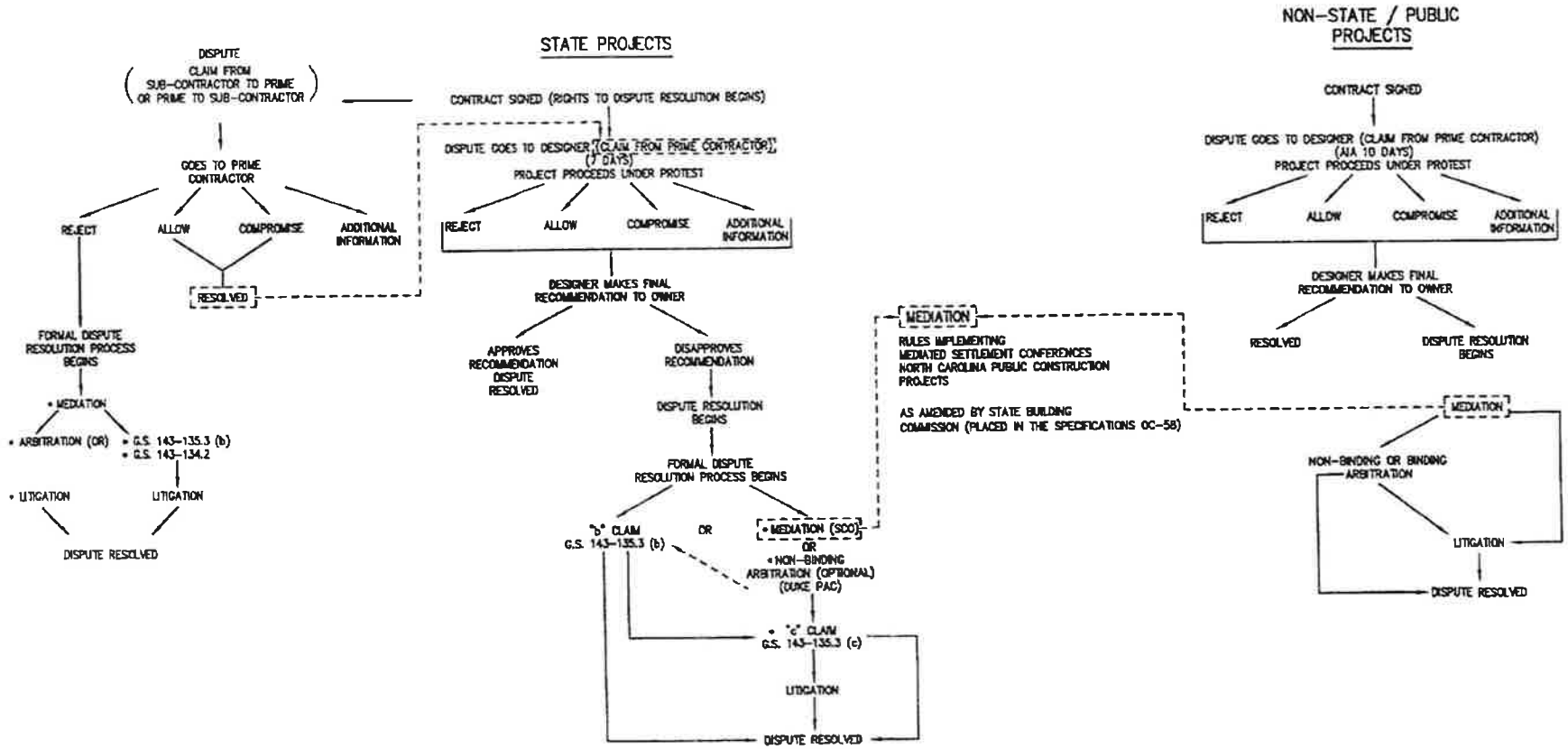
RULE 10. TIME LIMITS

On state contracts, any time limit provided for by these Rules may be waived or extended by the SCO for good cause shown.

On non-state contracts, any time limit provided for by these Rules may be waived or extended by the mediator it appoints for good cause shown. If the mediator has not yet been appointed, the designer of record shall decide all waivers or extensions of time for good cause shown.

Exhibit A

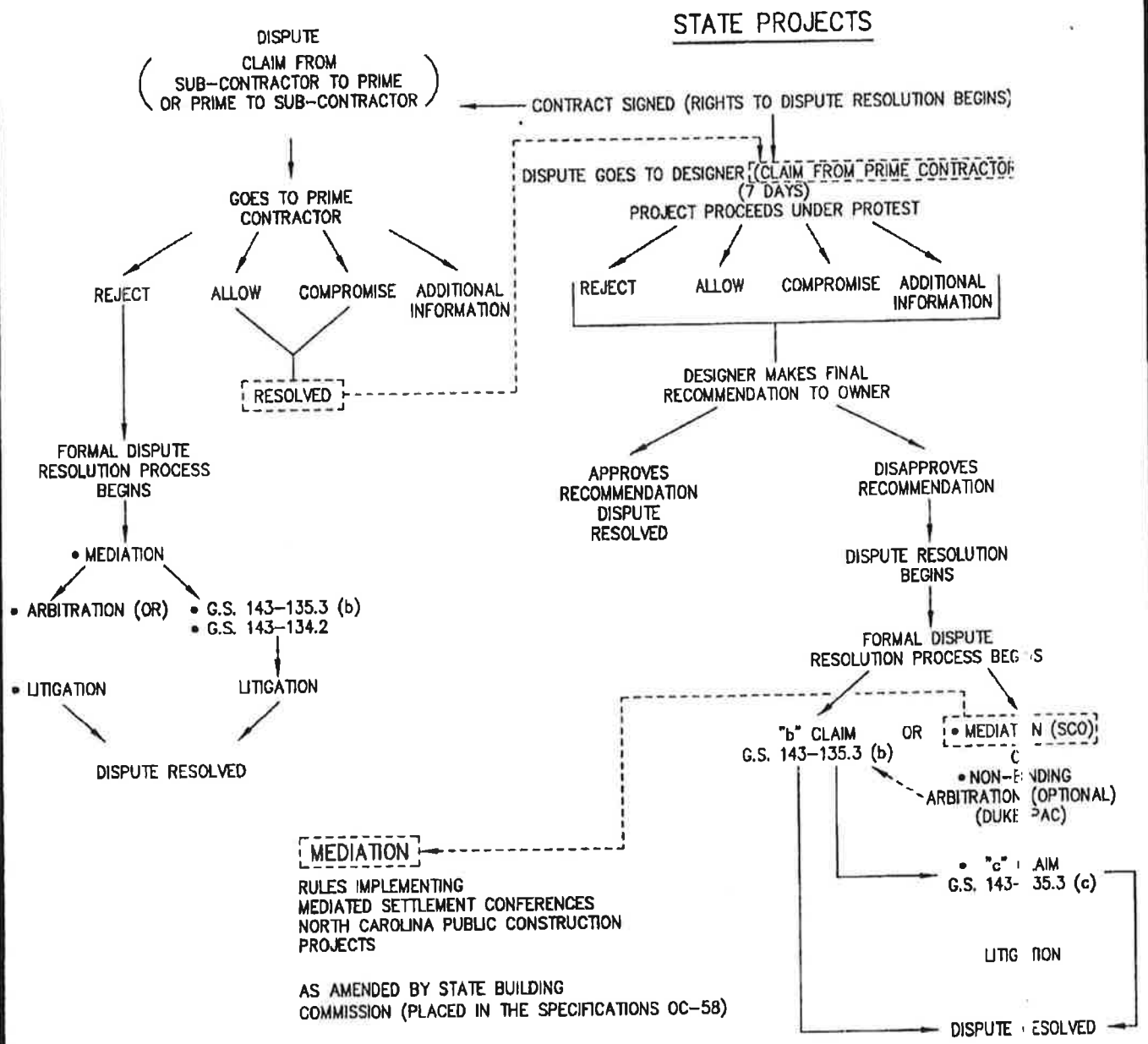
DISPUTE RESOLUTION



2/26/02

Exhibit A

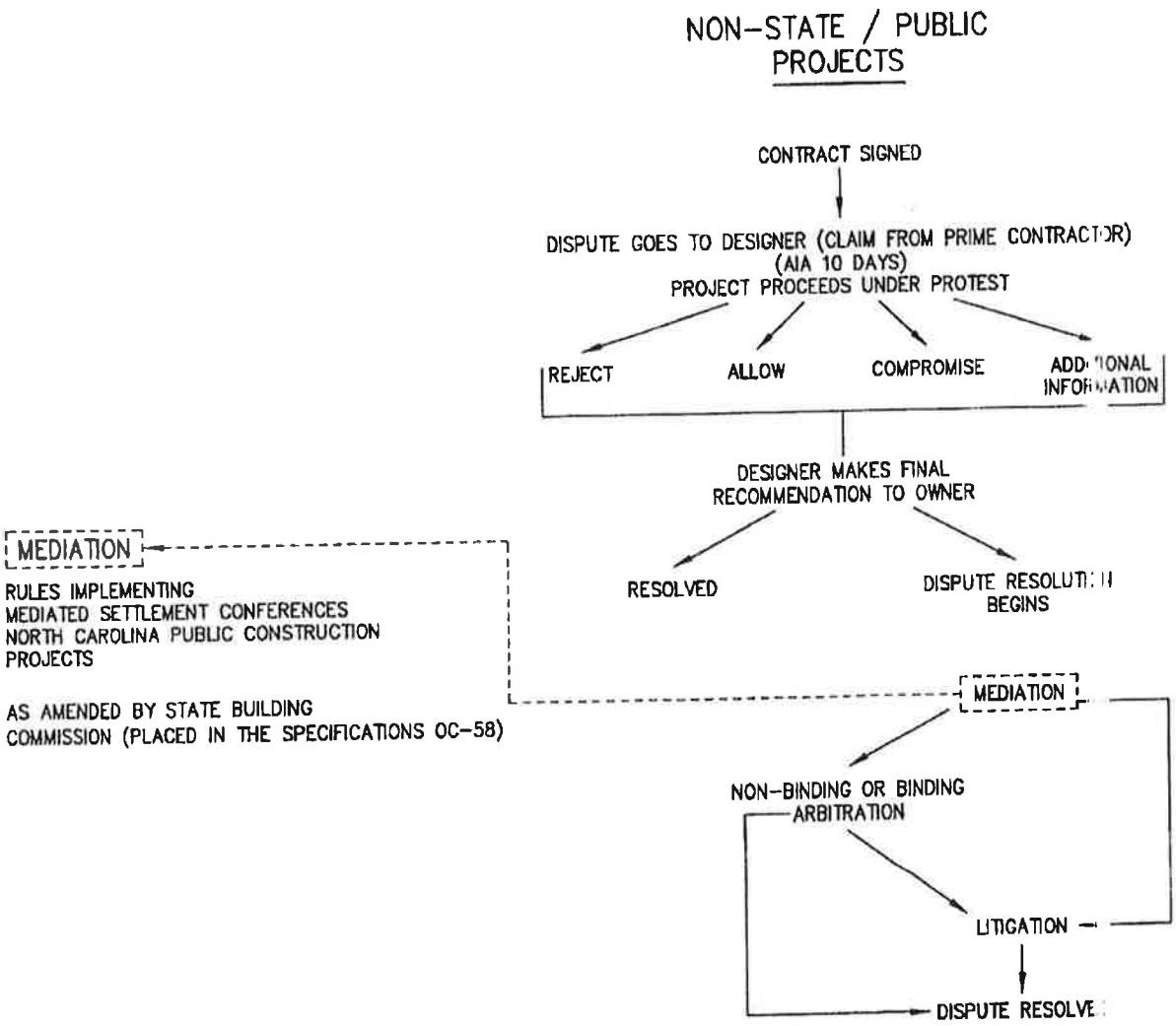
DISPUTE RESOLUTION



/26/02

Exhibit A

DISPUTE RESOLUTION



/26/02

Change Order

No. _____

Date of Issuance: _____ Effective Date: _____

Project:	Owner:	Owner's Contract No.:
Contract: N/A		Date of Contract:
Contractor:		Engineer's Project No.:

The Contract Documents are modified as follows upon execution of this Change Order:

Description:

Attachments (list documents supporting change):

CHANGE IN CONTRACT PRICE:	**CHANGE IN CONTRACT TIMES:**
Original Contract Price: $_____	Original Contract Times: ☐ Working days ☐ Calendar days Substantial completion (days or date): _____ Ready for final payment (days or date): _____
[Increase] [Decrease] from previously approved Change Orders No. _____ to No. _____: $_____	[Increase] [Decrease] from previously approved Change Orders No. _____ to No. _____: Substantial completion (days): _____ Ready for final payment (days): _____
Contract Price prior to this Change Order: $_____	Contract Times prior to this Change Order: Substantial completion (days or date): _____ Ready for final payment (days or date): _____
[Increase] [Decrease] of this Change Order: $_____	[Increase] [Decrease] of this Change Order: Substantial completion (days or date): _____ Ready for final payment (days or date): _____
Contract Price incorporating this Change Order: $_____	Contract Times with all approved Change Orders: Substantial completion (days or date): _____ Ready for final payment (days or date): _____

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By: _____	By: _____	By: _____
Engineer (Authorized Signature)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Date: _____	Date: _____	Date: _____

Approved by Funding Agency (if applicable):

_____ Date: _____

Change Order

Instructions

A. GENERAL INFORMATION

This document was developed to provide a uniform format for handling contract changes that affect Contract Price or Contract Times. Changes that have been initiated by a Work Change Directive must be incorporated into a subsequent Change Order if they affect Price or Times.

Changes that affect Contract Price or Contract Times should be promptly covered by a Change Order. The practice of accumulating Change Orders to reduce the administrative burden may lead to unnecessary disputes.

If Milestones have been listed in the Agreement, any effect of a Change Order thereon should be addressed.

For supplemental instructions and minor changes not involving a change in the Contract Price or Contract Times, a Field Order should be used.

B. COMPLETING THE CHANGE ORDER FORM

Engineer normally initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by Contractor, or requests from Owner, or both.

Once Engineer has completed and signed the form, all copies should be sent to Owner or Contractor for approval, depending on whether the Change Order is a true order to the Contractor or the formalization of a negotiated agreement for a previously performed change. After approval by one contracting party, all copies should be sent to the other party for approval. Engineer should make distribution of executed copies after approval by both parties.

If a change only applies to price or to times, cross out the part of the tabulation that does not apply.

SECTION 11214

REVERSE OSMOSIS (RO) FEED PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work shall include but not be limited to the following major items and necessary accessories for a complete and operational pump(s).
   1. Vertical turbine pumps in cans to be used as reverse osmosis (RO) feed pumps.
   2. Pumps to installed and tested by others under separate contact with Reverse Osmosis Equipment Manufacturer (ROEM) providing oversight.
   3. Variable Frequency Drives for the RO feed pumps are to be supplied and installed by the Installation Contractor.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Section 13510 Reverse Osmosis Treatment Train Units
   2. Section 13520 Field Instrument Panels
   3. Section 13530 Reverse Osmosis System Process Control Logic
   4. Section 13540 Reverse Osmosis System Training

1.03 SYSTEM DESCRIPTION

A. Reverse Osmosis Feed Pump
   1. Function: Raise the pressure of the reverse osmosis train feed water from a minimum of about 20 psig in the 24" feed water header to a pressure sufficient to produce 2.0 MGD of permeate at a recovery of 80% with the membranes of the ROEM's choice.
   2. Number of Pumps: Two(2)
   3. Performance requirements (Future Design Conditions)
      a. Pump Speed (RPM) 1780
      b. Capacity (gpm) 1736
      c. Minimum Bowl Efficiency(%) 82 at design point
      d. Total Dynamic Head(ft) 748
      e. Minimum Suction Head(ft) 46
      f. Capacity(gpm) 1215
      g. Minimum Bowl Efficiency(%) 78.5 at design point
      h. Total Dynamic Head(ft) 708.5
      i. Capacity(gpm) 1125
      j. Minimum Bowl Efficiency(%) 74.5
      k. Total Dynamic Head(ft) 653
   4. Performance requirements (Initial Conditions)
      a. Pump Speed (RPM) TBD
      b. Capacity (gpm) 1736
      c. Minimum Bowl Efficiency(%) 80
      d. Total Dynamic Head(ft) 681
      e. Minimum Suction Head(ft) 46
      f. Capacity(gpm) 1215
      g. Minimum Bowl Efficiency(%) TBD

h. Total Dynamic Head(ft) 640
i. Capacity(gpm) 1125
j. Minimum Bowl Efficiency(%) TBD
k. Total Dynamic Head(ft) 573

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittals:
1. Certification: A certified factory hydrostatic and performance test shall be performed on each bowl assembly in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to to speed for each of the six (6) design flow rates A minimum of six points shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition. Submit certified pump curves after approval of Manufacturer's Data and Shop Drawings.
2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
a. Pumps
b. Motors
c. Can
d. Base Plate
3. Manufacturer's Installation Procedures.
4. Operation and Maintenance Instructions: Submit complete operation and maintenance manual for the pump and motor as indicated below.
5. Equipment and Performance Data: Pump characteristic curves showing capacity in gpm, minimum submergence, head, efficiency, and pumping horsepower from 0 to 110 percent of design capacity.

B. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the equipment as supplied for the Project.
1. Each manual shall be a bound, indexed binder with drawings. Instructions shall include, but not be limited to, the following:
a. Approved shop drawings.
b. Control panel wiring diagrams.
c. Warranty information for each component.
d. Instructions for startup/shutdown of system and for adjustment of equipment.
e. Inventory, functional descriptions and operating instructions for equipment.
f. Recommended routine maintenance procedures for pumps
g. Recommended preventative maintenance for each major component.
h. Complete bill of material.
i. Installation instructions for the specific equipment.
j. Contact information for contractor capable of performing emergency repairs.
2. Front page(s) in binder shall include the following as a minimum:
a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service. for each piece of equipment.
b. Pump and motor plate data.
c. After the front page provide the pump curve and field test report.

1.05 QUALITY ASSURANCE

A. Quality assurance shall meet the following requirements.
   1. Product manufacturer shall have a minimum of ten (10) years of experience. Pump bowl assembly shall be a standard product of the manufacturer for a minimum of ten (10) years.
   2. All major components of the pump including bowl assembly, column, shaft, discharge head, soleplate and motor shall be supplied by the pump manufacturer. The manufacturer shall not under any circumstances re-brand the bowl assembly of one manufacturer to another.
   3. Equipment shall be as manufactured by Afton Pumps, Inc, Flow Serve; or Engineer approved equal.
   4. Pumps shall be manufactured at a facility that holds a certificate of registration for a Quality Management System with a ISO 9001:2008 rating.
   5. Pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.
   6. Submit the name, address, and phone number of the firm that will provide required repair or replacement during the warranty period.
   7. The RO Feed pump operation shall be controlled by the control panel and panel logic as provided in Sections 13520 and 13530.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery instructions will be provided by the ROEM. Pumps and motors will be delivered to the job site wrapped in plastic sheet in wooden crates. Pump and T-head will be delivered assembled, with can, base plate and motor shipped separately.

1.07 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of substantial completion of pump.

1.08 DEFINITIONS

A. Terms shall be as defined in ASME Performance Test Code PTC 8.2 for Centrifugal Pumps and AWWA E101, Section A2. If there is a discrepancy in definitions between the two publications, the definitions given in ASME shall govern.

PART 2 PRODUCTS

2.01 PUMP

A. Bowl Assembly

   1. Pump bowls shall be constructed of 316 stainless steel ASTM 351, Grade CF8M. Bowls shall be equipped with wear rings. Bowl wear rings shall be constructed of babbitted carbon or Engineer approved equal. Wear rings shall be designed to maintain pump efficiency. Wear rings shall be securely locked in place so that they will not move or loosen during any condition of operation or handling, including reverse rotation of the pump. Pump bowls shall also be provided with babbitted carbon bowl bearings or Engineer approved equal.
   2. Bowls shall be flanged with male and female rabbets for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be

smooth and free from nodules, bumps, and dips. Provide the bowls with a renewable wear ring adjacent to the impeller, made of babbitted carbon.

3. The suction bell shall be of the anti-vortexing type and shall have, as an integral part, vanes supporting a central hub in which the bottom bearing is carried below the impeller. The outer suction bell entrance shall be at least the size of the maximum pump bowl dimension and as much larger as is practical. The contour between the outer edge and the impeller suction eye shall be smooth, continuous, and bell shaped.
4. Bowls shall be flanged with male and female rabbets for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be smooth and free from nodules, bumps, and dips. Provide the bowls with a renewable wear ring adjacent to the impeller, made of babbitted carbon.

B. Impellers
1. Impeller shall be of the enclosed type, and shall be constructed of 316 stainless steel ASTM 351, Grade CF8M. Impeller shall be accurately machined, dynamically balanced and securely locked on the pump shaft by means of longitudinal shaft keys and circular thrust washers for each impeller.
2. Impellers shall have wear rings constructed of 316 stainless steel ASTM A276.

C. Impeller Shaft
1. The pump shaft shall be fabricated from a solid billet of 316 SST, and polished over its full length.
2. Total lateral deflection of the shaft above the packing box shall not exceed 0.002-inch total indicator reading.
3. A rigid four-piece adjustable spacer type coupling shall be furnished. The spacer length shall be long enough to permit removal of the mechanical seal assembly without removing the drive motor. The coupling shall be nickel plated to prevent corrosion. Coupling bolting shall be 316 stainless steel. Coupling alignment shall provide for a maximum pump shaft run out of 0.002-inches TIR. The coupling assembly shall be nickel-plated.

D. Suction-Discharge T Head
1. Provide a fabricated stainless steel T-head. The head shall be of one piece fabrication with all fabricated parts of 316L stainless-steel. The head shall have rabbet-fit connections for the motor. Discharge head shall have connections for the pump column and shall support the loadings which it imposes as well as hydrostatic and hydrodynamic heads.
2. Design columns and discharge heads for 150% of the pump discharge pressure (suction pressure plus pump differential pressure) at shutoff. Hydrostatically test columns and discharge heads at design pressure.
3. Access to the stuffing box shall be through windows placed 90 degrees from the discharge. Fit hand-holes and/or windows with Type 316 stainless-steel expanded metal guards to protect the exposed shaft and coupling.
4. The motor mounting flange on the discharge head shall be of the same diameter as the motor base flange with structural ribs to provide strong support for the motor.
5. Provide for lifting the heads by means of lifting eyes that are capable of sustaining the weight of the complete pump unit less the motor.
6. Provide threaded outlets on the discharge head for pressure gauge assemblies, vents, and flush connections.
7. The pump discharge head, shall be factory pickled and passivated by a full immersion process after all manufacturing and testing and prior to assembly.

E. Sole Plates
   1. A rigid sole plate shall be provided to support each pump can. The sole plate shall have rounded corners;
   2. Abutting surfaces between sole plate and suction can flange shall be machined to provide uniform bearing.
   3. Each sole plate shall have a center opening large enough to permit withdrawal of the entire pump assembly. The sole plate shall be constructed of 316 stainless steel.
   4. The sole plate shall be provided with four (4) bolt holes, one (1) inch in diameter, so that the sole plate can be firmly attached to anchor bolts set in a concrete pedestal (by others).

F. Pump cans
   1. Pump cans shall be 316 SST. Minimum wall thickness shall be 3/8 inch.
   2. Provide a flange at the top of the pump can so the pump T-head can be bolted onto the can. Pressure rating of pump can top flange shall be the same as the T-head suction flange. Flanges shall be flat face. Gaskets shall be confined or "O" ring. Gaskets shall be suitable for 1.5 times the pump shut off head psi at ambient temperature.
   3. Bolts and nuts for flanges shall be Type 316 stainless steel, conforming to ASTM A 193 (Grade B8M) for bolts and ASTM A 194 (Grade 8M) for nuts.
   4. Perform hydrostatic and performance testing of the pump can at the place of manufacture.

G. Lubrication
   1. Pumps shall be self-lubricating. The seal flush system for the RO feed pumps shall include an internal product lubrication system that allows the pumped liquid to enter the stuffing box between the clearance of the shaft and the stuffing box bearing into the stuffing box using the pump discharge pressure. The liquid leaving the stuffing box shall be directed through a tapped hole in the seal gland to the suction nozzle through type 316L SST tubing. The lubrication system is to be completely furnished by the pump manufacturer. This lubrication process is to be continuous when the pump is running and it will function to keep the seals clean, cool and lubricated.
   2. Provide a 1-inch 316 stainless steel half coupling welded to the side of the T-head for vent. Provide stainless-steel plug.

H. Vibrations
   1. The maximum vibration level measured on the top motor bearing housing at the rated pump speed (±10%) and at any total head for which efficiencies are shown on the manufacturer's published performance curve shall not exceed that shown in Figure 77 of the Hydraulic Institute Standards.

I. Pump Materials of Construction

Component	Material
Pump shafts	Stainless steel, ASTM A 276, Type 316
Bowl wear rings	Babbitted carbon
Impellers	Stainless steel, CF8M
Coupling	4 part, nickel-plated carbon steel
Impeller wear rings	Type 316 SST
Pump bowls	Stainless Steel type, CF8M

Bowl bearings	Babbitted carbon
All parts made of fabricated SST, including the discharge head	Type 316L SST
Pump can	Type 316L SST
Mounting plate	Stainless steel, ASTM A 276, Grade A or B
Bolts and nuts for T-head	Bolts shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M. Nuts shall be ASTM A 194 (Grade 8M)
Gland bolts and nuts	Stainless steel, Type 316, with ASTM A 194 (Grade 8M) nuts.
Mechanical seal metal parts	Tungsten or silicon carbide running against carbon, John Crane type, or equal

2.02 ELECTRIC MOTORS

A. The motor bearing loading for the driver shall include the total pump down-thrust. The motor bearings shall be designed to withstand any momentary total upthrust equivalent to at least 30% of the maximum down-thrust developed.

B. The pump supplier shall be responsible for supplying the motor and shall ensure proper coordination for mounting of the motor on the pump. They shall properly select and size the drive unit for the pump inclusive of thrust bearing capacity for all conditions as start-up, runout, and shutoff.

C. The motor bearing loading for the driver shall include the total pump line shaft down-thrust. The motor bearings shall be designed to withstand any momentary total up-thrust. Shaft run-out and mounting flange run-out shall not exceed 0.001 Total Indicator Reading.

D. Motors shall be premium efficiency, vertical solids shaft, WPI enclosure with a 1.15 service factor. Motors shall be suitable for inverter rated duty and shall have Class H insulation, with Class B temperature rise. Space heaters of 1/60/120 volt shall be supplied and energized when the motor is not running to help prevent moisture and condensation in the motor. Two normally closed automatic reset thermostats shall be imbedded in the motor windings and wired internally to the control cable. Contacts shall open on excessive heat stopping the motor through the control circuit. Motor shall be rated for continuous and corrosive duty. Motor bearings shall be antifriction oil lubricated with minimum B10 life of 100,000 hours.

2.03 SPARE PARTS

A. Provide the following spare parts for each model of pump:

1.	Bowl Bearings	one set
2.	Stuffing Box Bushing	one set
3.	Mechanical Seal	one
4.	Gaskets, O-rings and seals	one set

B. Pack spare parts in wooden boxes; label with manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained therein.

PART 3 EXECUTION

3.01 WELDING

A. Welding shall comply with the ASME Boiler and Pressure Vessel Code, Section IX.

3.02 PAINTING AND COATING

A. Do not coat stainless steel components.

B. Coat the motor per Owner's instructions. Apply prime coat at factory. Apply finish coat in field.

3.03 FACTORY PERFORMANCE TEST

A. Each pumping unit, with a calibrated test motor, shall be subjected to a witnessed factory performance test. Perform tests in conformance with the Hydraulic Institute Test Standards for vertical pumps, latest edition. To successfully pass a laboratory performance test, a pumping unit shall meet all performance requirements specified.

B. Perform tests and record data, including head, flow rate, speed, and power, at a minimum of five points. These points shall be shutoff, minimum continuous stable flow, midway between minimum stable flow and rated flow, rated flow, and 110% of rated flow.

C. Take vibration readings at rated flow at each test speed.

D. Performance tests shall be "full-scale." The complete pump, including column and discharge elbow, shall be used.

E. Conduct tests preferably at the same minimum submergence that will be realized in the field.

F. The pressure tap for head measurement shall be located not less than 10 pipe diameters downstream from the discharge elbow of the test pump.

G. No motor overload above nameplate horsepower will be allowed.

H. Should results of the full-scale tests indicate that the pumps will fail to meet any of the specified requirements, the Manufacturer will notify the System Supplier of such failure. The Manufacturer shall thereupon, at no expense to the Owner, make such modifications and perform additional tests as may be necessary to comply with these specifications.

3.04 SERVICE CONDITIONS

A. Pump hydraulic performance characteristics shall be as shown in Section 1.03 above.

B. Pump Tag Numbers: ROFP-1, ROFP-2.

C. Pump performance shall be based on the future design feed water TDS of 6,751 mg/l.

D. Liquid pumped: Cold ($19^{O}C$) brackish water which will be treated before entering the pump by addition of a synthetic organic scale inhibitor

E. Conditions

1.	Horsepower:	400 HP (maximum)
2.	Maximum pump speed:	1800 rpm
3.	Minimum NPSH available:	20 psi
4.	Pump lubrication:	Pumped fluid
5.	Suction connection size:	10", 150# RF flange
6.	Discharge connection size	8", 300# RF flange
7.	Single balanced inside mechanical	Seal John Crane8B1 or equal
8.	Bearing lubrication:	Pumped flow

3.05 INSTALLATION

A. Equipment installation shall be installed by the Installation Contractor with ROEM oversight.

B. Install equipment horizontal and vertical within 1 degree and according to the manufacturer's written instructions and the contract documents. Confirm that the pump cans and pumps are set to meet the vertical alignment requirements established by the manufacturer.

C. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.

D. Verify that the installed pump is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the pump assembly. Adjust the position of the pump assembly so that the pump flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning, or supporting equipment. Provide final grouting of the pump assembly base according to the General Contractor's specifications.

E. Provide continuous protection of the installed equipment from the elements, dust, debris, paint spatter, or other conditions which will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing.

3.06 FIELD TESTING

A. Field testing shall be performed by the Installation Contractor with ROEM oversight

B. Bump motor to ensure that motor has been connected for proper rotation prior to connecting the pump coupling.

C. If the measured flows vary by more than 5% below the flows obtained on the laboratory or factory test, adjust the impellers or provide new impellers or otherwise repair or replace the pumps or calibrate meters or pressure gauges.

D. Conduct vibration level tests with pumps operating at their rated capacity. Adjust or replace pumps that exceed the maximum vibration levels.

E. Operate each pump one at a time. Manually adjust the speed for each pump (one at a time) via the respective speed control unit such that the pump output is 40%, 50%, 60%, 80%, and 100% of the maximum capacity specified.

F. Assure that in the automatic mode each pump responds to the appropriate control signal. Assure that each pump operates at a steady rate (±5% of set point) at any given flow for 40%, 50%, 60%, 80%, and 100% of the maximum capacity specified.

END OF SECTION

SECTION 11220

WASTE TANK MIXER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide one (1) waste tank mixer for the waste tank as indicated on the Procurement Drawings and specified herein. The mixer will be used to blend acid or base neutralizing agent into the tank on a batch basis (30 minute to 1 hour detention time). Mixer shall include, but not be limited to, gear, reducer, motor, shafting, impeller, couplings, mounting hardware, and required appurtenant equipment for a complete and operable mixer.

1.02 SYSTEM DESCRIPTION

A. Design Requirements

1. Tank Size:	8.6 ft diameter 9 ft straight side height
2. Freeboard:	12 inches (8-ft sidewater depth)
3. Tank Volume:	454 cu ft (3,400 gallons)
4. Velocity Gradient:	350 sec^{-1}
5. Fluid temperature	68 F to 100 F (20 C to 38C)
6. Mixing Process	batch (no flow through)
7. Detention Time	30 minutes to 60 minutes

B. Impeller Requirements

1. Number:	1
2. Diameter:	33 inches
3. Type:	Axial
4. Number of blades:	3
5. Speed, Maximum:	130 rpm
6. Impeller Tip Speed	18 ft/sec
7. Shaft diameter, Minimum:	2.0 inch
8. Shaft length, Minimum	87 inches
9. Shaff, impeller, wetted parts	316 stainless steel
10. Off-bottom location	~ 33 inches

C. Motor Characteristics

1. Minimum Horsepower:	2.0
2. Power:	230/460 Volts, 3 phase, 60 Hz
3. Nominal speed:	1,800 RPM
4. Enclosure:	TEFC

1.03 QUALITY ASSURANCE

A. Mixer shall be completely shop assembled and factory tested to assure proper fit-up, and acceptable limits of vibration, shaft run-out and motor power draw. Equipment shall be packaged for shipment and jobsite storage to prevent damage or corrosion.

B. Equipment Supplier shall be fully responsible for warranty and mechanical design adequacy of the mixer as provided for the Project.

C. Tank Mixer shall be as manufactured by Lightning Model 14Q2, Chemineer, Philadelphia Mixer or Engineer approved equal.

1.04 SUBMITTALS

A. Submit the following in accordance with Section, Submittal Procedures:
   1. Catalog Data: Submit manufacturer's standard drawings and catalog cuts for the mixer. Clearly indicate equipment to be furnished for the Project including options to be provided. Individual components with material type shall be indicated on the drawings.
   2. Shop Drawings: Submit Project specific shop drawings with the following:
      a. Mixer design calculations.
      b. Equipment dimensions and weight.
      c. Mounting details indicating recommended position of mixer on waste tank and angle of impeller in relation to the horizontal top plane of the tank.
      d. Impeller details.
      e. Motor data.
      f. Details of the coupling-shaft sleeve arrangement.
      g. Mixer manufacturer to supply mixer's vertical downward load, torque and bending moment with the mixer submittal. The mixer drawing shall be stamped by a professional engineer employed by the mixer manufacturer.
   3. Test Reports: Submit for the following:
      a. Factory test.
      b. Field test report of start up by manufacturer representative.
   4. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the mixer as supplied for the Project. Each manual shall be a bound, indexed binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Start up data.
      b. Trouble shooting guides.
      c. Routine maintenance procedures.
      d. Lubrication data.
      e. Cut sheets and detail "blow-up" drawings for each part of the mixer.
      f. Complete bill of material.
      g. Surface preparation.
      h. Installation instructions for the specific mixer.
      i. Address and phone number for manufacturer and nearest supplier to Project site.
   5. Tools and Spare Parts
      a. Furnish one set of special tools required for the proper servicing of the equipment supplied.
      b. Furnish spare parts as recommended by the manufacturer for one year's normal operation and maintenance of the equipment. Parts shall be properly packaged for storage and marked for usage.

PART 2 PRODUCTS

2.01 SHAFT AND IMPELLER ASSEMBLIES

A. Each mixer assembly shall consist of a heavy duty speed reducer, electric motor connected through a flexible coupling, baseplate, agitator shaft, and mixing impellers.

B. The impeller shall be a three bladed high-efficiency, axial flow turbine, producing the specified pumping capacity. Impeller blades will be bolted to a keyed hub to the shaft.

C. Impellers shall be removable from the shaft by means of a detachable hub, detachable blades. Impellers shall be connected to the shaft by a key, designed to transmit full motor torque and to support the impeller assembly on the shaft. An extended keyway shall be provided of sufficient length to permit adjustment of the axial position 18 inches up in three-inch increments from the design location.

D. The impeller shall be of such design, and operate at such rotational speed that dynamic balancing is not required to prevent damaging vibration.

E. The mixer output shaft shall be totally overhung. When turned over by hand, impeller shaft runout or deflection shall not exceed 1/4" per 10' of length.

F. Materials of the impeller shafts, impeller hubs and blades shall be 316 stainless steel. The minimum material thickness for impeller fabrication is 1/8 inch.

2.02 SPEED REDUCERS

A. Speed reducer shall be a parallel shaft, all helical gear design. Worm gear drives are not acceptable. Gearbox shall be capable of continuous mixing service operation in an outdoor environment. The reducer case is to be ductile iron housing with mounting plate. Gears shall meet AGMA Class 10 quality level to assure minimum backlash, noise, heat and a minimum 95 percent gearbox efficiency.

B. Speed reducer is to be filled with oil and have breather and oil level plugs in proper position for specified operation. General maintenance, specifically including motor changes, and oil system maintenance, shall not require the removal of the speed reducer housing from its foundation. Provide speed reducer with lifting lugs. Design units to provide convenience of mounting, maintenance and installation.

C. Drive bearings shall anti-friction type and be designed for a minimum rated L_{10} life of 100,000 hours.

D. Thermal rating of the speed reducer shall exceed the mechanical rating to eliminate the need for external coolers.

E. Speed reducer shall have a minimum service factor of 1.5 based on the motor nameplate rating.

F. The mixer shaft shall be connected to the output shaft of the speed reducer by means of a split removable coupling accessible from outside the tank and located above the reducer. The rigid coupling shall be designed to minimize runout to less than' 1/4" per 10' of shaft length.

G. Full load operating noise level of the gear reducer shall meet the more stringent requirements of current OSHA occupational noise standards or AGMA 299.01 and shall not exceed 85 dBA at a distance of three feet from the drive assembly.

2.03 LUBRICATION

A. The speed reducer shall be provided with a suitable lubricating system for all-weather starting and operation on the unit. The speed reducer shall be oil lubricated with an oil level such that at least 90% or the gear box volume contains oil. All gearing must be immersed completely in lubricant. The lubrication system shall allow a maximum mixer-mounting angle of 10° from horizontal. A single oil drain shall be provided at the low point of the speed reducer. A dipstick or sightglass shall be provided to observe oil levels. All fill and drain lines shall be sized for efficient functioning, and located for easy accessibility.

B. Oil changes, following the initial run-in period, shall not be required at less than 2,500 hour intervals. Oil leakage down the low speed output shaft shall be prevented by means of a sealed dry well design. No oil seals shall be permitted below the operating oil level for rotating elements. The speed reducer breather shall be located above possible oil foam level.

2.04 MOTOR

A. Mixer manufacturer shall be responsible for the proper selection of the motor for the required application.

B. Motor to be connected to the speed reducer through a flexible coupling (Falk Steelflex or equivalent).

C. Motor shall be 230/460v, 60 Hz, 3-phase severe duty, high efficiency, totally enclosed fan cooled cast iron construction. Motor shall be designed for continuous operation in a 40 degree C ambient temperature with the horsepower ratings and speeds specified. Motor shall be nameplated 1.15 service factor and have a Class F insulation rating and be provided with a thermostat.

2.05 PAINTING AND SPECIAL COATINGS

A. Surfaces of the motor, drive assembly, and speed reducer shall be commercially blast-cleaned prior to application of the manufacturer's standard primer. Preparation shall meet SSPC-SP6. All blast cleaning shall take place before any assembly occurs.

B. Finish-coat painted surfaces shall be moisture and corrosion resistant and shall, at a minimum, be modified styrenated alkyd enamel. Final coat shall be corrosion resistant for exposure to pH 3 to pH 12 fluid.

C. Special measures shall be taken to treat all mixer internal and external mild steel parts that are without permanent coatings, e.g., paint, etc., for resistance to corrosion from water vapor. A vapor phase inhibitor shall be sprayed into each gear drive through one of the openings. The inside surfaces of the bearing adapter sleeves and the Quill Coupling respectively will be coated with molybdenum rich anti-seize compound. Exterior portions of the steel shaft and the quill coupling shall be protected with a waxy film, moisture-excluding coating such as CRC Industries SP400.

2.06 MIXER MOUNTING

A. Mixer manufacturer shall supply required mounting brackets necessary to achieve a 7 to 10% mixer motor angle on the tank in relation to the base plate. Brackets to be provided by the mixer manufacture and have an epoxy finish paint corrosion resistance coating for exposure to pH 3 to 12 fluids.

PART 3 EXECUTION

3.01 INSTALLATION & MOUNTING

A. Mixer to be supplied loose and installed by the Installation Contractor. Mixer to be installed in accordance with manufacturer's recommendations.

B. Mixer drive consisting of a speed reducer and motor shall be mounted to an Installation Contractor supplied base plate. The base plate shall be separated supported (i.e. not off the tank) and be located a distance over the tank edge per the mixer manufacturer recommendations. Support shall be a vertical I-beam with

attachment to the floor and the building wall and be provided by the Installation Contractor. The base plate would then extend over the tank as required by the mixer manufacturer.

C. Mixer unit shall be plumbed and leveled in-line with the mixer shaft and firmly mixer mounted to the .

3.02 START-UP SERVICES

A. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of one trip to the site will be required, consisting of a minimum of one 8-hour working day.

B. Provide new oil and grease of the type recommended by the manufacturer at start up.

C. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer..

3.03 TEST

A. Run mixer under actual operating conditions and demonstrate that the equipment installed performs to the criteria set forth in this specification. During the field test, adjustments shall be made to correct the problems noted. Provide adjustments as necessary.

B. Vibration of the mixer assembly shall be measured at the top of the motor. The amplitude and frequency shall be less than the maximum recommended by the manufacturer.

END OF SECTION

SECTION 11245

SCALE INHIBITOR FEED SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Provide a complete scale inhibitor feed system to provide metered solution feed to the raw water main at an injection point prior to RO cartridge filters. Chemical system shall be suitable for receiving, storing and feeding scale inhibitor (Avista Vitec 1400, or similar). System shall include, but not be limited to, the following components:
   1. Chemical feed skid with duplex chemical metering pumps
   2. Storage tank
   3. Flow Meter
   4. Ultrasonic Level Probe
   5. Accessories
   6. Complete feed system skid with pumps, valving, piping, gauges, and control panel/junction box.

1.02 SYSTEM DESCRIPTION

A. Feed system, tank, and flow meter shall provide total system to store and feed to the following location:
   1. Raw water line (prior to cartridge filters)

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01330 Submittals:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Storage tank and accessories
      b. Metering pumps
      c. Skid with all valves, pipes and appurtenances
      d. Flow meter
      e. Ultrasonic level detector
   2. Shop Drawings: Submit project specific shop drawings for the following:
      a. Storage tank and accessories
      b. Metering pumps
      c. Skid with all valves, pipes, and appurtenances
      d. Flow meter
      e. Ultrasonic level detector
   3. Operation and Maintenance Manuals: Submit complete operation and maintenance manual for the total System, which shall include, but not be limited, to the following:
      a. Storage tank and accessories
      b. Metering pumps
      c. Skid with all valves, pipes, and appurtenances
      d. Flow Meter
      e. Ultrasonic level detector
   4. Warranty: Submit all warranty documentation

1.04 QUALITY CONTROL

A. For the purpose of establishing quality assurance, experience, and system reliability, the products described herein are based on those metering pumps manufactured by Grundfos DDA FCM series, or equal.

B. Quality assurance shall be as required in Section 01450, Quality Control and the following requirements.
   1. The liquid chemical feed equipment specified in this section shall be furnished by one chemical metering pump manufacturer who will provide all components of the metering pump feed system.
   2. These specifications cover the intended function of the equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. The supplier shall supply all devices and appurtenances necessary to provide a complete, operable and satisfactory system as indicated or specified.

1.05 WARRANTY

A. The chemical metering pump manufacture shall warrant the chemical metering equipment/system to be free of defects in material and workmanship for a period of two (2) years from the date of installation.

B. Tank manufacturer shall warrant the tank to be free from defects in materials and workmanship and to be suitable for the application and chemical as specified in this section. Warranty shall be for a period of five (5) years from the date of installation.

PART 2 PRODUCTS

2.01 GENERAL

A. Products with surfaces intended to be in contact with the chemical shall be certified and listed in accordance with NSF 61 for potable drinking water.

2.02 STORAGE TANK

A. General: Chemical storage tank shall be designed for the storage of the chemical specified in this section.

B. Tank Construction:
   1. Number Required: 1
   2. Nominal Total Capacity: 300 gallons
   3. Diameter: 3'6"
   4. Height: 4'-11"
   5. Top: Sealed dome top with threaded center fill opening, vent, and flanged connection for level probe insertion.
   6. Tank shall be a vertical, high density cross-linked polyethylene.
   7. Tank shall be manufactured from materials certified to NSF 61
   8. Tank shall be constructed by the rotational molding process, one-piece seamless construction, cylindrical in cross-section and vertical with a flat bottom.
   9. Tank shall be adequately vented as shown on the drawings as prescribed by manufacturer. Where indicated, tank shall be provided with ancillary mechanical fittings and accessories.
   10. Outlet:
       a. At base of tank (flooded suction)

11. Tank shall be manufactured by PolyProcessing Co., Synder Industries Inc., Assmann Corp., or equal.

C. Tank Accessories
   1. Nozzles: Nozzles shall be of the size and location indicated on the Procurement Drawings. Provide flanged faces drilled to connect to pipe service indicated on the drawings. .
   2. Vent: Provide top vent at location and size indicated on the Procurement Drawings.
   3. Drain: Drain shall be designed to completely drain the tank contents and shall be integrally molded flanged outlet.
   4. Ultrasonic Level Indicator: Shall be mounted to top of tank using a flanged fitting as recommended by tank manufacturer.

2.03 CHEMICAL METERING SKID

A. The chemical feed system shall have the following major components, operational capabilities and capacities:
   1. Chemical Feed Skid
      a. Number of Pumps: 2 (one in operation and one in standby)
      b. Chemical Service: Scale Inhibitor (Avista Vitec 1400, or similar)
      c. Type of Metering Pumps: Mechanical Diaphragm Metering
      d. Adjustment Range: 1000:1
      e. Feed Rate Control: Manual adjustment or automatic 4-20 mA input signal adjustment with selectable maximum pump speed
      f. Voltage: 120 Volt with US plug
      g. Maximum Feed Rate: 1.98 gal/hr
      h. Minimum Feed Rate: 0.06 gal/hr
      i. Maximum Pump Discharge Pressure: 145 psi
      j. Minimum System Discharge Backpressure: 80 psi
      k. Normal Operating Discharge Backpressure: 25 to 55 psi

B. General
   1. Chemical metering pump shall be Mechanically Actuated Diaphragm, positive displacement, motor driven, metering pump.
   2. Chemical metering pump shall be driven by a microprocessor controlled stepper motor providing a minimum of 1000:1 turndown ratio. The stepper motor is to be coupled to a flat, PTFE diaphragm via a gear assembly. The drive assembly shall be a maintenance free design.
   3. The pump shall operate at 100% stroke length throughout the pumps entire capacity range.
   4. The liquid end and valve design shall provide for ease of maintenance. Ball checks shall be cartridge type design.
   5. The pump shall be able to measure actual flow through the head to monitor the dosing process without need for additional measuring equipment.
   6. The pump shall be able to compensate automatically for pressure fluctuations on the injecting point, maintaining the flow rate constant.

C. Enclosure
   1. Drive mechanism and microprocessor shall be housed in a corrosion resistant, plastic UV stabilized enclosure.
   2. The pump design shall include provisions for optional positioning of the control interface/display, for right/left side and front mounting.

3. Pump enclosure rating shall be to NEMA 4X standards.
4. The pump design shall include an integral removable click stop mounting plate, to allow for flat base or wall mounting.

D. Drive
1. The pump's stroke length shall be 100%. No adjustment to the stroke length, to regulate flow, or for other reasons, is acceptable.
2. An integral variable speed stepper motor shall be used to ensure the pump discharge phase extends throughout the full period between suction intervals.
3. The motor shall be integral, supplied with power cord and plug.
4. The drive mechanism shall not require regular field service or external lubrication.

E. Interface
1. User interface/display shall be backlit LCD with selectable on-site positioning for either side or front mounting.
2. The interface shall provide a selection of metered output to be displayed in gal/hr or l/hr. Pump displacing percent (%) of output only will not be accepted.
3. The interface should include a turn and push (click wheel) for easy navigation.
4. The interface shall include a lock function to protect against unauthorized changes.
5. A built in counter shall be included to provide a running total of, accumulated strokes, cumulative hours of operation and dosing flow.
6. A priming button shall be provided on the interface. The priming button shall initiate a time selectable prime cycle operating at full capacity without need of attenuating the pumps output setpoint.
7. A system of white, red, orange, and green LCD shall indicate pump status and alarm conditions.

F. Liquid End
1. The process diaphragm shall be PTFE.
2. Head and valves body material shall be PVC, with Ceramic ball material.
3. Wetted gasket material shall be EPDM.
4. Suction and discharge valve design shall incorporate double ball arrangement and be spring-loaded. Direction of flow shall be clearly marked on each check valve to ensure correct installation.
5. Head design shall incorporate integral priming valve.
6. A back-plate with separation chamber shall have a safety lip seal and drain hole.

G. Operation
1. Repeatable metering accuracy shall be ±1% at constant hydraulic conditions throughout the entire output range.
2. The pump shall be equipped with a slow mode function for use with high-viscosity liquids. The slow mode function shall reduce the suction speed to either 50 or 25% of maximum capacity to ensure optimal priming and pumping reliability.
3. The pump shall be able to compensate automatically for pressure fluctuations on the injecting point, maintaining the flow rate constant.
4. The pump shall be able to precisely measure and display the actual flow and transfer the actual value via a proportional analog signal 0/4-20mA.
5. The pump shall be equipped with a calibration function which when initiated operates the pump for a set number of strokes and displays the anticipated

pumped volume. The calibration process allows adjustment of the pump to set the calibration relative to the drawdown volume.

6. The pump shall be equipped with an analog re-scalable 0/4-20mA signal input. The scaling menu should allow for four point adjustments (two for signal, two for flow) within the signal and flow ranges.
7. The pump shall be equipped with provisions for selectable mode NO/NC external pump enable/disable interface.
8. The pump shall be equipped with a programmable proportional 0/4-20mA signal output.
9. The pump shall be able to automatically de-aerate the pump head without the need for external devices.
10. The pump shall be equipped with two spare selective programmable outputs.

H. Control

1. The pump shall come equipped with 5 menu selectable control modes; Manual, analog, pulse, timer or batch. Normal operating mode shall be analog control.
2. Manual Control
   a. Output of pump is displayed in gal or liters per hour. Pump output adjustment is performed with the turn and push knob (click wheel) on the interface.
   b. Pumping rate changes are to be achieved through precise speed control with fixed full stroke length.
   c. Pump should include a start/stop key.
3. Automatic Control
   a. Analog: Pump shall include direct interface provisions for input analog control. Both direct and reverse acting 0/4-20ma input configurations are to be acceptable inputs. The menu configuration shall permit pump maximum output multipoint scaling. The pump shall include a local alarm for loss of input signal.
   b. Pulse: The pump shall include direct interface provisions for pulse output devices. In pulse control mode, the pump shall be configured to deliver a volume of product per incoming pulse. The pump speed shall attenuate the delivery rate based on the frequency of pulses generated by the external device.
   c. Batch: In batch mode the pump shall respond to deliver a menu configurable quantity of liquid after receiving a remotely provided contact input.
   d. Cycle Timer: The configuration menu of the cycle timer shall permit the user to prescribe batch volume, timed sequence start point and the time between each successive timed delivery cycle.
   e. Week Timer: The pump shall be equipped with a real-time clock and a seven-day internal week timer. The configuration menu shall permit the user to prescribe up to 16 procedures with batch volume, dosing time, start time and weekdays.
4. Function Description
   a. The chemical metering pumps shall normally be in REMOTE mode on the pump local screen and be start/stopped via an external signal from the Plant SCADA system. Pump speed control shall be adjusted by a 4-20mA signal from the plant SCADA system. Selection of Scale Inhibitor Pump No. 1 or No. 2 as duty and standby pump shall be at the plant SCADA system.

b. The Plant SCADA system shall use a calculated raw water flow and an operator settable scale inhibitor dose and scale inhibitor density to calculate an initial scale inhibitor chemical feed rate (gal/hr). This rate shall be sent via 4-20 mA signal to the selected duty chemical feed pump via the skid control panel. The scale inhibitor flow measurement shall be sent from the scale inhibitor flow meter to the Plant SCADA system via a 4-20 mA signal. This flow shall be compared to the required chemical feed rate and pump speed adjustments made by the Plant SCADA system as necessary.
c. The selected chemical feed pump shall continue to operate until a stop signal is sent to the pump by the Plant SCADA system Control Panel.
d. MANUAL pump control mode operation from the skid assembly control panel is only to be used for initial system testing and pump calibration. MANUAL mode operation will not be allowed per the pump lockout function.

5. Operation
   a. The operator will input scale inhibitor target dose (mg/L) and density into Plant SCADA System Control Panel.
   b. Operator select AUTO mode for each chemical pump at the Plant SCADA System. Operator select Chemical Metering Pump P-103-1 and P-1-3-2 as duty or standby at selector switch at the skid assembly control panel.
   c. Pump on/off and speed shall be controlled by the Plant SCADA System.
   d. SCADA system to receive an actual flow 4-20mA flow signal from each metering pump.
   e. SCADA system to receive warning alarm signal from pump backpressure measurement function.
6. Pump Input and Output Controls (each pump)
   a. Two (2) Relay Output Signals
      1) Pump Run
      2) Pump Alarm
   b. Digital Input
      1) Pump Run
   c. Analog Input
      1) 0/4-20 mA Pump Speed
   d. Analog Output
      1) 0/4-20 mA Pump Measured Flow Output
7. Lockout, Alarms, and Shutdown
   a. A pump lockout function on each pump shall be password protected. Pump settings and functions can only be changed by the person with password. The person allowed access shall set the following setting in the local pump controller interface for each pump:
      1) Set pump to REMOTE mode
      2) Set the pump mode to Analog 0/4-20mA input control
      3) Set the 4-20mA input capacity scale setting on each pump
      4) Set one analog output to send flow measurement back to SCADA System.
      5) Set pump fail alarm relay output to Plant SCADA system
   b. The following events will trigger alarms, at the Plant SCADA and/or metering pump, as noted:
      1) Metering Pump Display
         i) Alarm — RED Screen Display/Pump Stops
      2) Plant SCADA System

i) Pump Run Not On When Called	RO Units Not Start
ii) Pump Run Turns off during operation	RO Units Shutdown
iii) Pump Alarm	RO Units Shutdown
iv) Low Scale Inhibitor Flow	RO Units Shutdown

I. Packaged Chemical Feed System (Skid)

1. The contractor shall furnish one (1) complete pre-assembled chemical feed system. Chemical feed systems shall be self-contained. Each package system shall include, but not limited to metering pumps, motors, calibration columns, back pressure valves, pressure relief valves, pulsation dampeners, piping, fittings, valves, GFI outlets, power box, and wiring junction box as specified to provide a complete system.
2. Packaged Chemical Feed System shall be a duplex pump system designed for a floor mount installation. Duplex pump systems will be configured as duty and standby with a single discharge line.
3. The system to be supplied shall be complete with suction and discharge piping and accessories as listed below. Piping shall be sized for proper flow and equal to the size of the pump suction and discharge connection. A pressure relief valve shall be installed in the discharge line of each pump and piped back to the suction to prevent system overpressure in the event of a plugged line or excessive pressure. Isolating ball valves shall be installed as appropriate to isolate system components for ease of service or operations. Isolating ball valves shall be vented for applications involving off-gassing liquids. A back pressure/anti-siphon valve and a pulsation dampener shall be installed in the discharge line. A calibration column shall be installed in the suction line with an isolation ball valve. A "Y" type strainer shall be installed on the suction line, if required by the application, to prevent debris from entering the metering pumps. All piping shall be PVC, Schedule 80. Accessories shall be PVC with union connections to allow for ease of maintenance and service removal. NPT or socket-weld connections are not acceptable for isolation, pressure relief and back pressure valves. Pump mounting pedestals shall be provided to elevate the metering pump above the skid base.
4. The skid base shall be constructed from HDPE (high density polypropylene), ½" sheet, thermal welded construction.
5. The system shall incorporate the following accessories:
   a. One (1) Clear PVC Calibration Column.
      1) Mount on common suction line with isolation ball valve.
      2) Calibration column to be 100mL, with 1-mL scale graduations.
      3) Floating yellow polypropylene level indicator.
      4) "O" ring sealed top with threaded connection for vent tube /standpipe.
   b. One (1) PVC Back Pressure/Anti-Siphon Valve.
      1) Provide on common pump discharge piping to provide constant back pressure and eliminate siphoning potential through the pump
      2) Factory set at 80 psig but adjustable from 7-150 psig.
      3) PTFE-face diaphragm.
      4) Dial range of 0 to 100 psi with dial size to be 2 ½" with stainless steel case.
      5) Gage-seal assembly shall be installed in the gage port of the backpressure valve.
      6) PVC diaphragm seal assembly.

c. Two (1) PVC Pressure Relief Valve.
   1) Mount on discharge line of each pump with tee relief to outlet true union ball valve on the skid.
   2) Set at a minimum of 25 psig higher than the system pressure or Back Pressure/Anti-Siphon Valve setting.
   3) Adjustable 7 to 150 psig.
   4) PTFE-faced diaphragm.
   5) No other valve or component shall be installed in the relief line.

d. One (1) Pulsation Dampener.
   1) PVC body with EPDM diaphragm.
   2) Dampener to be installed in the discharge piping common header.
   3) Pulsation dampeners shall be sized to operate at 90% dampening.
   4) Pulsation dampener shall be chargeable design with a diaphragm separating air chamber chargeable through a Schrader valve.
   5) Dampener shall include pressure gauge to indicate charging pressure.
   6) Diaphragm material to be compatible with the chemical to be pumped.

e. Provide FRP, NEMA 4X, junction box mounted on skid. Interface terminals for (2) pumps: 120 VAC for pump power (branch protection provided by others); (1) duplex receptacle for pump power (mounted on back panel); 4-20mA input signal (x2); 4-20mA output signal (x2); Run input (x2); (2) programmable relay outputs (dry contact)(x4).

2.04 FLOW METER

A. Function: Measure scale inhibitor flow.

B. Type: Variable Area Flowmeter with Horizontal Connection for Wall Mounting
   1. Manufacturer: Kobold Equipment Model Series KDS-CB, or Engineer approved equal.

C. Size: Flow element shall be sized to measure flows between 0.25 and 2.5 l/hr.

D. Materials
   1. Body: Stainless Steel
   2. Sealing: PTFE
   3. Connection: ¼" FPT Female

E. Provide analog, 2-wire, 4-20mA output signal.

2.05 ULTRA-SONIC LEVEL DETECTOR

A. Function: Measure fluid level in scale inhibitor feed tank and transmit reading to the plant SCADA system.

B. See Section 13550 for ultrasonic level detector requirements.

2.06 PIPE AND VALVING

A. Valves: Shall be Sch. 80 PVC bodied with corrosion resistant assemblies. Ball valves shall be true union type with teflon seats.

B. Piping: Suction and discharge piping shall be rigid Schedule 80 PVC. Joints shall be solvent welded with heavy duty PVC cement and cleaned and primed with purple primer. Pipe and fittings shall be prepared and joined in accordance with manufacturer's requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Handle and install all equipment and appurtenances in accordance with manufactures written instructions.

B. Floor Mounted pump skid assembly shall be shipped as a complete unit, pre-plumbed, and pre-wired ready for inlet/outlet pipe connection and electrical connection. Connection will be made by installation contractor.

C. Tank, flow meter, and level indicator will be shipped loose for installation by installation contractor.

3.02 FIELD TESTING

A. Tank and connection piping shall be tested by filling with water. Tank and fittings shall hold water without loss or evidence of weeping for a period of 24 hours prior to acceptance.

B. Clean and dry tank after testing.

3.03 START UP SERVICES

A. Owner shall provide potable water for testing and initial start up of the system. Notify Engineer in writing two (2) weeks prior to the date chemical shall be necessary for testing.

B. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of one trip to the site will be required, consisting of a minimum of one 8-hour working day.

C. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) week of plant operation.

D. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

END OF SECTION

SECTION 13228

HORIZONTAL CARTRIDGE FILTER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide horizontal cartridge filter vessels for the RO cleaning system. This section includes the furnishing, installation, and testing of cartridge filter housings, filter cartridges, and appurtenances.

B. Work shall include, but not be limited to, the following major items and necessary accessories for a complete and operational system:
   1. Complete Cleaning System Cartridge Filter

1.02 RELATED SECTIONS

A. None

1.03 SYSTEM DESCRIPTION

A. Cleaning System Cartridge Filter

1. Service	1% citric acid, 0.1 % caustic, up to 35,000 TDS
2. Number of horizontal cartridge filter vessels	1
3. Number of cartridge sets	2 (start-up and testing)
4. Number of cartridges per set	52
5. Type	Horizontal
6. Design Flow per Filter	840 gpm
7. Maximum Flow per 10" cartridge equivalents	4.5 gpm
8. Cartridge Length	40 inches
9. 90% efficiency particle size filtration	5 micron
10. Nominal Housing Internal Diameter	24 inches
11. Inlet and outlet Flanges	8 inches, raised face
12. Pressure Loss, Clean Cartridges	< 3 psi
13. Tag #	CCF-1

1.04 SUBMITTALS

A. Submit the following:
   1. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for the following. The equipment to be furnished for the Project shall be clearly indicated including all options to be provided.
      a. Horizontal Cartridge Filter Vessels.
      b. Cartridge Filters
   2. Shop Drawings: Submit Project specific dimensioned shop drawings for the following:
      a. Horizontal Cartridge Filter Vessels.
   3. Manufacturer's instruction manual including cartridge changing and housing maintenance.
   4. Test Reports: Submit for the following:
      a. Factory test.

B. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the equipment as supplied for the Project.
   1. Each manual shall be a bound, indexed 3-ring binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Approved shop drawings.
      b. Control panel wiring diagrams.
      c. ASME certifications
      d. Warranty information for each component.
      e. Instructions for startup/shutdown of system and for adjustment of equipment.
      f. Inventory, functional descriptions and operating instructions for equipment.
      g. Recommended routine maintenance procedures
      h. Recommended preventative maintenance for each major component.
      i. Complete bill of material.
      j. Installation instructions for the specific equipment.
      k. Contact information for contractor capable of performing emergency repairs.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service for each piece of equipment.

1.05 QUALITY ASSURANCE

A. Horizontal Cartridge Filter manufacturer shall have been engaged in producing filters for a minimum of ten years. This experience shall consist of installations where equipment of same size and design has been in operation successfully in a similar process for a minimum of three years.

B. Housing manufacturer shall be
   1. Parker Process Filtration Model #6LMP52H-4-8FK1 for cleaning system, or engineer approved equal.

C. Cartridge manufacturer shall be Parker Process Filtration, Model HFT5M40A-TX-N, or engineer approved equal.

D. Show materials of construction by ASTM reference and grade.

E. Submit certification of compliance with ASME code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver vessels as complete units as to require the minimum amount of field connection and assembly.

1.07 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of substantial completion of the project.

PART 2 PRODUCTS

2.01 HOUSINGS

A. Fabricate the filter cartridge housing, support legs and eyebolts for cover closure of Type 316L stainless steel.

B. Housing shall be divided into two chambers. The inlet chamber shall house the filter cartridges and have a removable cover. Cover closure shall use swing bolts with nuts. The outlet chamber shall be sized to transport water from the cartridge filters to the outlet.

C. The O-ring cover gaskets shall be Buna-N.

D. Inlet and outlet flanges shall be sized for piping diameters as specified in the "Service Condition". Flanges shall be Class 150, raised face.

E. Housing shall be of sufficient dimension to contain the cartridges as specified in the "Service Conditions."

F. Housing shall have the following connection: one 1/2-inch threaded vent connection on the cover, one 1/2-inch threaded pressure gauge/sample connection for each chamber, one 2-inch treaded connection for draining the inlet chamber, and one 2-inch threaded connection for draining the outlet chamber. Connections shall be 3,000-pound NPT female couplings. Provide plugs for all threaded connections. Provide flange gaskets in accordance with the detailed pipe specifications.

G. Design housing for 150-psi working pressure. Housing materials, design, fabrication, and inspection shall conform to Section VIII of the ASME Boiler and Pressure Vessel Code. Design temperature shall be 250°F. Provide the ASME code stamp.

H. The filter housings shall be factory-equipped with a manual davit lifting device for removing the access cover from the filter housing.

I. Design housing to meet the hydraulic conditions listed in the section on "Service Conditions."

J. Inlet and outlet nozzles shall be oriented as shown in the drawings.

K. Baffle the inlet nozzle so that the in-coming flow stream does not impact directly on the cartridges.

L. Provide a support assembly to be installed midway along the cartridges to prevent cartridge "sagging".

2.02 CARTRIDGES

A. All cartridges shall be single open end. Single open end cartridges have dual 222 O-rings on the sealing end, and a polypropylene capo on the closed end.

B. All cartridge materials shall be FDA grade polypropylene, NSF Standard 61 approved for use with potable water.

C. Cartridges shall be provide with a one (1) inch diameter polypropylene core.

D. The media shall be FDA grade polypropylene continuously wound to a tension that provides 90% efficiency at the micron rating.

E. Core covers are unacceptable.

2.03 SPARE PARTS

A. Provide the following spare parts:
   1. Provide one three (3) sets of cartridge filters for pretreatment filters, three (3) sets for cleaning filter. Spares are in addition to those used in startup.
   2. Provide 1 O-ring cover gasket for each type of vessel.

3. Pack spares in boxes; label with manufacturer's name and representative's name, address, and telephone number; and attach list of material contained within.

PART 3 EXECUTION

3.01 INSTALLATION

A. Set each cartridge filter in place on preset anchor bolts, plumb, level with leveling nuts, and securely anchor. Grout under feet as shown on the drawings. Extend drains and vent as shown in the drawings. Provide fittings as necessary.

B. Do not install cartridge elements until each element housing has been thoroughly cleaned and connecting pipelines have been thoroughly flushed.

3.02 FIELD TESTING

A. Factory pressure test the housings in accordance with ASME requirements, and provide test certificate..

3.03 START-UP SERVICE

A. Provide for a manufacturer's representative to check equipment installation, supervise initial start-up, and instruct Owner's personnel in proper operation and maintenance of equipment. A minimum of one trip to the site will be required consisting of a minimum of one 8-hour working day.

B. During startup and testing, the cleaning system shall be operated for each RO Train to simulate membrane cleaning using permeate instead of a cleaning solution.

C. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

END OF SECTION

SECTION 13510

REVERSE OSMOSIS TREATMENT TRAIN UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. A complete operational system is to be furnished by a single responsible Reverse Osmosis Equipment Manufacturer (ROEM). The ROEM assumes system and process responsibility for providing complete and functional Reverse Osmosis (RO) Treatment Train Units. The RO Treatment Train Units shall be designed to demineralize cold, high TDS, relatively soft, high bicarbonate, high chloride ground water.

B. Fabricate and supply two (2) Reverse Osmosis (RO) Treatment Train Units to be delivered to the Water Treatment Plant (WTP) site. Each treatment train shall consist of 33 x 15 vessel two stage array, membrane elements, pressure vessels, integral second stage energy recover device (ERD), permeate and concentrate collection piping, cleaning delivery and return piping, flow meters, automated and manual valves, instrumentation, treatment train control panel, sampling board, and other necessary appurtenances as described herein and shown in the Drawings included in the back of this Project Manual.

C. Supply RO flush system components including one (1) flush tank, water level indicating instrument, flush tank fill control valve and two (2) flush water feed pumps.

D. Supply RO cleaning system components including one (1) cleaning tank, one (1) waste tanks, one (1) cleaning pump (with variable speed motor), one (1) waste tank mixer, one (1) submerged heating coil for the cleaning tank and miscellaneous instrumentation

E. Valves not mounted directly on the treatment train unit but controlled by the ROEM control system shall be supplied and shipped to the site loose by the ROEM for installation by the Water Treatment Plant Contactor.

F. The Membrane Element Manufacturer (MEM) shall be defined as the corporation that manufactures and supplies the membrane elements. The ROEM will be allowed to select the MEM that will provide the membranes for the system. One (1) MEM must provide all of the membranes in both RO trains. In the performance of the Work, the ROEM is responsible for coordinating services from and work with the MEM.

G. ROEM is at liberty to offer an alternative arrangement for the RO treatment trains to that shown on the Drawings.

H. The first stage shall be cleaned in two parts, with the second stage being cleaned as a single unit.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Section 11214 Reverse Osmosis (RO) Feed Pumps
   2. Section 13530 Reverse Osmosis System Process Control Logic
   3. Section 13540 Reverse Osmosis System Training
   4. Section 13550 Reverse Osmosis Field-Mounted Instruments

1.03 DESIGN WATER QUALITY AND PERMEATE QUALITY

A. Each RO Treatment Train Unit shall be capable of treating the design feed water quality and meeting the permeate quality as listed in the following table:

	Start-up Feed Water mg/l	Design Feed Water mg/l	Maximum Permeate Quality mg/l
Calcium	29.5	32.8	
Magnesium	33.3	37.0	
Sodium	1990	2363	
Potassium	54.3	60.4	
Ammonium	1.15	2.1	
Strontium	1.8	2.0	
Barium	0.4	0.4	
Iron	0.3	0.3	
Bicarbonate	804.8	783.9	
Chloride	2800	3330	<100.0
Sulphate	111	122.7	
Fluoride	1.2	1.3	
Bromide	12.7	14.1	<1.0
Silica as SiO2	9.54	10.6	
pH	7.7	7.75	
Temperature (deg. C)	19	19	
SDI (15 min)	<1.0	<1.0	
Turbidity	<1 NTU	<1.0 NTU	
TDS (as sum of ions)	5742	6750	<250

1.04 TREATMENT TRAIN DESIGN CHARACTERISTICS

A. Each treatment train shall meet initial and future design characteristics. Initial conditions represent design requirements based on start-up feed water characteristics listed in Part 1.03. Future conditions represent design requirements based on the Design Feed Water characteristics listed in Part 1.03.

B. The following table lists the treatment train design requirements:

	Initial	Future
Permeate/train at turn down flux of 13 gfd	1215.3 gpm	1215.3 gpm
Permeate/train at design flux of 15 gfd	1389 gpm	1389 gpm
Permeate/train at minimum concentrate flow of 15 gpm/vessel	900 gpm	900gpm
Number of trains	2	4
Recovery	80%	80%
Maximum R.O. feed pump discharge pressure	315 psig	343 psig
Membrane diameter	8-inch	8-inch
Membrane length	40-inch	40-inch
Pressure vessel length	7 elements	7 elements
Proposed membrane array, 1stage/2nd stage	33/15	33/15
Number of vessel positions vertically	7	7
Number of vessel positions horizontally	8	8
Design flux	15 gfd	15 gfd
Turn down flux	13 gfd	13 gfd
Minimum Flux	9.64 gfd	9.64 gfd

1.05 SUBMITTALS

A. Submit the following:
   1. Submit Engineering Drawings showing the following items:
      a. Process & Instrumentation Diagrams (P&IDs) for each RO Treatment Train Unit.
      b. RO Treatment Train Unit arrangement drawings showing all components and piping and electrical connections.
      c. Submit membrane projections in accordance with Part 2.02.D.
   2. Submit dimensional drawings, descriptive literature, bulletins, and/or catalogs of the following:
      a. RO membranes
      b. Pressure vessels

c. Valves
d. Electric Actuators
e. Energy Recovery device, with calculations
f. Flow Meters
g. Instrumentation and control devices and control logic description
h. Instrument panel
i. Sample panel

B. Show dimensional and mounting details for RO Treatment Train Unit frame and support system. Provide point loadings for each of the frame supports.

C. Submit certification of compliance with ASME code, where required.

D. Show NSF compliance where applicable.

E. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the equipment as supplied for the Project.
   1. Each manual shall be a bound, indexed 3-ring binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Approved shop drawings.
      b. Copy of ASME and NSF certifications.
      c. Control panel wiring diagrams.
      d. Warranty information for each component.
      e. Instructions for startup/shutdown of system and for adjustment of equipment.
      f. Inventory, functional descriptions and operating instructions for equipment.
      g. Recommended routine maintenance procedures
      h. Recommended preventative maintenance for each major component.
      i. Complete bill of material.
      j. Installation instructions for the specific equipment.
      k. Contact information for contractor capable of performing emergency repairs.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service for each piece of equipment.

1.06 QUALITY ASSURANCE

A. Quality assurance shall be as following:
   1. ROEM shall provide three project references with the contact information of the individual responsible for the project.
   2. The following are a list of pre-approved ROEMs:
      a. Harn R.O. Systems, Venice, Florida
      b. Aerex Global Water Solutions, Fort Pierce, Florida
      c. H2O Innovations, Vista, California
      d. Doosan Hydro, Tampa, Florida
      e. Wigen Water Technologies, Chaska, Minnesota
      f. ROEMs who wish to be approved may submit a qualification statement to the Buyer's representative, the Wooten Company, Raleigh, NC for consideration. As part of the qualification statement, applicant must provide proof of compliance with the minimum requirements of qualification, which is 10 years of experience in constructing multi train RO treatment plants with train size of at least 1 MGD, dealing with similar water at similar design

conditions in the United States. Applicant must also have five (5) or more completed projects with multi-train installation. The prospective ROEM must submit sufficient proof a minimum of 15 days prior to the bid opening date. The Engineer has sole discretion in approval.

3. All components included in the assembly of the RO train shall be new and purpose purchased for this project.

B. Submit the name, address, and phone number of the firm(s) that will provide required repair or replacement during the warranty period.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver RO Treatment Train Units, loose components and associated control panel to the job site as complete as possible to minimize site assembly requirements. Provide written unloading, storage, handling, and installation instructions with the units.

1.08 WARRANTY

A. ROEM shall provide to the Buyer a minimum one year materials and workmanship warranty.

B. The ROEM shall furnish to the Buyer a written guarantee for all his work, materials, equipment, etc., against defects for a period of one year from the date of final acceptance, and shall provide performance warranties for the equipment supplied under this contract for a period of one year.

C. Membrane replacements and equipment repairs or replacement required during the first year of operation shall be performed at no cost to the Buyer.

D. In addition to the one year warranty period described above, the ROEM shall provide a pass through membrane performance guarantee from the membrane manufacturer (MEM) for a period of four (4) years from the first (1st) anniversary of the final acceptance of the equipment.

1. The membranes shall be warranteed by the ROEM to meet the permeate TDS and chloride water quality criteria as specified herein and based on the raw water quality parameters specified herein for a period of five (5) years from the date of acceptance by the Buyer. (1 year material and workmanship plus 4 years pass through from membrane manufacturer)
2. The membranes shall also be warranteed to meet the manufacturers published standard warranties relative to minimum permeate flow. The ROEM and the membrane manufacturer shall restore the system performance to the specified levels by replacing membrane elements as needed, within 3 weeks of notice of non-compliance by the Buyer.
3. Membrane replacement during the one (1) year period shall be at no cost to the Buyer. Membrane replacement for claims made after the first year shall be performed at the original membrane unit price less a prorated rebate on the unrealized life of the warranty.

PART 2 PRODUCTS

2.01 TREATMENT TRAIN UNITS

A. The treatment train units shall include, but not limited to, the following:

1. Membranes, pressure vessels, and support structures.
2. Stainless steel train-mounted piping and valves.

3. Instrument panel(s) and instrumentation.
4. Sample panels with sample valves and tubing.
5. Power and instrumentation wiring,
6. System and train control logic.

B. Two RO Treatment Train Units shall be provided.

2.02 MEMBRANE ELEMENTS

A. The membrane elements shall be thin film composite membranes with 400 square feet of active membrane area in each 8-inch x 40-inch spiral wound membrane element. Membranes shall be NSF 60/61 certified for use in potable water systems.

B. The operating characteristics of each membrane element shall be measured at the following conditions:

Test solution	2,000 mg/l, NaCl solution
Applied pressure	150-225 psig
Test temperature	25 degrees C
Element recovery	15%
pH range	6.5 – 8.0

Performance data taken after 30 minutes of stable operation

Minimum performance standards required, based on the above procedure:

NaCl Rejection	99.5% minimum
Permeate Flow	10,500 GPD

C. Prequalified membrane element manufacturers are:
1. Toray Membrane USA,
2. Hydranautics,
3. Dow Filmtec,
4. Lanxess,
5. LG-NanoH20

D. The membrane element manufacturer is responsible for choosing the membrane model best suited for the design conditions for start-up and design water quality. Membrane performance projections must be provided for both start-up and design water quality. Different membranes may be considered for each water quality, although it is preferred that the same membrane be used for both conditions.

E. It is preferred that membrane arrays be uniform, but hybrid membrane arrangements by stage may be offered for the design water quality condition.

F. It is understood that projections using design water quality may not be valid when the future state occurs, due to improvements in membranes being offered at that future time.

G. Membrane projections will be provided with the bid for initial water quality startup performance, and performance after 1, 2, and 3 years.

H. Membrane projections will be provided with the bid for design water quality startup performance, and performance after 1, 2, and 3 years.

I. Membranes should be bid as a line item lump sum bid price. Bid evaluation will include a 10-year present worth cost calculation which will take into account the feed pump energy cost over 10 years at a utilization factor of 75%, with a 2% per year electric power cost escalation. It will be assumed that one membrane replacement will take place during the 10-year period. Membrane price escalation will be assumed to be 5%.

J. Membrane element manufacturers should provide for the membranes offered no less than two plant references in the USA, treating water similar to the initial design feed water, at similar recovery, for a period of two years or more. Contact information for the plant managers shall be provided.

K. The membranes shall be individually tested and permanently marked with a factory serial number. Test conditions shall be as on the membrane data sheet submitted with the bid. A test report shall be submitted to the Buyer through the Engineer prior to membrane loading. The test report shall provide for each element, the following:
   1. Membrane Serial Number.
   2. Date of Test.
   3. Test conditions: temperature, pressure, feed water composition, recovery.
   4. NaCL rejection, normalized to 2,000 mg/L feed TDS.
   5. Permeate production, normalized to 225 psi applied test pressure.

L. A permeate back pressure of 30 psi can be assumed for both stages, with a concentrate discharge back-pressure of 20 psi.

M. The maximum 1st stage lead element flux shall be 23 gfd. The maximum 2nd stage lead element flux shall 20 gfd. Both these limitations apply to initial water quality conditions only.

N. Each Treatment Train Unit will be provided with an energy recovery pressure boost device. ROEMs should consult with the device manufacturers in order to ensure that the maximum RO feed pump motor size shall be 400 hp.

2.03 PRESSURE VESSELS

A. Pressure vessels shall be constructed of fiberglass reinforced plastic (FRP). Tube dimensions shall be suitable for seven (7) membrane elements of 8-inch diameter x 40-inch length. Each vessel shall be equipped with two end closures, with suitable retaining devices. The end closure surfaces in contact with the process fluid shall be of PVC or other inert plastic. Each end closure shall have ports for permeate. The pressure vessels shall be equipped with side entry feed/concentrate ports, three (3) inches nominal pipe diameter. The feed/concentrate port stub tubes shall be fabricated from super austenitic (6% Mo) stainless steel. The permeate ports shall be fabricated from NSF-approved ABS or other NSF approved plastic material. The end closure and retaining devices shall be designed as a unit to form a drip-tight seal. The primary means for end closure retention shall be a single piece retaining mechanism that provides ASME required redundancy, and is constructed of 316 stainless steel.

B. The 1st stage pressure vessels shall be designed for a working pressure of 450 psi at 120° F, and each vessel shall be factory-tested at 1.5 times working pressure. The 2nd stage vessels shall be designed for a working pressure of 600 psi at 120°F, and each vessel shall be factory-tested at 1.5 times working pressure. Vessel design, construction and inspection shall be in accordance with ASME Boiler and Pressure Vessel Code - Section X, Fiberglass Reinforced Plastic Pressure Vessels. The vessel manufacturer shall be qualified to produce Code Certifiable Pressure

Vessels per Section X of the Code, as verified by a current Certificate of Authorization issued by ASME.

C. The vessels shall be Code stamped.

D. The vessels shall be manufactured by Protec Arisawa, Pentaire Codeline, or approved equal.

2.04 PRESSURE VESSEL SUPPORT FRAME

A. The pressure vessels shall be supported on a coated FRP, stainless steel, or powder-coated steel support frame. The frame shall be designed for three (3) point vessel support. The pressure vessels with membranes shall be adequately supported on the support frame by plastic, contoured saddles or cradles and stainless steel retaining clamps, provided by the vessel manufacturer. The maximum length, width, and height of the treatment train unit shall be as set forth in the Procurement Drawings included in this project manual. The support frame should be fabricated in convenient sections, and equipped for field assembly. Vessels and piping may be attached to each section as is convenient for the ROEM, and for field assembly.

B. FRP structure shall be fabricated from pultruded FRP structural shapes complying with ASTM D-3917. Structural shapes shall be Extren 500 or equal. All joints shall be glued and bolted/rivetted for maximum strength. FRP shall be coated for protection against delamination. The coating system shall consist of a primer coat and a finish coat. Primer coat shall be NASON Select Prime 421-19 2K Urethane primer and finish coat shall be IMRON 3.5 HG High Gloss Polyurethane. Coatings shall be installed per manufacturer's recommendations.

C. Steel fabricated support structures must be free of pockets and niches which may not be coated initially. After fabrication the frame shall be powder coated in accordance with the guidelines of the Powder Coating Institute. Such components as "Unistrut"-type channel for clamping manifolds shall be fabricated from FRP, "Aikinstrut" or equal, and attached to the steel frame with 316 SS fasteners.

D. Stainless steel structural shapes shall be manufactured from 304L stainless steel. After fabrication the frames shall be thoroughly cleaned and bead blasted to a uniform finished color. Such components as "Unistrut"-type channel for clamping manifolds shall be fabricated from 304L stainless steel, "Aikinstrut" or equal, and attached to the steel frame with 316 SS fasteners.

E. All mounting hardware, for pressure vessels, manifolds, instrument panels and sample boards shall be 316 SS. Bolts, washers and other fasteners shall be 316 SS. Nuts for bolts shall be 304 stainless steel.

F. Support structures shall be anchored to concrete foundations, provided by others. Stainless steel expansion bolts, 1-inch diameter shall be used for this purpose.

2.05 FEED, CONCENTRATE AND PERMEATE PIPING

A. Vertical manifold piping shall be provided by the ROEM, and shall be an integral part of the membrane assemblies. RO Feed Pump suction piping shall be fabricated from 316L stainless steel piping, Schedule 40S. Feed manifolds shall be fabricated from 316L stainless steel piping, schedule 40S. Permeate manifolds shall be fabricated from 316L stainless steel, Schedule 5S. Concentrate manifolds shall be fabricated from 316L stainless steel, Schedule 40S. Assemblies shall be thoroughly cleaned inside and out, and all scale and welding slag removed. Completed

assemblies shall be passivated, and bead blasted to a uniform finish. Completed components shall be pressure-tested to 1.5 times working pressure as part of the final assembly. Permeate piping supplied shall meet NSF 60/61.

B. All manifold tees required for vessel connections shall be fabricated by the "pull-tee method". Welded stubs will not be permitted.

C. The feed and concentrate manifolds shall be connected to the pressure vessels ports with Victaulic-type connectors, with bolts, nuts, and washers as described elsewhere. Couplings shall be galvanized cast steel.

D. Connection between permeate manifolds and pressure vessels shall be with reinforced black plastic tubing, made from Food Grade material approved by NSF for use in potable water systems. The bend radius of the tubing shall be such that there is no flow restriction through bends. Provision shall be made for a sample port in each connection, ½ inch female threaded. The pressure vessel permeate stub tube which is not attached to the permeate manifold shall be plugged with a PVC plug.

E. Each vessel permeate connection shall be equipped with a sampling port connected to a sample valve centrally located on a train-mounted sample panel. The port shall be equipped with a stainless steel Swagelok or equal tubing fitting. Color coded polyethylene tubing will connect the permeate ports to sample valves on the sample panel.

F. Each feed and concentrate manifold shall be provided with an air relief system as shown on the Procurement Drawings. The half couplings shall be welded to the top of each manifold, and fitted with 316L stainless steel tube fittings. Half couplings shall be 3/8" FNPT, and tubing connectors shall be 3/8" OD. Stainless steel tubing shall be 3/8" OD, rated for a working pressure of at least 500 psi. The tubing shall be connected to a ¼ turn stainless steel ball valve, mounted at a convenient location for operator access. Downstream of the valve, polyethylene tubing will drop into the pipe trench to dispose of water.

G. Air relief for the main permeate piping header will be provided by Installation Contractor.

2.06 ENERGY RECOVERY DEVICES

A. An energy recovery device shall be provided for each RO Treatment Train Unit. This device will recover energy from the 2nd Stage concentrate flow stream and transfer it to boost the pressure of the interstage flow (2nd Stage feed) stream.

B. The energy recovery device shall be centrifugal type, consisting of radial inflow turbine section, energized by the RO concentrate flow, and centrifugal pump section which directly boosts the pressure of the interstage flow.

C. Material of construction for the casing shall be duplex stainless steel. External bolting shall be 316 stainless steel, external tubing shall be 316L stainless steel, and retaining rings shall be passivated 316 stainless steel. Bearings shall be non-metallic, suitable for use with high chloride brackish water.

D. Device control shall be by an auxiliary nozzle and manual valve, and a PID loop controlled concentrate bypass valve.

E. The energy recovery device shall be manufactured by Energy Recovery, Inc., (ERI), Model AT-1100, or Fluid Equipment Development Company (FEDCO), model HPB-250.

2.07 VALVES

A. General
   1. The RO treatment train valves shall be properly sized by the ROEM to ensure proper operation. The ROEM shall select the operating speed of control valves to be compatible with the membrane train design. Excessive noise and vibration in valves will not be accepted.
   2. All valves of the same type shall be from one (1) manufacturer, or as described herein. The name of the manufacturer, flow direction arrows, and working pressure for which they are designed shall be casted in raised letters upon the body of the valve.
   3. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.
   4. Control valves shall operate at forty to seventy percent (40% to 70%) open.
   5. Check Valves: Each RO train shall be provided with a check valve on the feed, low pressure concentrate, and permeate piping.
   6. RO Feed Pump Discharge Valves: The RO feed pump discharge valves on the RO trains shall be a stainless steel motorized butterfly valve. The valve shall be operated with an electric actuator as specified herein.
   7. Butterfly valves shall be used as isolation valves on piping 4-inches or more in diameter. Valves shall be as specified herein.
   8. Concentrate control valves shall be V-ball control valves with a modulating electric actuator as specified herein.
   9. A short piece of stainless steel piping, of the appropriate diameter, will be provided by the ROEM downstream of the valves. This stub shall be grooved to accept a grooved coupling for connecting to the cleaning delivery and return PVC piping which will be provided by the Installation Contractor.

B. Butterfly Valves (150 psi service)
   1. Provide fully lugged wafer style, 150 psi butterfly valves on aboveground piping for the total permeate, total permeate drain, permeate cleaning return, and permeate flushing.
   2. Butterfly valves 20-inch & smaller on 150 psi service shall be fully lugged style wafer valves with Nylon coated cast iron bodies. Disks and stems shall be 316 stainless steel. Disk-stem will be through-stem direct drive double "D" design requiring no disk screws or pins to connect stem to disc with no possible leak path. Stem shall be mechanically retained in body neck and no part of stem or body exposed to line media.
   3. Seats shall be EPDM-Food Grade with tongue and groove design with primary hub seal and molded O-ring. Seat shall totally encapsulate the body with no flange gaskets required.
   4. Discs shall be spherically machined, hand polished disc edge and hub for minimum torque and maximum sealing capabilities. Valves shall have non-corrosive bushings and self-adjusting stem seals. Valves shall be bi-directional and tested to one hundred ten percent (110%) of full rating. No field adjustment shall be necessary to maintain performance.
   5. All manually operated butterfly valves 8" or greater shall have gear driven hand wheel operators, and all manually operated butterfly valves 6" or smaller shall have manual lever operators.
   6. Gear operators for butterfly valves shall be marine trim series 04 with handwheel operation. Materials and equipment shall include a cast iron housing, bronze gear quadrant, 316 stainless steel worm gear shaft, 316 stainless steel fasteners, and non-water soluble grease.

7. Valves shall be Bray Series 31 (ANSI 150) or approved equal.

C. Butterfly Valves (greater than 150 psi, High Pressure Service)
   1. Provide high pressure butterfly valves on RO train Feed Pump discharge and cleaning supply and return valves.
   2. Butterfly valves for high pressure services shall be high performance fully-lugged wafer style valves. Stem and disc design shall be double offset that reduces seat wear with bi-directional, zero leakage, shut off throughout the full pressure range. Body and disc shall be 316 stainless steel. Bodies shall be ANSI class 300. Stem shall be stainless steel type: ASTM A564-Type 630, 17-4 PH SS.
   3. Stem packing for high performance butterfly valves shall be easily adjustable without requiring removal of the actuator. Packing shall be multi-level PTFE with a carbon fiber anti-extrusion ring sealing the packing. Valves shall have upper and base twin stem seals. Bearings shall be 316 stainless steel with a TFE / glass fiber bearing surface.
   4. Seats shall be RTFE. The two-part assembly shall consist of a resilient O-ring energizer, which is totally encapsulated by the RTFE seat. Seat shall be locked into the body by a full-faced seat retainer.
   5. Electric actuators specified in this section.
   6. Gear operators for high performance butterflies shall be marine trim series 04 with handwheel operation. Equipment and materials shall include a cast iron housing, bronze gear quadrant, 316 worm gear shaft, 316 stainless steel fasteners, and non-water soluble grease.
   7. Valves shall be Bray McCannalok metal seated high performance valves or approved equal.

D. PVC Butterfly Valves
   1. Provide on PVC concentrate, flushing, and cleaning pipes as required.
   2. Equal resilient seat butterfly valve, ANSI 150# PVC wafer body, polypropylene disk, 316 SS stem, EPDM seat with manual lever operator.
   3. Valves shall be Asahi Type 57 or approved equal.

E. Electric motor actuators for butterfly valves shall be manufactured by Bray. Motor actuators shall have the name of the manufacturer cast or molded onto the operator body or shown on a permanently attached plate in raised letters.
   1. Provide identifying tags for electric motor-operated valves. Show valve operator tag number, name or designation as shown on the drawings, and valve size. Attach tags to operators by means of stainless-steel wire.
   2. The output torque of the motor actuator shall be at least 1.5 times the maximum torque required to open or close the valve at any position but in no case exceed the maximum torque rating of the valve shaft. Each valve motor actuator shall have ample power capacity for accurately seating, unseating, and positioning the valve when subjected to the most severe operating condition including any mechanical friction and/or other restrictive conditions that are inherent in the valve assembly.
   3. Unless noted otherwise, each electric actuator shall be bidirectional type with permanent split capacitor totally enclosed, non ventilated, 120 volt, single phase A-C motor drive. Provide an integral motor starter. Provide built-in motor thermal overload protection. The control housing shall be NEMA 4 construction.
   4. Position switches shall be integrally geared to the actuator and shall be adjustable. Provide motor operators with position switches to stop motion at the

end of travel in each direction. Provide auxiliary switch contacts for transmitting open and close position.

5. The actuators shall have a manual override to allow operation of valve in case of power failure. Provide dis-engageable manual override so that the operator cannot be operated electrically while the manual override is engaged.

F. V-ball Control Valve

1. The concentrate control valves shall be v-ball valves, with equal percentage output. The valve shall be designed to take the full pressure drop from the concentrate pressure down to the disposal system back pressure. Valve body shall be rated at 150 lb. with flat face flanges and all stainless steel trim. Coordinate system pressures and valve size with the membrane system supplier. Materials of construction shall be as follows:

a.	Body, seal and seal protector ring	CF3M (316 stainless steel)
b.	V-notch ball	CF3M
c.	Ball seal	Composition
d.	Shaft	17-4PH stainless steel Alloy 20
e.	Packing	TFE

2. The valve positioner shall be an electric-actuated rotary device, with fail in place characteristics. The control shall be by 4-20 mA loop control. Options shall include position switches for fully open and fully closed and a handwheel for manual operation. The positioner shall be designed for mounting to the valve, as an integral unit.
3. The valve/actuator shall be Fisher-Rosemount, V-150 Rotary Valve, or approved equal.

G. Check Valves

1. Provide check valves on the RO Feed Discharge, total permeate, and total concentrate lines.
2. Check valves shall be wafer style, dual disc check valves. Valves shall meet ANSI B.16.34 for installation in horizontal or vertical upwards pipe. Check valves shall be hydrostatically tested to ANSI B 16.34 for zero leakage, bubble tight shut off. Bodies shall be ANSI Class 150 and 300, as required. Body shall be one-piece, narrow face-to-face, configured to fit with ANSI B 16.5 flanges. Body material shall be cast stainless steel ASTM A 351 Grade CF8M. Valve inlet shall be contoured to reduce pressure loss and turbulence.
3. Valve disc shall be one-piece, cast stainless steel, ASTM A 351Type CF8M. Disc travel shall be limited by a stop pin located in front of the hinge pin. Disc shall not come in contact with pipe. Disc hinge shall be centered on the body and shall be Inconnel X-750. Disc shaft shall be a blow-out proof design stainless steel, Grade 316. No keys or pins shall be allowed between hinge and shaft and spring adapter.
4. Valve seat shall be field-replaceable Buna-N. Seats shall be located in a dovetail groove to ensure they remain secure. All trim (plug, spacer, bushing, & disc nut) shall be 316 stainless steel.
5. Valves shall be Crane Duo-Check, or approved equal.

2.08 FLOW METERS

A. Provide flow meters on the RO Trains as shown on Procurement Drawings See Specification Section 13550.

2.09 CONDUCTIVITY TRANSMITTER AND SENSOR

A. Provide conductivity transmitters and sensors as shown on Procurement Drawings. See Specification Section 13550.

2.10 PRESSURE GAUGES

A. ROEM shall supply all pressure gauges as shown on the Procurement Drawings. See Specification Section 15132.

2.11 TRAIN MOUNTED INSTRUMENT PANEL BOARD

A. The ROEM shall provide one (1) train instrument panel board for each train. Panel board shall be mounted on the train frame. Fabrication requirements are as described below:
   1. The train mounted instrument panel shall be fabricated from 1/4 inch thick FRP sheet, with machine cut openings for instruments, gauges and interconnecting tubing.
   2. The train panel boards shall be attached to the support structure of the appropriate train, or floor mounted immediately adjacent to the train. The train-mounted panel is further described in the Membrane System specification section.
   3. Engraved plastic labels will be provided for each device on the panel, showing the device's tag number, and its function. (eg: PIT-201A- RO Feed Pressure).
   4. The labels will be white lettering on red background, and will be attached to the panel with stainless steel screws.
   5. All piping used on the panels shall be Schedule 80 PVC, with PVC true union ball valves and check valves. Piping shall be designed so that instruments may be easily disconnected and removed from the panel.
   6. Tubing used on the panels shall be 3/8" heavy wall 316L SS, with 316L SS fittings as manufactured by Swagelok, or equal.
   7. All interconnecting conduit shall be PVC corrugated flexible tubing, with compatible PVC conduit fittings manufactured by Carlon, or equal. Separate conduits shall be provided for 4-20mA and 110V circuits.
   8. Provide all instrumentation as specified below and shown on Procurement Drawings. See Specification Section 13550 for instrumentation requirements.

B. The panel board shall be equipped with the instrumentation described below:
   1. 1st stage permeate flow indicating transmitter.
   2. 2nd stage permeate flow indicating transmitter.
   3. Concentrate flow indicating transmitter.
   4. 1st stage feed pressure indicating transmitter.
   5. 1st stage concentrate pressure indicating transmitter.
   6. 2nd stage feed pressure indicating transmitter.
   7. 2nd stage concentrate pressure indicating transmitter.
   8. Permeate conductivity indicating transmitter.
   9. Concentrate conductivity indicating transmitter
   10. Train pressure gauge with five way selector valve, to measure RO feed, 1st stage concentrate, 2nd stage feed, concentrate, and concentrate to disposal.

2.12 TRAIN PLC CONTROL PANEL

A. The ROEM shall provide one (1) Train PLC Control Panel for each train. Panel shall have the following:
   1. HMI touchscreen, total permeate flow, and 1st and 2nd stage differential pressure shall be mounted on the door of the control panel.

2. Programmable Logic Controller and HMI:
   a. PLC shall be Allen-Bradley, Type ControlLogix.
   b. HMI shall be Allen Bradley, Panelview Plus 6 1000.
3. The control panel shall meet all the requirements in this Parts 2.18 and 2.19 of this specification.

B. Provide logic functions for the PLC for a fully functional system built on the control logic described in Section 13530.

C. Control of the RO trains and accessory equipment (i.e. control valves, etc.) shall be provided from the Train PLC. The overall water treatment plant shall be monitored and controlled as one functioning entity by the Plant SCADA system located in the control room.

D. Field monitoring of conductivity, pressures and flow rates shall be provided and used to monitor and control the RO train operation through the Train PLC and HMI, and displayed on the Plant SCADA system in the control room.

2.13 SAMPLE BOARD

A. The R.O. system supplier shall provide a sample board to be mounted on each Treatment Train Unit. The boards will be fabricated from FRP with 316L stainless steel hardware.

B. The board shall be fitted with sample valves. There shall be one (1) sample valve for each vessel permeate, plus valves for feed to each stage, concentrate, 1st stage , 2nd stage and combined permeate. The sample board shall be equipped with a 4-inch deep by 4-inch wide trough, of the same material as the panel, which will be drained to the pipe trench through a 2-inch PVC pipe. Sample valves shall be arranged in three horizontal rows with cutouts for 20 sample points per row, with the rows staggered so that the upper valves discharge between the lower valves. Each valve will be fitted with a ¼-inch ID 316L stainless steel tubing discharge spout, to prevent splashing. Valves shall be 1/4 turn plug valves. Each valve will be labeled with an engraved label white on blue for permeate, white on green for feed and/or concentrate, indicating source of sample.

C. Sample tubing shall be 3/8-inch OD. Tubing shall have a minimum working pressure of 300 psi @ 120° F for permeate, and 600 psi for feed and concentrate. Sample tubing shall be blue for permeate, red for feeds, black for concentrate, and green for combined permeate. Tubing material shall be nylon. Tubing shall be manufactured by Imperial Eastman Division, Imperial Clevite, Inc., or equal.

D. Tubing shall be neatly arranged, and bundled where possible. Bundles shall be retained with nylon "Tywraps", and "Polytube" racks, as required.

2.14 MEMBRANE FLUSH SYSTEM

A. General
   1. The ROEM shall supply as part of his scope a membrane flush system. This system consists of a flush water tank, flush pumps, motorized flush valve, instrumentation and control. Flush system shall be designed based on flushing a maximum of 35 1st stage and 21 2nd stage vessels.
   2. Flushing system components will be supplied as loose pieces by the ROEM and installed by the Installation Contactor. Interconnecting piping and manual on/off valves shall be supplied and installed by the Installation Contactor.
   3. ROEM will incorporate flush system operation control logic into the RO train control logic, with the exception of the tank fill valve operational control which

will reside in the Plant SCADA PLC logic. The RO train logic will receive tank level status input from the SCADA PLC.

B. Flush Water Tank
   1. ROEM will supply one (1) flush water tank, for installation by the Installation Contractor.
   2. The flush water tank shall be a polyethylene tank with a working volume of no less than 8,500 gallons. The tank shall incorporate bulkhead type flanged connections.
   3. Tank shall be 120" in diameter, with a straight side wall of approximately 200"
   4. The tank will be domed top with 24-inch manway, and flanged or threaded top connection for ultrasonic level meter.
   5. Tank flanged connections
      a. 6" flanged fill port will be located on the top dome of the tank.
      b. 4" flanged bottom outlet port will be located approximately 6" above the base of the tank. Locate per Procurement Drawings.
      c. 6" flanged overflow approximately 6" below the top of the tank straight side wall height. Locate per Procurement Drawings.
   6. Tank shall be fitted with a level sight tube to measure between 6" and 192". The level indicator shall be a magnetic flag-type sight level gauge with PVC ball isolation valve at the bottom connection. Provide flanged connections to tank. Provide with indicating scale. Gauge assembly shall be Gem's "Suresite" or equal. All wetted parts shall be PVC.
   7. Tank material shall be certified for compliance with NSF61.
   8. The tank shall be manufactured by PolyProcessing Company, Snyder Industries, Inc, Chemtainer, or approved equal.

C. Flush Tank Level Indicating Instrument
   1. Provide level indicating instrument for flush tank. See Specification Section 13550.

D. Motorized Flush Inlet Valve
   1. Permeate inlet valve to the flush tank shall be a PVC lugged butterfly valve, Asahi Model 57 with Series 92 electric actuator or equal. Valve will open and close based on tank level signal conditioned by the Water Treatment Plant SCADA system.

E. Flush Pumps
   1. ROEM will supply two (2) vertical multistage in-line centrifugal pumps, for installation by the Installation Contractor. Tags shall be FLP-1 and FLP-2.
   2. The pumps will be Grundfos, Model CRN, Goulds Series e-SV 46SV, or Engineer approved equal.
   3. The flush pump head, suction/discharge base,150 lb flanged inlet and outlet, base plate, shaft couplings, flange rings, shaft, impellers, and impeller wear rings shall be constructed entirely from cast stainless steel, 316 stainless or Duplex stainless steel. Shaft seal shall be 316 stainless steel construction with carbon/tungsten carbide rings and EPDM O-rings.
   4. The flush pumps shall each meet the stated flowrate at the maximum TDH. At lower TDH higher flows will be allowed (up to ~ 280 gpm) but the pump must operate at all times along the selected pump curve and pump operating window. Each pump will meet the following conditions
      a. Flooded Suction
      b. Static head range on the pump — 0 to 16 feet
      c. Flowrate — 175 gpm @ Max TDH

d.	Maximum Total Developed Head (TDH)	80 feet
e.	Minimum TDH	50 feet
f.	Pump speed type	Constant
g.	Pump speed	3600 rpm
h.	Suction size	3-inch
i.	Discharge size	3-inch
j.	Pumped fluid temperature	68 F

k. ROEM shall verify the head requirement for their specific RO skid unit and membranes.

5. Pumps shall operate as duty and standby, and shall rotate function at least monthly.
6. Pump control logic shall be provided by the ROEM, and shall be resident in the train-mounted PLC. Flush system status shall be displayed in the control room through the Plant SCADA PLC.
7. Each pumping unit shall be subjected to a nonwitnessed laboratory performance test. Conduct tests in accordance with Hydraulic Institute Standard Level Standard 14.6-2011 Level 1B.
8. Motors
   a. Motor shall be sized to be non-overloading over the entire pump curve.
   b. Motor shall be closed coupled to the pump.
   c. Motors shall be premium efficiency, TEFC, 230/460V, 3ph, 60Hz, 1.15 S.F., 3,600 rpm with horsepower of 7.5 HP unless otherwise approved by the Engineer. Each motor provided shall include normally closed thermostats for thermal protection
   d. Motor shall have Class H insulation with Class B temperature rise.
   e. Motor shall be rated for continuous and corrosive duty.
   f. Motor bearings shall have a minimum of 28,000 hours L 10/B 10 life.
   g. Motor nameplate to be mounted on the enclosure with stainless steel fasteners. Nameplate shall have, as a minimum, all information as described in NEMA Standard MG-1-10.40.1

2.15 MEMBRANE CLEANING SYSTEM

A. General
   1. The ROEM shall supply as part of his scope a membrane cleaning system. This system consists of a cleaning tank, one cleaning tank heater, one cleaning pump, waste tank, and waste tank mixer.
   2. Cleaning system components will be supplied as loose pieces by the ROEM and installed by the Installation Contactor. Interconnecting piping and manual on/off valves shall be supplied and installed by the Installation Contactor.

B. Cleaning and Waste Tank
   1. ROEM will supply one (1) cleaning tank and one (1) waste tank, for installation by the Installation Contractor.
   2. Each tank shall be of polyethylene construction and incorporate bulkhead type flange connections. Each tank shall have a minimum capacity of no less than 3,500 gallons.
   3. Each tank will be open top to allow addition of cleaning chemicals via top loading of the tank.
   4. Each tank shall be 102" in diameter, with a straight side wall of approximately 108."
   5. Tank material shall be certified for compliance with NSF61.

6. Each tank shall be fitted with a level gauge tube, to measure between 6" and 102". The level gauge tube shall be a magnetic flag-type sight level gauge with PVC ball isolation valve at the bottom connection. Provide flanged connections to tank for level indicator. Provide with indicating scale. Gauge assembly shall be Gem's "Suresite" or equal. All wetted parts shall be PVC.
7. Cleaning Tank Flanged Connections and Accessories
   a. 6" flanged bottom outlet for cleaning pump suction piping and drain connection located as shown on Procurement Drawings.
   b. 6" flanged connection for immersion heater located as shown on Procurement Drawings.
   c. One (1) flanged side mounted immersion heater and heater control panel terminal box as an integrated unit:
      1) Heat 2% b weight citric acid or 1.0% by weight caustic cleaning solution from 65F to 100F. Target temperature: 100 F.
      2) 6-inch 304 stainless steel flange, ANSI 150 lbs
      3) 316 stainless steel heating elements
      4) 53-inch immersed length
      5) Up to 50 psig operating pressure
      6) 82 kW,480V, 3 phase, 60 Hz
      7) Thermocouple Type "J" for Hi-Limit Protection
      8) Provide NEMA 4X Control Panel Terminal Box with main disconnect, CTRL transformer, contactors, temperature controller, Hi Limit Controller, On-Off selector switch, red light heater "ON", junction terminals for thermocouple Type "J" lead wire length.
      9) Wattco Model FLS1582X1053-T or Engineer approved equal.
8. Waste Tank Flange Connection and Accessories
   a. 6" flanged bottom outlet drain located as shown on Procurement Drawings
   b. Provide waste tank mixer per Section 11220 Waste Tank Mixer.
9. Cleaning and waste tanks shall be manufactured by Snyder Industries, Inc, Chemtainer, Rotational Moldings, Inc, or Engineer approved equal.

C. Cleaning Pump
   1. ROEM will supply one (1) horizontal end-suction centrifugal pump, for installation by the Installation Contractor. Tag shall be CP-1.
   2. The pump shall be Goulds Model 3196 MTi, Fybroc Series 1500, or Engineer approved equal. The pump shall have all 316 stainless steel wetted parts or all Fiberglass Reinforced Plastic (FRP) wetted parts.
   3. Pump Materials.
      a. Stainless Steel Pump
         1) All wetted parts shall be constructed entirely from 316 stainless steel including, but not limited to, the following:
            i) Casing, casing wear rings, casing drain, and ANSI 150 lb inlet and outlet flanges.
            ii) Open type impeller and Teflon O-ring.
            iii) Stuffing box cover.
            iv) Gland and gland hardware. Aramid Fiber and EPDM casing gaskets.
            v) Mechanical seal chamber.
            vi) Condition monitor (stainless steel/epoxy)
         2) 316 stainless steel sleeveless solid pump shaft.
         3) Oil filled bearing case with steel/glass sight glass.
         4) Stainless steel/bronze inboard and outboard oil seals.

5) Stainless steel, single row radial bearing and double row angular thrust bearings. L10 bearing life a minimum of 2 years for continuous duty per ANSI B73.1 M.
6) Single mechanical seals with Carbon vs Silicon Carbon faces with Viton and all 316 stainless steel parts.
7) Ductile Iron Frame Adapter.
8) ASTM A48 Cast Iron factory epoxy painted pump frame for chemical resistance (pH 3 to 12).
9) Chamber Top Cast Iron pump and motor base with manufacturer epoxy finish for corrosion resistance (pH 3 to 12).
10) Provide flush assembly complete with inlet shutoff valve, inlet pressure gauge (0 to 60 psi), discharge flow metering valve and discharge solenoid valve (110 V, 60Hz normally closed). Provide suitable mounting boards for inlet and outlet flush equipment. Solenoid valve to be wired to open when pump motor starts and shut when pump motor stops.
11) Baseplate shall be FRP construction, drilled and tapped for pump and motor mounting. Provide OSHA approved steel coupling guard.

b. FRP Pump
1) Pump shall be designed in accordance with ANSI/ASME B73.1 standards for chemical process pumps.
2) All wetted pump parts shall be constructed of continuous strand fiberglass reinforce with vinyl ester resin (VR-1) construction.
3) Casing to be one-piece construction with integral flat face flanges, ANSI B16.5, 150 lb. Casing hardware shall be 316 SST.
4) Impellers shall be semi-open type and dynamically balanced. Impeller shaft sleeve shall be FRP and integrally molded with the impeller.
5) Cover to be the same construction as the casing and impeller with threaded 316 stainless steel inserts for gland bolting. Casing and cover utilizing 316 stainless steel through bolts.
6) Mechanical seals shall be single outside and double inside mechanical seals. Seals to be constructed of chemical-grade carbon and ceramic faces, 316 stainless steel parts, and Viton secondary seals. Provide external seal water flush at 1/3 to ½ gpm at 15-25 psi above the stuffing box pressure.
7) Provide flush assembly complete with inlet shutoff valve, inlet pressure gauge (0 to 60 psi), discharge flow metering valve and discharge solenoid valve (110 V, 60Hz normally closed). Provide suitable mounting boards for inlet and outlet flush equipment. Solenoid valve to be wired to open when pump motor starts and shut when pump motor stops. Manufacturer to determine required seal water pressure requirement.
8) Gland shall be FRP V1 resin with three taps: two for flush water inlet an outlet and third tap to facilitate assembly. Seals to be Viton.
9) Pump shaft shall be316 stainless steel and meet deflection requirements of ANSI/ASME B73.1 standard
10) Cast Iron bearing frame to have polyester thermosetting powder coating (Spraylat PRPL 96005 or equal). Bearings shall be oil lubricated and have a minimum 8,760 hour L-10 life. A site glass shall be provided to monitor oil level. All bearing hardware 316 stainless steel. Bearing seals to be bronze.
11) Flexible spacer-type coupling.

12) Baseplate shall be FRP construction, drilled and tapped for pump and motor mounting. Provide OSHA approved steel coupling guard.

4. The cleaning pump shall each meet the stated flowrate at the maximum TDH. At lower TDH higher flows will be allowed but the pump will operate at all times along the selected pump curve and pump operating window. Each pump will meet the following conditions

a.	Flooded Suction	
b.	Static head range on the pump	2 to 10.5 feet
c.	Flowrate	840 gpm @ Max TDH
d.	Maximum Total Developed Head (TDH)	160 feet
e.	Minimum TDH	120 feet
f.	Pump speed type	Constant
g.	Pump speed	3500 rpm
h.	Inlet Flange	4-inch, ANSI 150 lb
i.	Outlet Flange	3-inch or 4-inch, ANSI 150 lb
j.	Pumped fluid temperature	100 F

   k. ROEM shall verify the head requirement for their specific RO skid unit and membranes.

5. Pumped fluid shall be a 2% by weight solution of citric acid and 0.1% by weight solution of sodium hydroxide (caustic). Fluid pH range of 3 to 12. ROEM shall verify the cleaning pump is compatible with this pH range.
6. Pump Motor.
   a. Motor shall be non-overloading over the entire pump curve.
   b. Motor shall be 3600 rpm, TEFC, 460V, 3ph, 60Hz with a horsepower of 75 HP and S.F. of 1.15. Motor enclosure rated for severe duty.
   c. The motor shall be inverter duty rated, premium efficiency, Class H insulation with Class F temperature rise. Each motor provided shall include normally closed thermostats for thermal protection.
   d. Motor shall be rated for continuous and corrosive duty.
   e. Motor bearings shall have a minimum of 100,000 hours L 10/B 10 life.
   f. Motor nameplate to be mounted on the enclosure with stainless steel fasteners. Nameplate shall have, as a minimum, all information as described in NEMA Standard MG-1-10.40.1.
7. Variable Frequency Drive shall be provided by the Installation Contractor.
8. Pumps shall have seal water connections for potable quality flushing water.
9. Pump on/off, speed control, and alarm control logic shall be provided by the Installation Contractor at local panel located at the cleaning/waste tank location.
10. Each pumping unit shall be subjected to a nonwitnessed laboratory/factory Certified performance test. equivalent to Hydraulic Institute Standard Level Standard 14.6-2011 Level 1B.
11. Run pumps under actual field service and demonstrate that the pump installed performs to the criteria specified. During the field test, make adjustments to correct problems noted. Provide adjustments or parts renewal as necessary.
12. Measure vibration of the pump assembly at the top of the motor. Amplitude and frequency shall be less than the maximum recommended by the Hydraulic Institute.

2.16 SILT DENSITE INDEX (SDI) TESTING APPARTUS

A. Provide a manual SDI testing apparatus, including 0.45 micron filter papers, filter holder, pressure reducing valve, shutoff valves, and tubing. Provide minimum of 5 100 count packs of filter paper to Buyer with the apparatus.

B. Coordinate sampling connections on the piping before and after the cartridge filters with the Installation Contractor.

2.17 TOOLS AND SPARE PARTS

A. All special tools required for normal operation and maintenance of the equipment shall be furnished by the ROEM.

B. ROEM shall provide a comprehensive spare parts package, which must be delivered prior to plant start-up At a minimum, this package shall include:
   1. Ten (10) sets of spares for each type of pressure vessel for each train.
   2. Twenty (20) sets of spare membrane O-rings (inboard and outboard) and brine seals for the membranes for each train.
   3. One (1) service kit for each valve and actuator provided.
   4. Two (2) grooved coupling seals for each size used for piping, and ten(10) seals for couplings used to connect the pressure vessels to the manifolds.
   5. One (1) service kit for each type of instrument supplied for each train.

2.18 CONTROL PANEL COMPONENTS AND ACCESSORIES

A. Pilot Relays
   1. Pilot relays shall be supplied with the following:
      a. 24 VDC coils.
      b. At a minimum, DPDT contacts rated at 5 A, 120 VAC or 28 VDC.
      c. Socket of different configuration from 120 VAC relays.
      d. Clips for attachment to sockets.
      e. Indicator lights that glow when the relay coil is powered.
   2. Pilot relays shall be as manufactured by Square D, Allen Bradley, Potter & Brumfield, or equal.

B. Programmable Logic Controllers
   1. General
      a. The UV System Manufacturer shall furnish programmable controllers (PLC's) as specified herein and as shown on the Drawings. PLC's shall be provided complete with rack, power supply, I/O cards, special function cards, instructions, memory, input/output capacity, and appurtenances to provide all features and functions as described herein. No substitutions will be permitted.
      b. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.
      c. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.

d. Where applicable, the minimum PLC rack size for rack-based PLCs shall be 7 slots power supply slots. All input/output modules shall be hot-swappable.
e. System configuration shall be as shown on the Control System Block Diagram. PLC types shall be designated on the Control System Block Diagram and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLC's of a designated type. Memory and processor shall be adequate for all control functions specified. PLC's shall be ControlLogix-series as manufactured by Allen-Bradley.

2. Processors
   a. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Nonvolatile memory in the form of a manufacturer supplied industrial CompactFlash card or equivalent technology shall be required to maintain the entire current program and firmware of the controller in the event of power loss. The program shall be updated onto the flash memory each time a program change such as an online edit or tag value is changed. When nonvolatile memory (flash memory) is not available for certain controller models as offered by the PLC manufacturer, long-life lithium batteries shall be used to maintain process RAM memory for at least one year in the event of power loss. The lithium battery unit shall be an externally mounted battery assembly with the highest available capacity. The PLC shall send an alarm to the plant control system if battery level is low and the low battery warning LED shall be indicated on the processor module.
   b. The instructions set for the PLC shall conform to the requirements of IEC 61131-3. Each PLC shall have the capability to run all five of the standard IEC 61131-3 languages simultaneously. These five languages shall be:
      1) Ladder Diagram
      2) Stuctured Text
      3) Instruction List
      4) Function Block Diagram
      5) Sequential Function Chart
   c. PLC processors shall be provided with substantial user program, data and logic memory to allow for future expansion of the overall system. The total memory used on each processor shall be less than 60% of available memory at project completion.

3. Communications
   a. In addition to a communications port for the data highway network, communication ports shall be provided for any other devices required (i.e., operator interface unit) plus an additional communication port for connection to a notebook computer.
   b. Additional communication modules or protocol gateways may be required to support specific communication protocols required under this Contract, and shall be supplied at no extra cost to the Buyer.

4. Input/Output Subsystems
   a. Input/output hardware shall be plug-in modules in associated I/O rack or DIN-rail mounting assemblies. Each unit shall handle the required number

of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.

b. Discrete inputs shall be 24 VDC (integral to the PLC) from dry field contacts. Discrete outputs shall be 24 VDC outputs sourced from the PLC, or dry relay contacts (2A minimum) as required. Refer to Section 17060 – Signal Coordination Requirements for further details of discrete signal type and voltage requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 17550. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 32 per input module and 16 per output module.

c. Analog input circuits shall be isolated, minimum 12-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTD's. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Lightning/surge protection shall be provided as specified in Section 17560 - Transient Voltage Surge Suppression Devices. Maximum density for analog I/O modules shall be 8 per module.

d. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting mode, or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

e. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

5. Remote I/O Subsystems

a. Remote I/O shall be provided as designated on the Control System Architecture Drawing. Remote I/O shall be either PLC rack type I/O or field modules as manufactured by the PLC manufacturer. Field modules shall meet the requirements of Subsection 2.04, Input/Output Subsystems.

Remote I/O processor or communication modules shall be modular and individually replaceable.

b. Remote I/O shall communicate with the PLC using the PLC manufacturer's standard protocol or an open standard network such as DeviceNet, Ethernet IP, Profibus, Foundation Fieldbus, Modbus, or equal.

6. Programming Software
   a. The PLC programming and configuration software shall be the manufacturer's latest version, Windows-based. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. Programming shall be accomplished through the use of ladder logic and other IEC 1131.3 languages. PLC programming software shall include CD-ROM documentation.
   b. Third-party programming software shall be acceptable if recommended by the manufacturer and if that software exceeds the capabilities of the PLC manufacturer's standard software package.

C. Operator Interface Unit
1. An Operator Interface Unit (OIU) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface. The OIU shall provide the following features as a minimum.
   a. Minimum of 10.4 inch diagonal display
   b. 18-bit color TFT LCD display of 640 x 480 pixels
   c. Resistive film touch screen interface
   d. Minimum of 512 MB internal storage
   e. Minimum of 512 MB RAM application memory
   f. 1.0 GHz CPU
   g. Windows CE Operating System
   h. Battery Backed real-time clock
   i. SD, 2 USB-A, 1 Mini-USB, and PCI interface
   j. RJ-45 Ethernet communication interface, 10/100 Mb auto selecting
   k. RS-232 serial port
   l. Sound and buzzer output
   m. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
   n. Enclosure Rating: shall match the enclosure's rating that it is mounted in.
   o. Environment: 0-50°C, 20-85% relative humidity, non-condensing
2. The operator interface unit shall be Allen Bradley PanelView Plus 6 1000, or equal.

D. Ethernet Network Switches
1. Except where specifically allowed on the Control System Architecture Drawing, industrial Ethernet network switches shall be provided for each device connected to the process control system network. The switches shall create switched Ethernet networks that conform to the IEEE 802.3 and 802.3u standards using copper wires or optical fibers in a bus, tree or ring network topology as shown on the Drawings. Ethernet network switches shall be modular, rack mounted, or standard DIN-rail mounted within the PLC cabinet or in an adjacent communication cabinet, as shown on the Drawings.
2. Ethernet network switches shall support ring, bus, tree, or point-to-point network topologies. The Ethernet network switches shall support the non-

proprietary Rapid Spanning Tree Protocol (RSTP) in addition to the switch manufacturer's standard redundant ring network protocol, both of which shall provide self-healing communication recovery.

3. Ethernet network switches shall meet the following minimum performance requirements:
   a. Functions: Modular managed switch with store and forward switching mode, 10 Mbps Ethernet or 100 Mbps Fast-Ethernet support, muLti-address capability, auto-crossing, auto-negotiation, auto-polarity. Each network switch shall manage up to eight (8) ports possible via integrated media modules specified below.
   b. Management: Simple Network Management Protocol (SNMP) (v1/v2/v3) and Common Industrial Protocol (CIP) support; IGMP filtering and snooping.
   c. Power Requirements: Redundant 24 VDC power supply
   d. Operating Temperature: 0° - 60°C
   e. Relative Humidity: 10 – 95%
   f. Network Size: Up to 50 nodes in ring structure
   g. Port Type & Quantity (at each PLC location)
      1) Minimum of four (4) 10/100Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment
      2) Two (2) 100Base-FX, multimode fiber optic cables (62.5/125 µm), ST or SC sockets, 0-5000 meters LAN segment
   h. Link Budget: 8 dB @ 1300 nm; 10 dB @ 850 nm
   i. Wavelength: 850 or 1300 nm
4. Acceptable Ethernet network switches shall be as manufactured by Hirschmann, or equal.

E. Uninteruruptible Power Systems
1. Each UPS shall consist of a tower or rack-mounted UPS module and battery modules as required to meet backup run time requirements.
2. UPS systems shall be true on-line, double-conversion type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.
3. UPS units using line interactive or ferro-resonant transformer technology shall not be acceptable.
4. An automatic bypass switch shall be provided on each UPS. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.
5. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.
6. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.

7. Each UPS shall meet the following requirements:
   a. Input voltage shall be 117 VAC, single phase, 60 Hz.
   b. Voltage regulation shall be +/-5 percent for line and load changes.
   c. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.
   d. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for servers, client workstations, and PLC-based control panels, and 45 minutes for remote telemetry units.
   e. A status monitoring and control panel shall be provided and shall include the following:
      1) Status indicating lights for both normal and abnormal conditions.
      2) Common alarm contacts that shall be wired to the closest discrete input subsystem. An RS-232 and USB port shall provided for communication of UPS status to a server, client, or other suitable hardware. All required interface software and hardware shall be provided.
      3) Circuit breaker for the AC input.
      4) Sound absorbing enclosure.
      5) EMI/RF noise filtering.
      6) Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
   f. UPS systems shall be Eaton Powerware 9130, Emerson Network Power (Liebert) Model GXT3, equivalent by MGE UPS Systems, GE Digital Energy, or equal.

F. Terminal Blocks
1. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Wieland, Square D, or equal.
2. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30 amps.
3. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

G. Cabinets and Panels
1. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.
2. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.
3. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free

aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in chlorine storage/feed areas shall be of non-metallic, FRP construction, rated NEMA 4X.

4. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.
5. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel, fast operating clamp assemblies that do not require bolts or screws to secure. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.
6. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
7. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC or DCU) shall be provided with a folding laptop programmer shelf on the inside of the door.
8. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Rittal. The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

H. Electronic Indicators

1. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor services as required and shall have the same NEMA rating as the enclosure it is installed on. Indicators shall be Red Lion Model IMP or APLCL, or equal.

I. Signal Converters

1. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.
2. General Requirements – Converters shall be of the miniature type, utilizing all solid state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.
3. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and

control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.

4. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4-20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.
5. Frequency to Current Transducers – Frequency to current transducers shall convert pulse-rate and pulse-duration signals to 4-20 mA, 24 VDC analog signals. Converters shall include field-adjustable input frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Timeverter as manufactured by AGM, Moore Industries equivalent, Rochester Instrument Systems (RIS) equivalent, or equal.
6. Current to Frequency Transducers – Current to frequency transducers shall convert 4-20 mA, 24 VDC analog signals to pulse-rate and pulse-duration signals. Converters shall include field-adjustable output frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Quantimer as manufactured by AGM, Moore Industries equivalent, Rochester Instrument Systems (RIS) equivalent, or equal.
7. Integrators – Integrators shall be provided as interchangeable plug-in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be + 0.1% of input span. Integrators shall convert linear analog signals to pulse rate and provide a solid-state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), or equal.
8. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4-20 mADC, and the set point shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be +0.1% per degree F. The repeatability shall be +0.1% of span. The units shall be furnished with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.
9. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4-20 mADC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Contractor shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer's standard enclosure for installation in an existing indoor electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.
10. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the

monitoring and/or control functions specified herein. Interposing relays shall be miniature type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall be Type KU as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

11. Timing Relays – Timing Relays (TR) shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.
12. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA-classified hazardous areas. Intrinsically safe relays and barriers shall be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

J. Accessories
1. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.
2. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type. Pilot lights shall be of the proper control voltage, LED type with light lens colors shall be as specified below.

Color	Function
Red	Running (Open)
Green	Stopped or Off (Closed)
Amber	Fault
White	Other

3. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.
4. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.

2.19 ELECTRICAL

A. Building Wire and Cable
1. Manufacturers
   a. The wire and cable covered by this Specification is intended to be standard equipment of proven performance. Wire and cable shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings. Only one (1) manufacturer for each wire and cable type shall be permitted.
   b. The wire and cable manufacturer shall be ISO 9000 registered.
2. 600 Volt Power Wire and Cable

a. 600 volt cable and wire shall consist of stranded, copper conductor with insulation rated THHN, 90°C for dry locations and THWN, 75°C for wet locations.
b. Conductors shall be stranded copper per ASTM-B8 and B-33, and Class B or C stranding contingent on the size unless otherwise specified. Minimum size wire shall be No. 12 AWG.
c. 600 volt individual power wire and cable shall be Okoseal-N as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent with SIMPull jacket, or equal. Multi-conductor power cables shall be Okoseal-N Type TC Cable as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent, or equal.

3. 600 Volt Control Cable
   a. 600 volt control cable shall consist of stranded, copper conductor with insulation rated THHN, 90°C for dry locations and THWN, 75°C for wet locations. The individual conductors of the multiple conductor cable shall be color coded for proper identification. Color coding shall be equal to ICEA S-68-514, Method 1, E2. Cables shall meet requirements of IEEE-383.
   b. Conductors shall be stranded copper per ASTM B-8 and B 33, and Class B or C stranding contingent on the size unless otherwise specified. Minimum wire size shall be No. 14 AWG.
   c. 600 volt individual conductor control wire shall be Okoseal-N as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent with SIMPull jacket, or equal. Multi-conductor control cable shall be Okoseal-N Type TC Cable as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent, or equal.
4. Instrumentation Cable
   a. The instrumentation cable for analog signals shall be single, shielded, twisted pairs or triads with 600 volt insulation and shall have a 90°C insulation rating.
   b. Conductors shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM-B8, Class B stranding unless otherwise specified. Minimum size wire shall be No. 16 AWG.
   c. The instrumentation cable shall be Okoseal-N Type P-OS for single pair or triad applications and Okoseal-N Type SP-OS for multiple pair or triad applications as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent, or equal.

B. Conduit
1. Manufacturers
   a. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.
2. Rigid Steel Conduit
   a. Steel conduits shall be rigid type, heavy wall, hot-dipped galvanized inside and outside and as manufactured by Allied Tube and Conduit Corporation, Wheatland Tube Company, Jones & Laughlin Steel Company, or equal.

b. Each length of conduit shall be shipped with a coupling on one end and a color coded thread protector at the other end.

3. Liquid-Tight Flexible Metal Conduit
   a. Liquid tight flexible conduit (LFMC) shall be galvanized steel, single strip, with a copper strip interwoven and suitable as a grounding means. LFMC shall be UL listed. LFMC shall have an extruded moisture and oil-proof PVC jacket. LFMC shall be Liquatite Type "LA" as manufactured by Electri-Flex, "Ultratite" Type UL "Ultralite" as manufactured by Alflex Corporation, Type "A" as manufactured by Anaconda, or equal.
   b. PVC coated or stainless steel watertight connectors shall be used with liquid tight flexible metal conduit on both ends. LFMC shall be used to connect all vibrating equipment installed outdoors, in wet or damp areas, and other applications as directed by the Engineer.
4. Conduit Fittings
   a. Fittings for all conduit types shall conform to UL 467 and UL 514 as applicable.
   b. Set screw or indentor type connectors shall not be used. Fittings for conduit installed in wet locations and underground shall provide a watertight joint. Fittings for rigid conduit shall be threaded.
   c. Fittings or bushings shall be installed in easily accessible locations.
   d. Conduit fittings shall be cast type of non ferrous metal or malleable iron thoroughly coated inside and outside with metallic zinc or cadmium after all machining has been completed. Cast fittings shall be provided with heavy threaded hubs to fit the conduit required. Covers shall be of the same material as the fittings to which they are attached and shall be screwed on with rubber or neoprene gaskets between the covers and fittings. Cast fittings 1 1/2 inches and above shall be of the "mogul" type. Where cast fittings are used to house wiring devices such as receptacles and switches, they shall be of the "deep" type.

C. Identification
1. Nameplates
   a. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or equal.
2. Conduit Identification
   a. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, condulets, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:
      1) Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
      2) In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word "TO:" and the text in the 'TO' column of the conduit and wire schedule (e.g. TO: FIT-208-1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word "FROM:" and the text in the 'FROM' column of the conduit and wire schedule

(e.g. FROM: RO TRAIN NO.1 PLC). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.

3) For conduits ¾" through 1½" in size, the text shall be a minimum 18 point font. For conduits 2" and larger, the text shall be a minimum 24 point font.
4) Label height shall be ¾" minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
5) Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.
6) Labels shall be made of permanent vinyl with adhesive backing as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal. Labels made of any other material are not acceptable.

b. Alternatives to this proposed conduit identification method shall be submitted to the Engineer as part of the shop drawing submittal.

3. Wire and Cable Identification
   a. In addition to color coding, all wiring shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. Wire numbers shall not be duplicated.
   b. Wire identification shall be by means of a heat shrinkable sleeve. Sleeves shall have a white background with black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.
   c. Sleeves shall be suitable for the size of wire on which they are installed. When installation is complete, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.
   d. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.
   e. Sleeves shall be white polyolefin as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal.

2.20 ROEM'S SERVICES AFFECTING THE WORK OF THE INSTALLATION CONTRACTOR.

A. ROEM shall be required to review and provide comments on any shop drawing submittal of the Installation Contractor relating to or impacting the installation of the membrane treatment system equipment. The Installation Contractor shall be responsible to submit in a timely manner any shop drawing for ROEM's review necessary to coordinate completion of the work.

PART 3 EXECUTION

3.01 RO TREATMENT TRAIN INSTALLATION

A. RO treatment trains shall be installed by the Installation Contractor, in accordance with ROEM's installation instructions and on-site oversight.

B. The ROEM shall provide the services of an experienced supervisor skilled in membrane train installation. The supervisor will observe the installation of membrane train equipment, support structures, interconnecting piping, electrical systems, clean and flush system and instrumentation systems. The supervisor shall be present at all times necessary for proper installation, and shall provide needed guidance to the Installation Contractor during installation.

C. The treatment train support frame shall be level and properly positioned in accordance with the drawings. Any deviations from the frame locations shall be approved in the shop drawing review and approval stage.

D. ROEM to provide assistance to the Installation Contractor in providing the correct 480V and 120 V power connections to the RO treatment trains.

E. ROEM to provide assistance in the correct installation/mounting of equipment and materials shipped loose by the ROEM to the job site.

F. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

3.02 FACTORY AND FIELD TESTING

A. Pressure Testing
   1. Pressure testing of the completed RO Treatment Train Unit will be accomplished upon assembly at the ROEM factory. Test pressure shall be 1.5 times the operating pressure (minimum 600 psi). This testing shall be witnessed and certified by a P.E. that is employed by the ROEM

B. Functional Testing
   1. After installation by the Installation Contractor, all motorized valves associated with the RO trains and flush system will be tested by the ROEM, and certified by a PE in the employ of the ROEM that the valves and actuators have been correctly installed and are working as designed.
   2. The RO feed pumps will be tested as described in the specification for that equipment.
   3. The flush pumps will be tested for head and flow.

C. Prior to loading the membranes the trains shall be equipped with orifices sized to simulate the flow of permeate and concentrate, and the units will be commissioned with a complete functional test of the plant and train control systems. This test will include verifying timers, valve operation, wellfield operation start-up and shut down,

flush system operation, RO train startup and shutdown, and verification of the accuracy of the integration of the control system between that supplied by the ROEM and the balance of the plant supplied by the Installation Contractor.

D. During functional testing, both RO trains shall be operated simultaneously and all train logic tested.

E. When the commissioning has been completed to the satisfaction of the Engineer, the ROEM will be given written notice that the membranes may be loaded.

3.03 MEMBRANE INSTALLATION

A. Membranes shall not be installed until after a successful hydrostatic test and after system disinfection, flushing, and bacteriological testing of the membrane units' pressure vessels and associated piping has been completed, including successful bacteriological testing for all plant and upstream piping and wells. Instrumentation and PLC/computer testing shall also have been completed.

B. The ROEM shall have complete responsibility for ordering, purchasing, receiving, storing, handling, and installing the membrane elements. If there is damage to or loss of membrane elements after the date of their transfer to the ROEM, the damaged or lost membranes shall be replaced with new identical membrane elements at the expense of the ROEM.

C. The ROEM shall record the delivery of the membrane elements at the Water Treatment Plant. Upon delivery of the membrane elements, the ROEM shall inspect the shipping packaging of the membranes and record and report any damaged membranes to the Engineer, and to the MEM. Any damaged or lost membranes shall be replaced with new identical membrane elements.

D. Prior to the installation of the membrane elements, the ROEM shall hold a meeting with the Buyer to review the procedure for installation of the membrane elements into the membrane trains. A representative of the MEM shall be present at this meeting.

E. Installation of the membrane elements shall fully conform with the MEM and the ROEM's recommended procedures, instructions, and approved shop drawings. The ROEM will record the serial numbers and location of the membrane elements in each pressure vessel.

F. The ROEM shall provide all supervision, tools, incidental materials, and necessary supervision required to install the membrane elements in a clean and contaminant-free environment.

3.04 EQUIPMENT START UP AND TESTING

A. The ROEM shall be responsible for coordinating with the Installation Contractor and the MEM in order to complete startup and testing of the RO treatment train equipment units. Prior to initiation of the specified startup and testing activities, a coordination meeting shall be held by the ROEM with representatives of the MEM, the Installation Contractor including the instrumentation and control subcontractor (if used), and the Engineer. The Engineer shall be notified of the meeting at least ten (10) calendar days in advance and shall attend the meeting. The ROEM shall submit a detailed startup and testing plan at least 30 days prior to the anticipated start-up to the Engineer and shall clearly indicate the start-up sequence, system tests such as second train on line, train off line, flushing sequence, shut down and alarming, and during the test the anticipated flows, duration of flows, and the nature

of the content of the produced streams, The Engineer will review and approve the plan prior to initiation of start-up.

B. Startup Tests. Once the preoperational tests have been successfully completed, the membrane system equipment and controls shall be operated and adjustments made to demonstrate that equipment and controls will operate as a complete and functional system. Each RO treatment train unit shall be operated automatically for at least twenty-four (24) continuous hours at a permeate flow of 1.75 mgd with the units started and stopped at least three times under the ROEM's supervision and with the Installation Contractor, as required.

C. If the above tests successfully demonstrate that the membrane system treatment equipment and controls operate as a complete and functional system to the satisfaction of the Engineer, then and only with the approval of the Engineer, will the ROEM, in conjunction the Installation Contractor, be allowed to proceed with the performance acceptance testing.

3.05 PERFORMANCE TESTING

A. ROEM shall provide field personnel to be on site during the performance testing of the RO equipment.

B. Test Duration
   1. A five (5) day (24 hours per day continuous test) performance demonstration test at a permeate flow of at least 1.75 mgd shall be conducted for each train by the ROEM to monitor and demonstrate the performance of all RO Treatment Train Units, make minor adjustments to the equipment, and to provide O&M training to the Buyer's operating staff. The Buyer's operating staff shall be present at all times during the performance test and receive operational training during that period. A representative from the membrane manufacturer (MEM) must be present during the first two days of performance testing for the first train to be tested and the final two days of overall performance testing. This test shall be coordinated with the Installation Contractor.
   2. The units specified for testing during a specific performance testing period shall be required to be in operation at the same time except as directed by Engineer and the Buyer. At certain times, Engineer and Buyer will request individual or units to be stopped and started to demonstrate satisfactory operation of the Instrumentation and Control System.
   3. If the plant is shut down for any reason, other than the following, the down time shall be added to the duration of the test. If the test is interrupted for the following reasons, the period elapsed while the plant is not operating shall be credited toward the contract period, but the test must be completed.
      a. Loss of feed water delivered to the membrane system treatment equipment for reasons beyond the control of the Installation Contractor.
      b. Loss of power to the membrane system treatment equipment for reasons beyond the control of the Installation Contractor.

C. Testing Conditions
   1. Each RO Treatment Train Unit shall be tested under the following conditions, which must be maintained throughout the entire performance tests:
      a. Start-up feed pressure as projected, adjusted for differences in feed water quality from that used for start-up design.
      b. Design flux of 15 gfd.
      c. Recovery of 80%.

d. Total permeate flow of 1388 gpm (2 MGD), with 1st and 2nd stage permeate flows as projected.

D. Continuous Data Collection and Reporting Requirements
1. The following continuous data unless otherwise specified shall be collected and recorded by the control system data logger during the performance testing:
   a. Overall System:
      1) Feed water temperature
      2) Feed water pressure
      3) Feed water conductivity
      4) Feed water pH
      5) Permeate pressure
      6) Permeate conductivity
      7) Permeate pH
      8) Concentrate pressure
      9) Concentrate conductivity
      10) Concentrate pH
   b. Each RO Treatment Train
      1) Feed water pressure
      2) Interstage pressure
      3) Concentrate pressure (prior to ERD)
      4) Concentrate pressure (after ERD)
      5) Total permeate flow
      6) First stage permeate flow
      7) Second stage permeate flow
      8) Concentrate flow
      9) Total Permeate pressure (main permeate header to post treatment)
      10) Total permeate conductivity
      11) *Each Individual Vessel's Permeate conductivity
      12) *Each Individual Vessel's Concentrate conductivity
      13) *Each Individual Vessel's Interstage Conductivity
      Note: * denotes data points not available on computer. These data points shall be collected manually every 24 hours.)
   c. All of the above automatically collected data shall be trended on the HMI, with data points collected and recorded every 30 minutes, and archived.
2. The following performance parameters shall be plotted against total time of operation in hours for each RO Treatment Train and provided to the Engineer on a daily basis.
   a. 1st stage feed pressure, 1st stage concentrate pressure, first stage flux, first stage dP and 1st stage salt passage based on conductivities of the permeate and feed water.
   b. 2nd stage feed pressure, 2nd stage flux, second stage dP, concentrate pressure immediately upstream of the ERD, and 2nd stage salt passage based on conductivities of the permeate and feed water.

E. Water Quality Sampling
1. Samples shall be collected every 24 hours of operation during performance testing for each RO Treatment Train Unit at the ROEM's expense. During a sampling event, the ROEM shall collect discrete water samples from each train's feed, permeate, and concentrate streams for all the required parameters. Feed silt density index measurement shall be done once per 8 hours. The ROEM shall arrange for laboratory analysis of these discrete water samples at a state certified laboratory approved by the Engineer and the Buyer. The

analytical laboratory shall utilize analytical methodologies approved by the USEPA or contained in Standard Methods (latest edition), that has a detection limit sufficiently sensitive to allow determination of compliance with the stated performance requirements. All analyses shall be completed and the results delivered to the Engineer within fourteen (14) days after sample collection. All analytical results shall be transmitted directly to the Engineer from the laboratory. All appropriate quality assurance/quality control (QA/QC) data shall also be submitted. The Buyer and/or Installation Contractor may choose to split samples with the ROEM during the performance testing. Although the splitting of samples is not the responsibility of the ROEM, the ROEM shall cooperate and coordinate fully with the Engineer, the Buyer, and the Installation Contractor in providing the split samples if requested.

a. Feed water sample analytical list (5 samples)
b. Permeate sample analytical list (10 samples)
c. Concentrate sample analytical list (10 concentrate)

F. Test Report

1. At the end of the performance test, the ROEM, in conjunction with the membrane manufacturer, shall prepare a test report which shall include daily operating and normalized performance data for each day of the test. Submittal of the reports and subsequent approval by the Engineer shall be required for acceptance of the test and substantial project completion. Test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate final positions of controls.
2. The test report shall include, as a minimum, the following data for each RO Treatment Train:
   a. Daily Performance Data
      1) Date
      2) Scale inhibitor consumption (total)
      3) Feed flow, pressure, conductivity, temperature, turbidity
      4) 1st Stage permeate flow, conductivity
      5) 2nd Stage permeate flow, conductivity
      6) 2nd Stage Concentrate Flow, pressure, conductivity
      7) Recovery Rate
      8) Total permeate flow, pressure, conductivity
   b. Plot the following normalized performance parameters
      1) 1st stage flux, 1st stage dP, and salt passage based on chloride and total dissolved solids.
      2) 2nd stage flux, 2nd stage dP, and salt passage based on chloride and total dissolved solids.
      3) System flux, and salt passage based on chloride and total dissolved solids.
   c. Log of operational events including membrane unit downtime and causes, operational adjustments, and operator observations.

G. Performance Test Acceptance Criteria

1. Acceptance of the performance test shall be based on the demonstrated ability of the trains to meet all of the following design criteria consistently throughout the test.
   a. Permeate water production of a minimum of 2.00 mgd from each RO Treatment Train Unit.

b. Meeting required permeate water quality parameter concentration limits or ranges specified.
c. Meeting all testing condition functional operating parameters specified in the contract documents.
d. Starting up and shutdown of all RO Treatment Train Units, one at a time in any sequence, all under computer control.
e. Successful demonstration of parameter-induced shutdowns, such as low concentrate flow, high turbidity, etc.

2. Failed Performance Test Required Actions
   a. If a RO Treatment Train does not perform according to the Performance Test Acceptance Criteria and terms of the membrane warranty, then the ROEM shall make all necessary adjustments, design changes, and modifications required to meet the performance requirements in accordance with the Specifications at his expense. After the completion of any changes, the test will be restarted. The ROEM may be required to repeat the entire performance test on any train up to three (3) separate times, should the performance criteria not be met on re-test.
   b. If the ROEM fails to demonstrate proper startup/shutdown of each RO Treatment Train, the Performance Test shall be considered to be failed and the specific system operation or operational criteria demonstration shall be repeated. The ROEM may be required to perform the required system operation or operational criteria demonstration up to three (3) times.

3.06 SERVICES COMPLETION

A. Regardless of the time spent at the site, RO Treatment Train services will not be considered complete until the system operates as intended for a minimum of one (1) month of plant operation.

3.07 FLUSHING AND CLEANING SYSTEM INSTALLATION AND START-UP

A. Flushing and cleaning system equipment shall be installed by the Installation Contractor.

B. Provide for manufacturer's representatives to check equipment installation, supervise initial start-up, and instruct Buyer's personnel in proper operation and maintenance of each piece of equipment in the cleaning and flushing system. A minimum of one trip to the site will be required consisting of a minimum of two 8-hour working days.

C. Submit copies of tests and checks performed in the field, complete with meter readings and recordings, where applicable, to the Engineer.

D. During startup and testing, the cleaning system shall be operated for each RO Train to simulate membrane cleaning using permeate instead of a cleaning solution.

E. The ROEM shall provide operator training on the complete procedures for RO Train flushing and cleaning and maintenance of the equipment.

3.08 CONTROL PANEL COMPONENTS AND ACCESSORIES

A. Operator Interface Units
   1. The OIU shall be configured to display all PLC I/O, setpoints, and parameters. All equipment failures shall be alarmed. PLC I/O values and operator-entered setpoints shall be displayed with associated units and service descriptions. Menus shall be provided to navigate between screens of different equipment items. Displays shall be arranged in a hierarchical structure with displays for

specific equipment items grouped together. Additional functionality shall be as specified elsewhere in this Division.

2. All necessary configuration and programming software shall be provided on CD media and turned over to the Buyer.
3. All necessary configuration and programming software shall be provided on optical media and turned over to the Buyer.

B. Enclosures

1. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.
2. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel.
3. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.
4. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16 of the specifications. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.
5. Separate terminal strips shall be provided for each type of power and signal used within each cabinet.
6. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.
7. A copper 120 VAC ground bus shall be installed in each cabinet, and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.
8. Interior panel wiring and field wiring shall be tagged at all terminations with machine-printed plastic sleeves. The wire numbering system and identification tags shall be as specified in Division 16. Where applicable, the wire number shall be the ID number listed in the input/output schedules.
9. Wires shall be color coded as follows:
    a. Equipment Ground – GREEN
    b. 120 VAC Power – BLACK
    c. 120 VAC Power Neutral – WHITE
    d. 120 VAC Control (Internally Powered) – RED
    e. 120 VAC Control (Externally Powered) – YELLOW
    f. 24 VAC Control – ORANGE
    g. DC Power (+) – RED
    h. DC Power (-) – BLACK
    i. DC Control – BLUE
    j. Analog Signal – BLACK/WHITE or BLACK/RED

10. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

3.09 ELECTRICAL

A. Building Wire and Cable
   1. 600 Volt Cable Installation
      a. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
      b. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide inhibiting joint compound recommended for copper-to-copper connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or equal.
      c. All interior cable not protected by a compartment enclosure shall be installed in conduit.
   2. Wire and Cable Sizes
      a. Minimum wire size within control panels and similar equipment shall be No. 12 AWG for power and No. 14 AWG for control.
   3. Instrumentation Cable Installation
      a. All cable or conductors used for instrumentation wiring (4-20mA DC, etc.) shall be installed in rigid galvanized steel conduit. Analog signal wires shall exclusively occupy these conduits. No other wiring for AC or discrete DC circuits shall be installed in these conduits.
      b. All shielding shall be continuous and shall be grounded at one point only, or in accordance with the instrumentation equipment manufacturer's recommendations.

B. Conduit and Fittings
   1. The minimum size conduit shall be 3/4 inch for exposed work.
   2. Where practical, exposed raceways containing instrumentation cable shall cross raceway containing conductors of other systems at right angles.
   3. For floor mounted equipment, conduit may be installed overhead and dropped down, where underfloor installation is not practical. Groups of conduits shall be uniformly spaced, where straight and at turns. Conduit shall be cut with a hacksaw or an approved conduit cutting machine and reamed after threading to remove all burrs. Securely fasten conduit to outlets, junction and pull boxes to effect firm electrical contact. Join conduit with approved couplings. Conduits shall be freed from all obstructions.
   4. Each piece of conduit installed shall be free from blisters or other defects. Each piece installed shall be cut square, taper reamed, and a coat of galvanizing compound shall be applied to the threads. Galvanizing compound shall be CRC Zinc-It or equal. Threads on conduits shall be painted with a conducting compound prior to making up in a fitting. Conduit connections shall be made with standard coupling and the ends of the conduit shall butt tightly into the couplings. Where standard coupling cannot be used, Erickson three-piece couplings shall be used. Where conduits are installed in concrete, concrete-tight three-piece couplings shall be used.
   5. Conduit threaded in the field shall be of standard sizes and lengths.
   6. All bends shall be made with standard factory conduit elbows or field bent elbows. Field bending of conduit shall be done using tools approved for the

purpose. Heating of conduit to facilitate bending is prohibited. Field bends shall be not less than the same radius than a standard factory conduit elbow. Bends with kinks shall not be acceptable.

7. Unless otherwise specified herein, indicated on the Drawings, or required by the NEC, conduit shall be supported every 8 feet (minimum) and shall be installed parallel with or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right angle turns consisting of fittings or symmetrical bends. Conduits shall be supported within 1 foot of all changes in direction. Supports shall be approved pipe straps, wall brackets, hangers or ceiling trapeze. For indoor damp/wet process areas, the pre-formed channels shall be aluminum or Type 304 stainless steel. All fasteners, clamps, straps, and anchors shall be Type 304 stainless steel. Perforated strap hangers shall not be used.
8. In no case shall conduit be supported or fastened to another pipe or installed to prevent the removal of other pipe for repairs. Fastenings shall be by expansion bolts on concrete; by machine screws, welded threaded studs, or spring-tension clamps on steel work. Powder actuated fasteners may only be used to make connections where the use of this equipment complies with safety regulations and for structures in Seismic Design Categories A or B, unless the fasteners are approved for seismic use. Wooden plugs inserted in masonry and the use of nails as fastening media are prohibited. Threaded C clamps may be used on rigid steel conduit only. Conduits or pipe straps shall not be welded to steel.
9. No more than three (3) 90 degree bends will be allowed in any one conduit run. Where more bends are necessary, a condulet or pull box shall be installed. All bends in 3/4 inch conduit shall be made with a conduit bender, and all larger sizes shall have machine bends. Joints in threaded conduit shall be made up watertight with the appropriate pipe thread sealant or compound applied to male threads only; and, all field joints shall be cut square, reamed smooth, and properly threaded to receive couplings. No running threads are permitted. All conduit ends at switch and outlet boxes shall be fitted with an approved locknut and bushing forming an approved tight bond with box when screwed up tightly in place.
10. Conduit shall be protected immediately after installation by installing flat non corrosive metallic discs and steel bushings, designed for this purpose, at each end. Discs shall not be removed until it is necessary to clean the conduit and install the conductors. Before the conductors are installed, insulated bushings shall be installed at each end of the conduit.
11. Where "all-thread" nipples are used between fittings and electrical equipment, they shall be so installed that no threads are exposed.
12. Connections from rigid conduit to motors and other vibrating equipment, limit switches, solenoid valves, level controls, and similar equipment, shall be made with short lengths of liquid tight flexible metal conduit. These conduits shall be installed in accordance with the NEC and shall be furnished and installed with appropriate connectors with devices which will provide an excellent electrical connection between the equipment and the rigid conduit for the flow of ground current. Flexible metal conduit and liquid-tight flexible metal conduit length shall be three (3) feet, maximum.
13. All threaded ends of conduits shall be coated with an approved conducting compound as manufactured by Thomas & Betts, or equal prior to making up the joint.
14. Weatherproof, insulated throat "Meyers" hubs shall be used on all conduit entries to boxes and devices without integral hubs in process areas to maintain

NEMA 4X integrity. The Contractor shall furnish and install "Meyers" hubs on all conduit entries into non-cast enclosures such as metallic or non-metallic control panels, control component enclosures, wireways, pull boxes, junction boxes, control stations, and similar type equipment when this type of equipment is located in process areas requiring NEMA 4X integrity. This specified requirement for "Meyers" hubs does not apply to any area of the plant facilities where NEMA 4X integrity is not required.

C. Identification
   1. Nameplates
      a. Nameplates shall be attached to the equipment enclosures with (2) two stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.
   2. Power Source Identification

D. After installation of all field equipment (i.e. valves, motors, fans, unit heaters, instruments, etc) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC number, panelboard, etc), circuit number, conduit number from schedule and voltage/phase.

END OF SECTION

SECTION 13530

REVERSE OSMOSIS TREATMENT TRAIN PROCESS CONTROL LOGIC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section describes the operating logic of the reverse osmosis treatment train system to be supplied by the Reverse Osmosis Equipment Manufacturer (ROEM).

B. The ROEM is responsible for the reverse osmosis (RO) control system logic for each treatment train (RO Treatment Train Instrument Panel). A Systems Integrator will be responsible for developing a Water Treatment Plant SCADA Control System (Plant SCADA System) for the overall water treatment plant and raw water well and feed pumping system monitoring and control.

C. The ROEM is responsible for developing the RO control system logic based on the logic described in this specification.

D. The new water supply system will include five (5) new supply well locations. Each supply well location will have one brackish water well pairs; one well pump will pump from the Black Creek Aquifer (BCA), and the other from the Lower Pee Dee Aquifer (LPDA). The flow ratio from the well pair at each supply well location will be approximately 60% of the flow from BCA and 40% of the flow from the LPDA.

E. A minimum of two supply well locations will need to operate simultaneously to provide sufficient water for one RO Treatment Train. For the full single train capacity of 2 mgd, operation of up to three well locations may be necessary. For simultaneous operation of two trains at full capacity, operation of three well sites simultaneously will be required.

F. RO equipment and treatment train control panel device hardware and software are specified in the related sections as indicated below in Part 1.02.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve the ROEM of his responsibility of proper coordination of all the work:
   1. Section 13510 Reverse Osmosis Treatment Train Units
   2. Section 13520 Field Instrument Panels

1.03 RO CONTROL SYSTEM DESCRIPTION

A. The ROEM shall generally conform with the following logic outline in the development of the RO Treatment Train Control System. The ROEM is allowed some latitude in developing the RO Treatment Train Control System, but major divergence from the intent of these specifications shall require the concurrence of the Owner and the Engineer.

B. The following equipment shall be controlled from the RO Treatment Train Instrument Panel:
   1. RO Feed Pump
      a. RO Feed Pump Motorized Suction Valve Open/Close.
      b. RO Feed Pump On/Off and speed control.
      c. RO Feed Pump Motorized Discharge Valve Open/Close.
   2. RO Treatment Train

a. Energy Recovery Device (ERD) Control Valve Position and percent open

3. RO Treatment Train Flush System
   a. Flush Pump On/Off.
   b. Flush Pump Discharge Motorized Valve Open/Close.

C. The status of the equipment listed in 1.03.B above, train flow and pressure measurements, and instrument monitoring electronic readouts and alarms as specified herein or in Sections 13510 and 13520 shall be sent from each RO Treatment Train Instrument Panel to the Plant SCADA system for display.

D. General
   1. The RO Treatment Train Instrument Panel at each train shall have a manual and automatic mode. Automatic mode shall be the normal operating mode.
      a. Automatic Mode. In automatic mode, each RO Treatment Train will be started, operated, and stopped by the RO Train Instrument Panel based on internal signals or signals from the Plant SCADA System.
   2. Alarm shutdown of RO Treatment Train Units will be initiated by the Plant SCADA System or the RO Train Instrument Panel based on the alarm type as listed in Part 1.04.
   3. Well pump operation will be controlled by the Plant SCADA System. The Plant SCADA system shall have an algorithm to determine the train and total raw feed water flow requirements based on each RO treatment train permeate flow set point.
   4. The start-stop signal for each RO Treatment Train shall be provided via Ethernet from the Plant SCADA System (furnished by the Water Treatment Plant Contractor). The operator shall manually trigger the start signal from the Plant SCADA system. The normal stop signal shall be initiated by the operator at the Plant SCADA system control panel or by alarm conditions as listed in Section 1.04. The operator shall pre-select the following at the Plant SCADA System Control Panel prior to triggering the start:
      a. Raw water supply wells to be operated.
      b. RO Treatment Trains to be operated.
      c. Lead and lag RO Treatment Train start-up and shut-down.
      d. Permeate flow rate set point for each RO Treatment Train.
      e. Initial well flush cycle period and turbidity set point (~ 0.6 to 0.8) to allow RO Treatment Train start signal.
      f. Post RO Treatment Train flush period (in minutes) and flush pump flow rate (gpm) for each RO Treatment Train.
      g. Select which scale inhibitor pump will operate as duty pump and as standby.
   5. RO Treatment Trains will not be allowed to start simultaneously. The start signal sequence will be controlled by the Plant SCADA System. The stop signal shall be sent by either the Plant SCADA system (system alarm) or the RO Treatment Train Instrument Panel (train alarm). Train shut down and post flushing shall be controlled by the RO Treatment Train Instrument Panel.
   6. The start signal to the RO Treatment Train Units will not be transmitted until after an initial well flush cycle is completed by the Plant SCADA System. The initial well flush cycle will flush well water (to the RO concentrate discharge line) for a user-adjustable period of time or a target turbidity value is reached. This operation shall be automatic with an open/close automatically actuated valve on the feed water bypass line controlled by the Plant SCADA System.
   7. The RO Feed Pump suction valve, permeate flush valve, RO Feed Pump discharge valve and RO Feed Pump speed will be controlled by the RO Train

Instrument Panel once a train start signal is received from the Plant SCADA System. Flow will be based on the selected permeate flow setting (operator settable).

8. A permeate flush cycle will be used to displace all concentrate water and scale inhibitor from the RO Feed Pump and RO Treatment Units. The flush system is specified in Section 15510 RO Treatment Train Units. Flushing will occur each time a RO Treatment Unit is shut down and the flush water will be discharged to the RO concentrate line
   a. The flush cycle start/stop and cycle time shall be controlled by the RO Train Instrument Panel. Each panel shall receive a signal from the Plant SCADA System on the number of trains operating.
   b. If more than one train is operating, then simultaneous flushing of multiple trains will not be allowed even if an alarm shutdown of all units is initiated. Rather, flushing will be enabled in sequence as set in the Plant SCADA system logic.
9. Equipment for the Flush Pumps and Permeate Flush Tank Feed valves shall be provided by the ROEM and integrated into the RO Train Instrument Panel logic.
10. Control of the Clean-in-Place system for cleaning of the RO membranes shall be by the Plant SCADA System. No control logic is required from the ROEM.

E. The ROEM will base the RO treatment train control software development upon the following logic.
   1. Pre-RO Treatment Train Start (at RO Train Instrument Panel).
      a. The Operator input the following before start is allowed.
         1) Permeate flow set point for each RO train.
   2. Pre-RO Treatment Train Start (at Plant SCADA System Control Panel).
      a. The Operator input the following before start is allowed
         1) Supply wells to be operating.
         2) No. of RO trains to operate (RO-T-1 or RO-T-2 or both).
         3) Set first and second RO train operating sequence (i.e. lead/lag).
         4) Initial well flush time period and turbidity set point.
         5) Post flush cycle time.
         6) Select scale inhibitor lead and lag metering pump.
         7) Select scale inhibitor dose.
      b. Operator will manually initiate a normal train start by selecting the Start button. The Plant SCADA system will only allow one train start at a time.
      c. For the first train started, the Plant SCADA System will calculate raw water flow value for the well system for the operator input permeate flow on the RO Train Instrument Panel for the selected RO Train to be started and send an instruction to the selected supply wells to start and ramp up to about 50% of the target raw feed water flow.
      d. Plant SCADA System sends signal to open RO bypass butterfly valve on the raw water feed line for initial flush.
      e. Plant SCADA System sends signal to the scale inhibitor pump to start.
      f. Run in this mode for pre-set initial flush time period (~5 minutes) and monitor the feed water turbidity, pH, and conductivity from the feed water panel on the Plant SCADA System.
      g. After the predetermined flush time and if turbidity value is below the turbidity set point, ramp up the well pumps speed to deliver design feed water flow, start the scale inhibitor chemical pump system, and continue to monitor the raw feed water turbidity.

h. When the scale inhibitor flow is steady via flow meter reading, and the turbidity is confirmed to be below the turbidity setpoint, send the start signal to the RO Treatment Train Instrument Panel and close the RO bypass valve.

3. First RO Treatment Train Start
   a. The RO Treatment Train Instrument Panel receives the start signal from the Plant SCADA System and starts the RO Treatment Train start-up sequence.
   b. The RO Treatment Train Instrument Panel shall then control the following starting operations of the RO train:
      1) Open the RO Treatment Train RO Feed Pump suction and discharge valve.
      2) Start RO Feed Pump and ramp the speed from zero speed to 50% speed over pre-set time period (~ 60 seconds).
      3) Open the concentrate control valve (ERD bypass valve) to a preset value. The concentrate control valve will begin operation to maintain design recovery.
      4) After a predetermined time at these conditions, the RO Treatment Train controls will cascade into automatic control, with total permeate flow as the set point.
      5) When the train reaches steady state conditions, all train and system alarms and shut downs will be enabled by the RO Treatment Train Instrument Panel.
   c. As the RO Feed Pump speed cascades into automatic operation, post treatment chemicals feed systems will be initiated (pumps will be previously selected by operator) to start by the Plant SCADA System.
   d. When the first RO Treatment Train, the selected water supply wells, and the post treatment system are in operation, the Plant SCADA Control System will adjust post treatment chemicals to achieve predetermined set points.
4. Additional RO Treatment Train Start
   a. The second RO Treatment train will be started manually by the operator at the Plant SCADA System Control Panel.
   b. The Plant SCADA System will calculate raw water flow value for the well system for the operator input permeate flow for the second RO Treatment Train and send an instruction to the additional supply wells to start and ramp up to 100% of the target raw feed water flow for operation of two RO treatment trains. The Plant SCADA system will calculate a sum of the permeate flows and corresponding raw water flow and compare the raw water flow to the main raw water flow meter reading. The RO feed water by-pass valve shall remain closed.
   c. The Plant SCADA system will ramp up the scale inhibitor pump speed to maintain the operator settable scale inhibitor dose.
   d. The Plant SCADA system will send a start signal to the second RO Treatment Train Instrument Panel to start.
   e. The RO Treatment Train Instrument Panel will start the second RO Treatment Train in the same sequence as listed above for the first RO Treatment Train.
   f. Upon initiating a second train start, the Plant SCADA System will adjust scale inhibitor flow, well pumps speed and adjust post treatment systems for the increased permeate flow rate (without additional operator input) by

adjusting the scale inhibitor, carbon dioxide feed, caustic feed, polyphosphate feed, and chlorine feed controls.

1.04 TRAIN OPERATION

A. Once each selected RO Treatment Train has cascaded into PID control, the following logic will apply at the RO Treatment Train Instrument Panel:
   1. The total permeate flow will be calculated by summing the total of FE/FIT-208-X and FE/FIT-211-X, compared to a set point, and a 4-20mA output generated which will control the speed of the RO Feed Pump.
   2. The concentrate flow will be measured by FE/FIT-217-X, compared to a set point, and will generate a 4-20mA output. This output will set the concentrate (ERD bypass) valve controller ZC-215X, and will maintain a constant concentrate flow rate based upon the value of the design recovery.
   3. PIT-205X, 209X, 210X and 212X will measure the train pressures: feed to first stage, first stage concentrate, feed to second stage, and second stage concentrate. A stage differential pressure will be computed and displayed on the RO Treatment Train Instrument Panel screen and at the Plant SCADA System Control Panel screen.

1.05 ALARMS AND SHUTDOWNS

A. Alarms. The following events will trigger alarms, and, in some cases, train or system shutdowns, as noted. Train alarms and shut-downs will be initiated by the RO Treatment Train Instrument Panel and be communicated back to the Plant SCADA System. System alarms and shutdowns will be initiated by the Plant SCADA System. Alarm times prior to shutdowns will be field set.

1. Train	
a. Low RO pump suction pressure	shutdown
b. High RO pump discharge pressure	shutdown
c. RO Pump high temperature	advisory
d. Low concentrate flow	shutdown
e. High first stage permeate back pressure	advisory
f. High permeate flow	advisory
g. Low permeate flow	shutdown
h. High permeate conductivity	advisory
i. High 1st and 2nd stage dP	advisory
2. System	
a. Feed water high conductivity	advisory
b. Feed water high turbidity	shutdown
c. High feed water pH	advisory
d. Low feed water pH	advisory
e. Feed water High Temperature	advisory
f. Feed water Low Temperature	advisory
g. Scale Inhibitor Low Flow (after time out)	shutdown
h. Carbon Dioxide Feed System Failure	shutdown
i. Post chemical Feed System Failure	shutdown
j. Finished storage tank high level Alarm	shutdown
k. Final pH Low	advisory

B. Shutdown.
   1. Emergency Shutdowns: When emergency shutdowns occur for reasons other than power failure or feed water failure, RO trains will shut down in sequence, and will receive a permeate water flush. Audio and visual and printed alarms

will keep the operator informed as to the system status. Total flush time for two (2) trains should be 40 minutes – 60 minutes, and be established during system start-up operation.

2. Power Failure and Feed Water Failure Shutdowns: In the event of a power failure or feed water failure, there will be no flush sequence. Upon restoration of power, there will be no restart of equipment. However, all valves and software interlocks will be programmed to seek their normal "ready" position on repowering. The exception will be the feed water bypass valve. This valve's actuator will be provided with a battery backup UPS, to drive the valve open upon power failure, to act as surge relief. The valve will remain in this position until manually reset, and will lockout all other system control functions until it is reset.
3. Provision will be made in the ROEM software for the operator to manually start an RO train flush. Flush shall only be allowed if RO Train Unit is off.
4. Automatic Train Shutdown: Normal RO train shutdown, in response to a system or train shutdown signal or an operator manual shutdown command, shall be as follows:
   a. Disable RO train monitoring and alarms.
   b. Open concentrate (ERD bypass) valve to full
   c. Plant SCADA system lower scale inhibitor chemical pumping speed (if two RO trains operating) or shut off scale inhibitor chemical pump (if only one RO train operating).
   d. Shut off RO feed pump
   e. Plant SCADA system shut-off appropriate well pumps.
   f. Close RO feed pump suction valve, pump discharge valve remains open
   g. Open flush inlet valve
   h. Start selected flush pump
   i. Start flush timer
   j. Flush times out
   k. Flush pump stops
   l. Slowly close flush inlet valve and RO feed pump discharge valve
   m. Reset ERD by-pass valve to start-up position (closed).
   n. Subsequent trains will follow the same procedure, except that the "last train on line" will initiate the RO feed water bypass valve to open to assist in surge control. After the last train in line has shut down, the RO feed water bypass valve will close <u>after</u> the well pumps have received and executed a stop command.
5. The ROEM system supplier is responsible for all sequencing and timing of the RO Treatment Trains. Field evaluation and adjustment during commissioning is encouraged, in consultation with the Owner, and the Owner's Consultants.

1.06 RO TREATMENT TRAIN FLUSH SEQUENCE

A. The RO Treatment Train flushing system consists of a 8,500 gallon permeate storage tank, fabricated from polyethylene; two stainless steel vertical pedestal pumps; a flush inlet valve mounted near the RO feed pump;, and piping and valves, instruments and control logic.

B. The flush tank is filled by a Sch 80 PVC pipe from the permeate header in the main pipe trench. An ultrasonic level element/transmitter senses the level in the tank, and at preset high and low level set points, the control logic resident in the Plant SCADA System causes the fill control valve to either open or close.

C. Upon receipt of a shut-down signal from the Plant SCADA System, the RO treatment Train control logic will generate signals to (a) close the train feed pump inlet valve, and (b) open the train flush valve after the feed pump and feed water wells have stopped operating.

D. When an open signal from the train flush valve limit switch, and a closed signal from the feed pump inlet valve limit switch have been received by the Train PLC, a signal to start one flush pump will be sent, and the flush timer will start.

E. When the flush timer times out, the flush pump will stop, the flush valve will close, and the RO feed pump discharge valve will close.

1.07 DATA LOGGING AND STORAGE

A. Each RO Treatment Train Instrument Panel PLC shall be capable of storing all train operating data as measured at the panel. PLC shall be capable of storing up to 24 months of data. Operating data will also be transmitted to the SCADA system PLC, and archived in the historic data archives.

B. Data logging shall be sufficient to provide all data and graphing functions for data measured/recorded by the RO Treatment Train Instrument Panel PLC as needed for the performance test requirements in Section 13510. Graphing shall be accessed through the SCADA system PLC.

1.08 SUBMITTALS

A. Within 15 days of Notice to Proceed, the ROEM shall request a meeting with the Owner, Engineer, and RO Process Consultant, to coordinate the design development of the control system.

B. Within 30 days of Notice to Proceed, the ROEM shall provide control system block diagrams for the RO process control system, together with P&IDs.

C. Within 45 days of Notice to Proceed, the ROEM shall provide a complete package describing the control system hardware and software, text and illustrations, and identifying additional input, and hardware required from others.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 13540

REVERSE OSMOSIS TREATMENT TRAIN SYSTEM TRAINING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section contains requirements for training the plant operating and maintenance staff in the proper operation and maintenance of the RO Treatment Train equipment and systems supplied.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Section 11214 Reverse Osmosis Feed Pumps
   2. Section 13510 Reverse Osmosis Treatment Train Units
   3. Section 13530 Reverse Osmosis Treatment Train System Process Control Logic

1.03 QUALITY ASSURANCE

A. The ROEM shall provide classroom and on-the-job training of the plant operating and maintenance staff. The training sessions shall be conducted by qualified, experienced (two (2) years minimum), factory-trained representatives. Training shall include instruction of operating personnel in equipment operation and preventive maintenance.

B. Instruct plant operators, mechanics, electricians, and electronics technicians in normal maintenance up to major repair.

PART 2 PRODUCTS

2.01 GENERAL

A. General
   1. Conduct training sessions for the operation and maintenance personnel to instruct the staff on the proper operation, care, and maintenance of the RO Treatment Train equipment and system supplied. Training shall take place at the site of the work and under the conditions specified in the following paragraphs.
   2. Operation and maintenance manuals shall be available to the Owner at least 30 days prior to the date scheduled for the individual training session.

2.02 LOCATION

A. Field training sessions shall take place at the project site. The Owner will provide facilities for classroom training sessions.

2.03 FORMAT AND CONTENT

A. Each training session shall be comprised of time spend both in the classroom and at the specific location of the subject equipment or system. As a minimum, a training session shall cover the following topics:
   1. Familiarization
      a. Review O&M Manuals, drawings and catalogue information.

b. Provide overview of design intent.
c. Review the installation of specific equipment items.
d. Demonstrate the units operation.
e. Answer questions.

2. Safety
   a. Point out safety requirements.
   b. Discuss safety precautions around equipment.
3. Operation
   a. Discuss safety precautions around equipment.
   b. Explain all modes of operation including emergency procedures.
   c. Test personnel on proper use of equipment by letting them operate it.
4. Troubleshooting and Corrective Maintenance
   a. Review typical faults, failures and possible problems.
   b. Review and discuss repairs.
   c. Open/disassemble equipment where practical to demonstrate procedures.
5. Preventative Maintenance (PM)
   a. Review preventative maintenance requirements including reference material.
   b. Review daily, weekly, monthly, quarterly, semi-annual and annual PM tasks.
6. Spare Parts
   a. Review spare parts list.
   b. Instruct on use and/or installation of spare parts.
7. Support
   a. Review contact requirements for commissioning and warranty period.

2.04 VIDEO RECORDING

A. The Owner may record each training session. After taping, the material may be edited and supplemented with professionally produced graphics to provide a permanent record.

2.05 TRAINING SESSIONS

A. Operator training shall consist of a minimum of 16 hours of training sessions. The first will follow immediately after start-up and just prior to commissioning of the equipment. All training sessions shall be completed at the conclusion of the commissioning and testing period.

B. Coordinate the training to be provided with the Owner.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Training shall be conducted immediately following equipment start-up and just prior to commissioning periods and subject to operational staff availability. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence.

B. The Owner/Engineer will arrange to have the training conducted on consecutive days.

3.02 OPERATOR CLASSROOM TRAINING

A. Regardless of the time spent at the site, services will not be considered complete until the system operates as intended for a minimum of one (1) month of plant operation.

B. As a minimum, classroom equipment training for operations personnel will include:
   1. Using slides and drawings, discussing the equipment's specific location in the plant, and an operational overview.
   2. Purpose and plant function of the equipment.
   3. A working knowledge of the operating theory of the equipment.
   4. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
   5. Identify and discuss safety items and procedures.
   6. Routine preventative maintenance, including specific details on lubrication and maintenance and corrosion protection of the equipment and ancillary components.
   7. Operator detection, without test instruments, of specific equipment trouble symptoms.
   8. Required equipment exercise procedures and intervals.
   9. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

3.03 OPERATOR HANDS-ON TRAINING

A. As a minimum, hands-on equipment training for operations personnel will include:
   1. Identify location of equipment and review the purpose.
   2. Identifying piping and flow options.
   3. Identifying valves and their purpose.
   4. Identifying instrumentation:
      a. Location of primary element.
      b. Location of instrument readout.
      c. Discuss purpose, basic operation, and information interpretation.
   5. Discuss, demonstrate, and perform standard operating procedures and rountine checks.
   6. Discuss and perform preventative maintenance activities.
   7. Discuss and perform start-up and shutdown procedures.
   8. Perform the required equipment exercise procedures.
   9. Perform routine disassembly and assembly of equipment, if applicable.
   10. Identify and review safety items and perform safety procedures, if feasible.

3.04 MAINTENANCE CLASSROOM TRAINING

A. Classroom equipment training for the maintenance and repair personnel will include:
   1. Theory of operation.
   2. Description and function of equipment.
   3. Start-up and shutdown procedures.
   4. Normal and major repair procedures.
   5. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
   6. Routine and long-term calibration procedures.
      a. Safety procedures.

b. Preventive maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, etc.

3.05 MAINTENANCE HANDS-ON TRAINING

A. Hands-on equipment training for maintenance and repair personnel shall include:
   1. Locate and identify equipment components.
   2. Review the equipment function and theory of operation.
   3. Review normal repair procedures.
   4. Perform start-up and shutdown procedures.
   5. Review and perform the safety procedures.
   6. Perform Owner-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.
   7. Review and use equipment manufacturer's manuals in the hands-on training.

3.06 MEMBRANE CLEANING

A. During the first cleaning of the membranes by the Owner's personnel, the ROEM shall provide the services of a qualified representative to be present on-site for two (2) days to assist with the membrane cleaning. This first cleaning will occur within one (1) year of successful system startup and substantial completion, unless otherwise mutually agreed to by the ROEM and Owner.

3.07 FOLLOW-UP TRAINING

A. The ROEM shall provide the services of a qualified technical representative to provide one (1) 8-hour session of operator refresher training at the membrane treatment plant site within one year after system startup and substantial completion at a time as requested by the Owner.

END OF SECTION

SECTION 13550

REVERSE OSMOSIS FIELD-MOUNTED INSTRUMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes materials and installation of the following calibrated field-mounted instruments not included elsewhere in the specifications:
   1. Differential pressure indicating transmitter
   2. Pressure switch
   3. Pressure indicating transmitter
   4. Flow meters
   5. Conductivity transmitter and sensor
   6. Process analog indicating transmitters
   7. Level indicating instruments and transmitters
   8. Tubing, valves, fittings, and manifolds

B. ROEM to provide instrumentation as indicated on the Procurement Drawings and as specified herein. Instrumentation related to the RO Treatment Train shall be provided for each of two (2) trains.

1.02 RELATED SECTIONS

A. The following Sections have work that is directly related to this Section. This does not relieve Contractor of his responsibility of proper coordination of all the work:
   1. Section 11245 Scale Inhibitor Feed System
   2. Section 13510 Reverse Osmosis Treatment Train Units
   3. Section 13530 Reverse Osmosis Treatment Process Control Logic

1.03 SUBMITTALS

A. Submit the following:
   1. Descriptive literature and drawings, including parts list, bulletins and/or catalog cuts for the instruments and all accessories, with the items to be furnished clearly marked in the submittal material.
   2. A list of the Manufacturer's recommended spare parts and hardware.
   3. Manufacturer's Installation Procedures.

B. Operation and Maintenance Instructions: Submit complete operation and maintenance manual prepared specifically for the instruments as supplied for the Project.
   1. Each manual shall be a bound, indexed binder with drawings. Instructions shall include, but not be limited to, the following:
      a. Approved shop drawings.
      b. Warranty information for each component.
      c. Inventory, functional descriptions and operating instructions for instruments.
      d. Recommended routine calibration procedures.
      e. Complete bill of material.
      f. Installation instructions for the specific instruments.
   2. Front page(s) in binder shall include the following as a minimum:
      a. Name, address and phone number for manufacturer and manufacturer's local representative capable of providing service. for each instrument.

b. Instrument name plate data.
c. After the front page provide field test report.

1.04 QUALITY ASSURANCE

A. Quality assurance shall meet the following requirements.
1. The instruments, as specified herein, shall be furnished by suppliers with at least 10 years of prior experience in supplying devices of the type specified.
2. Instruments shall fit within the space available. Any devices that are too large are unacceptable.
3. Instruments shall be mounted horizontally and vertically plumb, at a height that is convenient for an operator to read.
4. For the equipment specified herein, the supplier shall be ISO 9001 2000 certified.
5. Submit the name, address, and phone number of the firm that will provide required repair or replacement during the warranty period.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage and handling instructions for the instruments will be provided by the supplier prior to delivery.

1.06 WARRANTY

A. Provide standard manufacturer's warranty but shall not be less than one year. Warranty shall start from date of successful equipment start-up.

PART 2 PRODUCTS

2.01 DIFFERENTIAL PRESSURE INDICATING TRANSMITTER

A. This device will measure the difference in pressure between the inlet and the outlet of the cleaning cartridge filter.

B. The device will be mounted on the feed water field instrument panel.

C. The device shall transmit its data to the Master PLC, mounted in the control room

D. The inlet pressure shall be in the range of 30-50 psig.

E. The outlet pressure shall be in the range of 15-35 psig

F. The transmitter shall provide a true 2-wire 4- to 20-mA d-c current signal proportional to pressure differential applied across the unit's high and low diaphragm sensing elements.

G. The differential pressure sensing element shall be silicone oil filled with a process media operating temperature range of -40°F to 220°F.

H. The calibration range of the differential transmitter shall be compatible with the operating range of the primary measuring element.

I. Provide the differential pressure transmitter with the following features:
1. Independent digital zero and span adjustments.
2. Over-range protection.
3. Vent/drain valve.
4. Integral LCD meter, calibrated in the appropriate engineering units.
5. Mounting bracket.
6. Two electrical conduit connections, 1/2-inch NPT female.
7. 316 stainless-steel mounting adapters.

8. Smart electronics capable of digital calibration, configuration, diagnostics, and communication.

J. Accuracy of the differential pressure transmitter shall be 0.10% of calibrated span.

K. The differential pressure transmitter shall be manufactured by Rosemount Inc., Model 2051DP or approved equal.

2.02 PRESSURE SWITCH

A. Provide on suction and discharge sides of reverse osmosis feed pumps.

B. The pressure-sensing element shall be a 316L diaphragm, bellows or Bourdon tube.

C. The switch shall be a single pole double throw (SPDT) switch with a single output

D. The switch connections shall be clearly and permanently marked. The assembly shall be provided with an indicating scale to show the trip setting of switch.

E. The switch shall have adjustable dead band and adjustable range

F. The switch shall have an external reset.

G. Switches shall be located on the suction (low pressure) and discharge (high pressure) of the RO feed pumps. Set points shall be selected by the ROEM for maximum pump and RO train protection.

H. The pressure switch shall be manufactured by United Electric Controls Co., Mercoid Corp., Ashcroft, or Engineer approved equal.

2.03 PRESSURE INDICATING TRANSMITTER

A. The transmitter shall provide a true 2-wire 4- to 20-mA d-c current signal proportional to pressure applied to the unit's diaphragm sensing element. The pressure sensing element shall be silicone oil filled with a process media operating range of -40°F to 220°F. The calibrated range of the transmitter shall be compatible with the operating range of the process conditions. Provide the pressure transmitter with the following features:
   1. Independent digital zero and span adjustments.
   2. Overrange protection.
   3. Integral LCD meter, calibrated in the appropriate engineering units.
   4. Two electrical conduit connections, 1/2-inch NPT female.
   5. 316 stainless-steel mounting adapters.
   6. Smart electronics capable of digital calibration, configuration, diagnostics, and communication.

B. Accuracy of the pressure transmitter shall be 0.10% of calibrated span.

C. The pressure transmitter shall be as manufactured by Rosemount Inc., Model 2088GP or Engineer approved equal.

2.04 FLOW METERS

A. Flow meters shall be supplied by the ROEM on the 1st and 2nd stage permeate lines and the concentrate line as shown on the Drawings and specified herein. Flow meters shall be magnetic meter type.

B. Meter Design
   1. The magnetic flowmeter shall be an obstruction-less pipeline-mounted instrument to magnetically measure the flow of the process media. The output signal shall not be affected by changes in fluid viscosity or density and shall

have zero point stability and auto zeroing functions. Provide the magnetic flowmeter with the following features:

a. Drip and splash proof, capable of withstanding temporary submersion of up to 30 feet of water for 48 hours.
b. Integral terminal box with watertight cable seals.
c. Stainless-steel grounding rings and grounding straps.
d. Interconnecting cables.

C. Meter Performance
1. Accuracy: 0.5% of flow rate with minimum fluid velocity of 1 fps.
2. Repeatability: +0.1% of flow rate.
3. The accuracy of each meter shall be verified by calibration in a flow laboratory traceable to the U.S. National Institute of Standards and Technology.
4. Adjustable full-scale range.
5. Outputs: Bidirectional, isolated 4- to 20-ma d-c.
6. Minimum Conductivity: 5 micromho/centimeter.
7. Power Consumption: 20 watts maximum.
8. Temperature Limits, Ambient: -20°F to +140°F.
9. Temperature Limits, Process: Elastomers +160°F, Teflons +300°F, ceramic 350°F.
10. The flowmeter shall have a positive zero return (PZR) input controlled by an external dry contact.
11. Environmental Rating: NEMA 4X, Class I, Division 1, Groups B, C, and D for both sensor, and electronics.
12. The meter shall have empty pipe detection.
13. A common alarm discrete output (a dry contact or a transistor switch) shall be provided for remote indication of fault conditions.

D. Materials of Construction
1. The flow tube shall be Type 316 stainless steel.
2. Liner shall be Teflon
3. Electrodes shall be 316L stainless steel.

E. Indicator/Totalizer
1. The indicator/totalizer shall accept the process flow signal from the magnetic flowmeter and convert its electrical output signals directly proportional to the instantaneous metered flow rate. The housing shall be suitable for field mounting.

F. Transmitter
1. The transmitter shall be microprocessor based with flow rate indicator in engineering units, forward, reversed, and net flow totalizer, all in user-selectable engineering units.
2. The transmitter shall be remotely mounted on the train instrument panel.
3. The preamplifier input impedance shall be a minimum of 10E+11 ohms.
4. Power Requirements: 115-volt a-c, 60 Hz.
5. Totalized flow and programmed configuration shall be maintained in memory for up to 10 years.

G. Interconnecting Cable
1. The interconnecting cable between the sensor and the transmitter shall be furnished by the magnetic flowmeter manufacturer.

H. Manufacturers

1. The magnetic flow meters for 1st and 2nd stage permeate flow, and concentrate flow shall be manufactured by Rosemount, Yokogawa, Endress & Hauser, or approved equal.

2.05 CONDUCTIVITY TRANSMITTER AND SENSOR

A. Provide for total train permeate and train concentrate conductivity.

B. Provide a four-electrode conductivity sensor with thermal compensation. Th electrode material shall be stainless steel. The sensor shall include circuitry to detect the buildup of deposits, scale, and corrosion products. The sensor shall automatically compensate for the effects of the buildup. The sensor shall have ¾-inch NPT male connection and 20 feet of interconnecting cable.

C. Provide an LCD indicating analyzer transmitter with solid-state electronics for continuous conductivity measurement of an aqueous solution. The transmitter shall have a maximum full scale range of 1,000,000 micros/cm. The full scale range shall be field selectable through a range switch. The range switch shall have a minimum of five settings (0.01, 0.10, 1.00, 10.00, and 100.00).

D. Readings shall be automatically compensated for temperature variations between 32°F and 212°F with an accuracy of 1% full scale. Provide an output signal of 4- to 20-mA d-c for remote indication and control. The transmitter shall be a two-wire unit and operate from 24-volt d-c into 600 ohms maximum. Housing shall be NEMA 4X suitable for wall or pipe mounting.

E. The conductivity analyzing transmitter shall be Rosemount Model 1054A Conductivity Analyzer with sensor appropriate to the service.

2.06 PROCESS ANALOG INDICATOR

A. The process analog indicator shall be a solid-state electronic four-digit panel meter utilizing a green LED display, with a range of 0 to 9,999 in engineering units.

B. The indicator shall operate on a 115-volt, 60-Hz power source, with a maximum power consumption of 5 watts. Standard input signal range shall be 4- 20-mA d-c.

C. The indicator shall be capable of being configured and scaled in the field. Zero and span adjustments shall be accessible without removal of the unit.

D. The process analog indicator shall be a 205-P manufactured by Newport Electronics, Inc., Santa Ana, California; or Engineer approved equal.

2.07 ULTRASONIC LEVEL INDICATOR/TRANSMITTER

A. Ultrasonic level indicating/transmitters shall be supplied at the flush tank and the scale inhibitor feed tank.

B. Power: 24 VDC, 115 VAC or 230 VAC, 50/60-Hz

C. Measuring Range: 1 to 39 ft

D. Output: The output signals shall be (2) Active 4-20 mA into a maximum 1000 ohms loop resistance, or digital outputs.

E. Relays: The system shall have six (6) SPDT relays rated to 5A at 250 VAC. Each relay will be operated by a software assignable set point with a 0-100% adjustable dead band for open and close. Each relay will be assignable for control or alarm. There shall be an acknowledge push-button on the front panel for acknowledging alarm set points. All set points and relays can be assigned to either of the two input channels in any combination. Relays can be assigned for fault conditions of 3.7 mA

or 22 mA error signals. Relays may be assigned for Batch Sample Activation with a programmable momentary dry contact closure duration. Each relay will have a visible indication on the display denoting the relay state; configured or un-configured, energized or de-energized.

F. Enclosure: The 2-channel electronic transmitter shall be housed in a rugged Fiberglass Reinforced Polyester (FRP) indicating housing rated to NEMA 4X (IP-66) for corrosion resistance and wash down service. The sensor(s) shall be completely encapsulated in a CPVC housing rated to NEMA 4X, NEMA 6 / 6P, IP-68, with a 25 ft. sealed flying lead. The sensor shall be capable of full submersion.

G. Sensor: The sensor(s) shall be supplied with a 25-foot flying lead allowing field termination and sensor lead extension via a standard 2-wire twisted shielded pair. The sensor(s) shall be capable of being remotely mounted up to 1200 feet from the transmitter. The sensor(s) shall be supplied with a ¾" and 2" NPT or 2" BSP process connection and be capable of being recessed in a 2 inch diameter nozzle up to 18 inches (0.45 m), which shall permit the system to measure level, volume or distance to the top of the vessel.

H. Operating Temperature and Temperature Compensation: The recommended operating temperature range for the sensor shall be from -40°F to 158°F (-40°C to +70°C). The electronic unit shall be capable of ambient temperature ranges of –40°F to 158°F (-40°C to +70°C). An internal temperature sensor shall provide temperature compensation for variations in the speed of sound due to temperature changes and shall be automatic over the entire operating range of the system.

I. Acoustic Beam: The electronic unit shall employ a nominal 50KHz operating frequency with a 10° acoustic beam angle (+/- 5° from transducer centerline).

J. Configuration and Display: System configuration shall be accomplished through a standard integral display with a 4-key, environmentally sealed membrane keypad and a 2-line, 7-digit, LCD display for level, distance, volume, totalization, or milliamp output. The user may select any (or all) display parameters (level, distance, etc.) and toggle to each or configure to continuously scroll through all display selections. Echo strength will be displayed concurrent with displayed level data. The system shall be capable of displaying level data in the following engineering units: feet, inches, meters, centimeters, millimeters, or percent. The configuration menu shall be password protected to prevent unauthorized changes.

K. Standard Software: System software will support level, distance, and volume. A 21-point strapping table is included for user-defined vessels. The system shall incorporate two (2) totalizers, one (1) nonresettable and one (1) user resettable.

L. Area Classification: The level measuring system shall be suitable for sensor installations in Class I, Div. 1 or Zone 0, or Zone 1 hazardous areas. The electronic enclosure will be suitable for Class I, Div. 2 (Zone 2) installations.

M. Manufacturers: The ultrasonic level / flow detector shall be manufactured by Rosemount, Siemens, Drexelbrook or equal.

2.08 TUBING, VALVES, FITTINGS, AND MANIFOLDS

A. Instrument tubing connections between process lines and instruments shall be 1/4 inch outside diameter with 0.035-inch seamless wall, annealed ASTM A 269, Type 316L stainless steel.

B. Fittings shall be 316L stainless-steel double ferrule design. Fittings shall be Swagelok, Parker CPI, or equal.

C. Valves shall be full port ball valves with 316 stainless-steel body and Teflon seats and packing. Valves shall be Parker CPI, Whitey, Watts Regulator, or equal.

D. Provide three-valve manifolds on differential pressure transmitters. Manifold shall be one-piece body of extruded 316 bar stock. Manifolds shall mount directly to differential transmitter flange. Valve shall be globe type with 316 seats and Teflon stem packing. Provide purge taps, 1/8-inch NPT. Manifolds shall be Anderson Greenwood M4T or equal.

PART 3 EXECUTION

3.01 INSTALLERS QUALIFICATIONS

A. Installer shall be specialized in installing the type of equipment specified herein with a minimum of 5 years documented experience.

B. The Owner/Engineer will arrange to have the training conducted on consecutive days.

3.02 EXAMINATION

A. Examine installation area to assure there is enough clearance to properly install the instrument

B. Verify that the instrument is ready to install, with all pre-installation adjustment completed.

C. Verify field measurements ar as instructed by the supplier.

3.03 INSTALLATION

A. The Installer shall install all instruments per the supplier's recommendation and the contract drawings.

B. All process connections shall be 316L stainless steel tubing, unless otherwise shown on the drawings. Fittings shall be as specified herein.

C. All conduit entries into the instruments shall be as specified in the Electrical specifications. All connections shall be water tight.

D. Install stainless steel instrument name tags with stainless steel wire.

3.04 RACEWAY SEALING

A. Where raceways enter terminal boxes, junction boxes, or instrumentation equipment, all entrances shall be sealed with3M 1000NS Watertight Sealant, or approved equivalent.

3.05 FIELD QUALITY CONTROL

A. Inspect installed instruments for anchoring, alignment, grounding and physical damage.

B. Check tightness of all electrical connections. Minimum acceptable values shall be as specified by the supplier.

3.06 FIELD ADJUSTING AND TESTING

A. Adjust all instruments for proper range and field conditions, as described in the supplier's instructions.

B. Any field adjustments, required for proper system operation, shall be be described in detail notes in the O&M manual.

C. Perform all electrical field tests recommended by the supplier

D. Test each interlock system for proper functioning

E. Test all control logic for proper operation

3.07 EQUIPMENT PROTECTION AND RESTORATION

A. Protect factory finish during installation and connection of all devices.

B. Touch up and restore damaged surfaces to factory standards as approved by the supplier. Replace any surface that cannot be satisfactorily restored to factory specification.

3.08 CERTIFICATION AND TRAINING

A. During the first cleaning of the membranes by the Owner's personnel, the ROEM shall provide the services of a qualified representative to be present on-site for two (2) days to assist with the membrane cleaning. This first cleaning will occur within one (1) year of successful system startup and substantial completion, unless otherwise mutually agreed to by the ROEM and Owner.

END OF SECTION

SECTION 15132

RO SYSTEM PRESSURE GAUGES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes materials and installation of pressure gauges, vacuum gauges, compound pressure/vacuum gauges, and accessories.

B. Gauges to be furnished by the ROEM as specified herein

1.02 RELATED SECTIONS

A. The following sections describe equipment that is directly related to this section. Providing this list does not relieve the ROEM of the responsibility for the proper co-ordination of all the equipment and appurtenances to be supplied.

1. Section 13510 Reverse Osmosis Treatment Train Units and Cleaning System

1.03 REFERENCED STANDARDS

A. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1.

B. Unless otherwise specified, gauge accuracy shall be ANSI Grade A or better. Overall accuracy for diaphragm seal protected and liquid filled gauges shall be ANSI Grade B or better.

1.04 DESCRIPTION

A. Gauge Designations. Pressure range shall be as designated by the following type numbers shown in the Procurement Drawings: If no type number is shown in the drawings, use Type 6 gauges.

Type Number	Description	Pressure Range
1	Vacuum	0-30 in. Hg
2	Differential pressure	0-30 psi
3	Pressure	0-30 psi
4	Pressure	0-60 psi
5	Pressure	0-100 psi
6	Pressure	0-150 psi
7	Pressure	0-300 psi
8	Pressure	0-600 psi

B. Gauge Schedule.

Gauge Location	Gauge No. (P&ID)	Type Number
RO Feed Pump Suction	PI 203-1	4

RO Feed Pump Discharge	PI 206-1	8
Train Board display	PI 205A	8
Total Permeate	PI 204-1	4

C. Gauges shall comply with ANSI B40.1, Grade 2A (± 0.5% OF SPAN). Gauges shall incorporate the following features:
   1. Solid or open front with side or rear blowout relief.
   2. Pressure tight.
   3. 270-degree arc with adjustable pointer.
   4. Stem mounted.
   5. Liquid filled with glycerin or silicone.
   6. Gauge shall be 4-1/2 inches. Connection shall be 1/2 inch NPT.
   7. All pressure gauges shall be equipped with diaphragm seals.
   8. Dials shall be black on white.

1.05 SUBMITTALS

A. Submit the following in accordance with Section 01300 Submittals:
   1. Manufacturers Data: Submit manufacturer's standard drawings or catalog cuts for the following:
      a. Pressure gauges
   2. Certificates of Compliance: Submit for each of the following materials:
      a. Pressure gauges
   3. Call out materials of construction by ASTM reference and grade

1.06 QUALITY ASSURANCE

A. The pressure gauge manufacturer shall have been regularly engaged in the manufacture of these devices for at least ten (10) years.

B. Manufacturer of the gauges and diaphragm seals shall be, Ashcroft, Marshalltown, Wika, or Iomega.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Pressure gauges shall be delivered to the site mounted on the feed water instrument panel or the RO train instrument panel.

PART 2 PRODUCTS

2.01 GAUGE CONSTRUCTION

A. Materials of construction shall be as shown in the following table:

Item	Material	Specification
1. Case	Poly- propylene, or phenolic plastic	-----
2. Bourdon tube	Stainless steel	AISI 316
3. Windows	Acrylic plastic	-----

4. Ring	Stainless steel	AISI 316
5. Stem	Stainless steel	AISI 316
6. Dial face	Aluminum with clear baked-on acrylic coating	ASTM B 209, 6061-T6

B. Provide pressure snubbers with gauge assemblies. Material of construction shall be Type 316 stainless steel. Snubber design shall incorporate a porous metal disc for use with the process fluid in the pipeline. Inlet and outlet connections shall be NPT and shall match the connection size of the attached pressure gauge.

C. Nipples for connecting gauges to piping shall be Schedule 40S, 316 seamless stainless steel, conforming to ASTM A 312. Fittings shall conform to ASTM A 403, Class WP316. Threads shall conform to ANSI B1.20.1. Size of pipe nipple shall match the gauge connection size.

D. Diaphragm seals shall be fabricated from 316L stainless steel, with 316L stainless steel diaphragms. Seals shall be factory assembled with gauges.

E. Provide two gauge tool kits, each containing a hand jack set, screwdriver, five reamers (minimum), two pin vise holders, wiggler, tweezer, and carrying case

F. Provide gauge dead weight test equipment for calibration.

PART 3 EXECUTION

3.01 INSTALLATION

A. Gauges shall be installed at the locations indicated on the drawings.

B. Install gauges before conducting pressure tests. Do not disassemble gauges from the factory-assembled diaphragm seals

C. Install with isolation valves as shown on the drawings.

END OF SECTION

REVISIONS

ISSUED FOR BID 03 / 13 / 2017

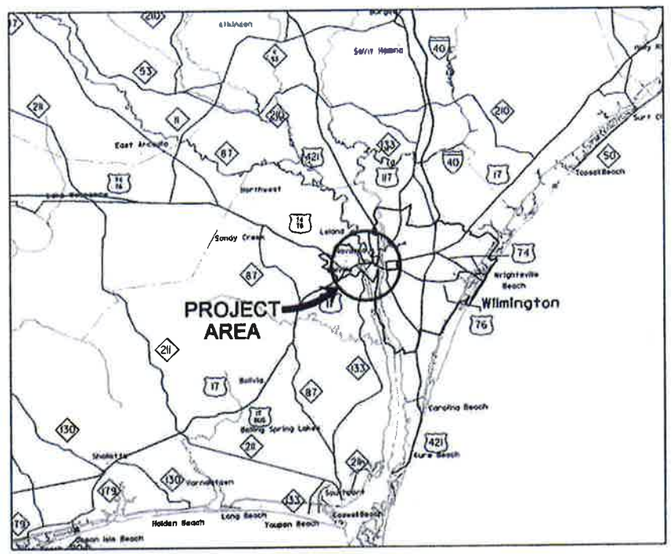
BRUNSWICK REGIONAL WATER AND SEWER H2GO

NORTH CAROLINA

REVERSE OSMOSIS EQUIPMENT PROCUREMENT FOR WATER TREATMENT PLANT

DRAWING INDEX

1.	XI	COVER
2.	PR-1	OVERALL SITE PLAN
3.	PR-2	OVERALL PROCESS BUILDING LAYOUT
4.	PR-3	R.O. TREATMENT TRAIN LAYOUT - PLAN VIEW
5.	PR-4	R.O. TREATMENT TRAIN LAYOUT - PUMP SIDE ELEVATION
6.	PR-5	R.O. TREATMENT TRAIN LAYOUT - CONTROL SIDE ELEVATION
7.	PR-6	R.O. TREATMENT TRAIN LAYOUT - FEED END ELEVATION
8.	PR-7	R.O. TREATMENT TRAIN LAYOUT - INTERSTAGE ELEVATION
9.	PR-8	R.O. TREATMENT TRAIN LAYOUT - FEED PUMP ELEVATION
10.	PR-9	R.O. TRAIN SAMPLE AND INSTRUMENTATION PANEL
11.	PR-10	R.O. FLUSH AND CLEAN SYSTEM - PLAN VIEW
12.	PR-11	R.O. FLUSH AND CLEAN SYSTEM - ELEVATION
13.	PR-12	SCALE INHIBITOR FEED SYSTEM
14.	1100	P&ID - SYMBOLS LEGEND
15.	1102	P&ID - R.O. PROCESS
16.	1103	P&ID - FLUSH AND CLEAN SYSTEM
17.	1109	P&ID - ANTI-SCALENT SYSTEM



VICINITY MAP
NOT TO SCALE

DIRECTOR

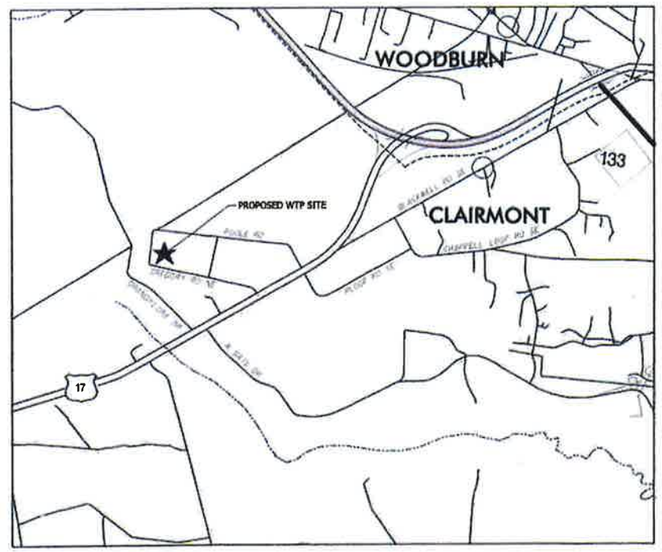
Bob Walker

COMMISSIONERS

Bill Browning, Chairman
Ron Jenkins, Vice Chairman
Carl Antos, Secretary
Jeff Gerken
Trudy Trombley

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
120 North Boylan Avenue Raleigh NC 27603-1423
919.828.0531 fax 919.834.3589
License Number: F-0115

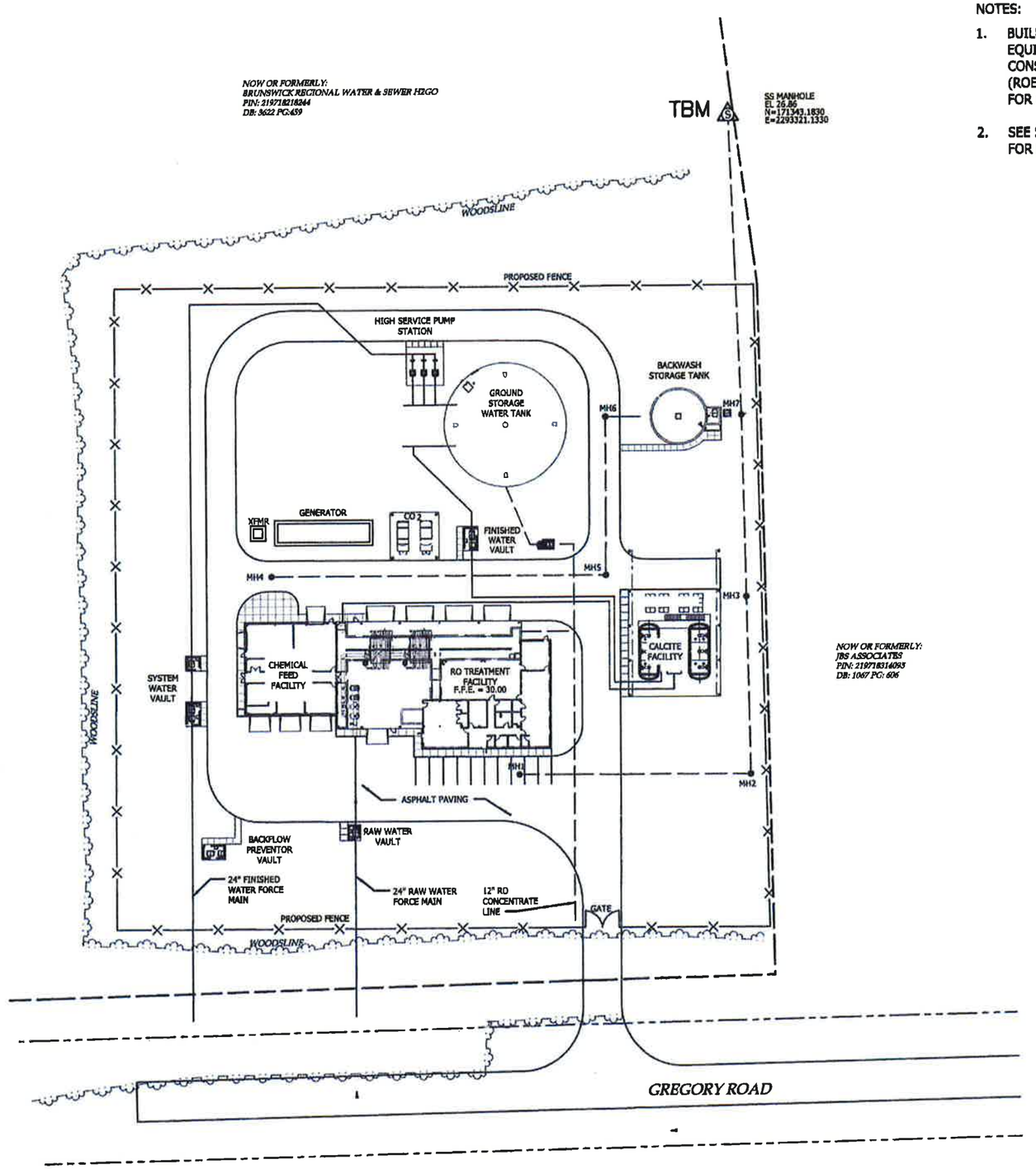
NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL M. SCHARR
3-13-2017



LOCATION MAP
NOT TO SCALE

BRUNSWICK REGIONAL W&S H2GO 3081-Z US 17 REGIONAL PUMP STATION AND FORCE MAIN

Plotted: 3/10/2017 4:18:22 PM
By: Jeffrey Dougherty
File: I:\Projects\Brunswick_Regional_W&S_H2GO-3081.46-Water_Supply&_Treatment_Plant\Sheets\Equipment procurement\01-cvr.dgn



1 PR-1 **OVERALL SITE PLAN**

SCALE: 1" = 80'-0"

1"=80'-0"

80' 40' 0 80'

NOTES:

1. BUILDING SITEPLAN SHOWN FOR PURPOSE OF REVERSE OSMOSIS EQUIPMENT PROCUREMENT. BUILDING LAYOUT SHOULD NOT BE CONSIDERED FINAL. REVERSE OSMOSIS EQUIPMENT MANUFACTURERS (ROEM) SHOULD NOTE CHANGES TO ENGINEER REQUIRED TO BUILDING FOR INSTALLATION, OPERATION AND MAINTENANCE OF R.O. EQUIPMENT.
2. SEE SPECIFICATIONS FOR COMPLETE LIST OF TREATMENT EQUIPMENT FOR PROCUREMENT UNDER BID PACKAGE.

TBM SS MANHOLE
EL 26.86
N=171343.1830

100 YR FLOOD
EL. 16.7
(PER FIRM MAP 37202197000J, MAP REVISED JUNE 6, 2006)

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
120 North Dekalb Street Suite 200 Wilmington, NC 28401-1422
Phone (910) 251-0555 Fax (910) 251-0559
License Number: P-0115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

OVERALL SITE PLAN

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHARFF

3-13-2017

DESIGNED BY:	CWD
DRAWN BY:	PMD/EML
CHECKED BY:	CWD
PROJECT NO.:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 2 OF 17

PR-1

Bentley
...\Projects\Brunswick_Regional WAS_H2GO-3081\AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-1-OVERALL_SITE.dgn
3/9/2017 2:09:58 PM
1 in.
Default
...\printpots.plt

60'-8"

120'-8"

20'-0"

16'-0" ROLL UP DOOR

9'-6"

16'-0" ROLL UP DOOR

9'-6"

16'-0" ROLL UP DOOR

9'-6"

16'-0" ROLL UP DOOR

R.O. TREATMENT TRAINS, SEE DWG PR-3 THRU PR-9

FUTURE R.O. TREATMENT TRAINS

PERMEATE LINE

R.O. TRAINS CENTER SUPPORT WALL

CONCENTRATE LINE

6'-0"

24'-11"

HYPOCHLORITE ROOM

ELECTRICAL ROOM

TRENCH W/ GRATING

70'-0"

61'-4"

28'-3"

25'-6"

25'-6"

25'-6"

15'-3"

R.O. FLUSH PUMPS

R.O. WASTE TANK

R.O. CLEAN TANK

83'-8"

CAUSTIC ROOM

CORROSION INHIBITOR ROOM

SHOP/STORAGE

CARTRIDGE FILTERS

R.O. FLUSH TANK

R.O. CLEANING AND FLUSH SYSTEM, SEE DWG PR-10 AND PR-11

SCALE INHIBITOR SYSTEM, SEE DWG PR-12

RAW FEED WATER LINE

55'-4"

86'-0"

NOTES:

1. BUILDING LAYOUT SHOWN FOR PURPOSE OF REVERSE OSMOSIS EQUIPMENT PROCUREMENT. BUILDING LAYOUT SHOULD NOT BE CONSIDERED FINAL. REVERSE OSMOSIS EQUIPMENT MANUFACTURERS (ROEM) SHOULD NOTE CHANGES TO ENGINEER REQUIRED TO BUILDING FOR INSTALLATION, OPERATION AND MAINTENANCE OF R.O. EQUIPMENT.

2. SEE SPECIFICATIONS FOR COMPLETE LIST OF TREATMENT EQUIPMENT FOR PROCUREMENT UNDER BID PACKAGE.

1 / PR-2 **REVERSE OSMOSIS PROCESS BUILDING**

SCALE: 1/16" = 1'-0"

16' 8' 0 16'

1/16"=1'-0"

ISSUED FOR BID 03/13/2017

REVISIONS

THE WOOTEN COMPANY

ENGINEERING · PLANNING · ARCHITECTURE

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY, NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

OVERALL PROCESS BUILDING LAYOUT

NORTH CAROLINA PROFESSIONAL SEAL 040526 ENGINEER CARL W. SCHARFF 3-13-2017

DESIGNED BY: CWD
DRAWN BY: PMD/EMR
CHECKED BY: CWD
PROJECT NO.: 3081-AB
DATE: MARCH 2017
SCALE: AS NOTED

SHEET 3 OF 17

PR-2

Plotted: 6.0000 by: Wednesday, March 15, 2017 11:54:07 PM
T:\Projects\Brunswick_Regional_WAS_H2GO-3081\AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-2-BLDG layout.dgn

8" PVC 2nd St Cleaning Return (BY OTHERS)

4" PVC Permeate Flush Supply (BY OTHERS)

4" PVC Permeate Flush Return (BY OTHERS)

8" PVC 1st St Cleaning Return (BY OTHERS)

24" Feed Water (BY OTHERS)

2/PR-4

24" Permeate to Post-treatment (BY OTHERS)

8" PVC 2nd St Cleaning Supply (BY OTHERS)

12" SUCTION PIPING

RO FEED PUMP

8" DISCHARGE PIPING

10" 1st STAGE PERMEATE CHECK VALVE

8" WAFER CHECK VALVE

8" 1st STAGE PERMEATE FLOW METER

10" PERMEATE DISCHARGE BEND

8" MOTORIZED BUTTERFLY VALVE

4" PERMEATE FLUSH INLET

4" MOTORIZED PERMEATE FLUSH VALVE

4" 1st STAGE PERMEATE, TYP

8" BUTTERFLY VALVE (CLEANING RETURN)

8" 1st STAGE CONCENTRATE HEADER

8" BUTTERFLY VALVE

8" 1st STAGE CLEANING RETURN (BELOW)

8" 1st STAGE CLEANING SUPPLY

4/PR-6

4/PR-7

6" 2nd STAGE FEED

2ND STAGE ENERGY RECOVERY DEVICE (ERD)

1st STAGE

12'-1 1/2"

2nd STAGE

2nd STAGE CLEANING BUTTERFLY VALVE

6" 2nd STAGE CLEANING RETURN

6" 2nd STAGE CLEANING SUPPLY

4" 2nd STAGE PERMEATE, TYP

2" CONCENTRATE MOTORIZED CONTROL VALVE

2" CONCENTRATE ISOLATION BF VALVE

R.O. PRESSURE VESSEL, TYP

R.O. SUPPORT FRAME

12" Concrete Wall (BY OTHERS)

8" PVC 1st St Cleaning Supply (BY OTHERS)

3/PR-5

4" 2nd STAGE PERMEATE FLOW METER

4" CONCENTRATE DISCHARGE

4" CONCENTRATE FLOW METER

4" CONCENTRATE CHECK VALVE

12" PVC Concentrate Line (BY OTHERS)

8'-8"

8'-8"

NOTES:

1. PIPING AND EQUIPMENT SHOWN IN BOLD LINEWEIGHT SHALL BE PROVIDED BY THE R.O. EQUIPMENT MANUFACTURER.
2. PIPING AND EQUIPMENT SHOWN IN LIGHT LINEWEIGHT SHALL BE PROVIDED BY WATER TREATMENT PLANT CONTRACTOR.

1 / PR-3 R.O. TREATMENT TRAIN - PLAN VIEW

SCALE: 3/8" = 1'-0"

3/8"=1'-0"

12" 0 1' 2' 4'

ISSUED FOR BID 03/13/2017

REVISIONS

THE WOOTEN COMPANY

ENGINEERING · PLANNING · ARCHITECTURE

120 North Boylan Avenue Raleigh, NC 27603-1423

919.828.0531 fax 919.834.3589

Licence Number: F-0115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY

BRUNSWICK COUNTY NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

R.O. TREATMENT TRAIN LAYOUT - PLAN VIEW

NORTH CAROLINA PROFESSIONAL SEAL 040625 ENGINEER CARL W. SCHARFF 3-13-2017

DESIGNED BY:	CWD
DRAWN BY:	PMD/EMI
CHECKED BY:	CWD
PROJECT NO:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 4 OF 17

PR-3

printed at 4:45:12 PM
2.6667 " / in.
topography
3/10/2017
T:\Projects\Brunswick_Regional_WAS_H2GO-308\AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-3-skid layout.dgn

24'-11"
8'-8"
8'-8"
4" 1st STAGE PERMEATE
PERMEATE COLLECTION PIPE
PERMEATE DISCHARGE BEND
R.O. PRESSURE VESSEL, TYP
R.O. SUPPORT FRAME
RAW WATER FEED PIPE
RO FEED PUMP
11'-10"
8" 1st STAGE CONCENTRATE COLLECTION PIPE
4" MOTORIZED PERMEATE FLUSH VALVE
2ND STAGE ENERGY RECOVERY DEVICE (ERD)
4" 2nd STAGE CONCENTRATE
8" DISCHARGE PIPING
10" PERMEATE DISCHARGE PIPE (BY OTHERS)
PUMP SETTING (BY OTHERS)
8" BUTTERFLY VALVE (CLEANING RETURN)
12" SUCTION PIPING
8" 1st STAGE CLEANING RETURN
8" PVC 1st St Cleaning Supply (BY OTHERS)
8" PVC 2nd St Cleaning Supply (BY OTHERS)
8" PVC 2nd St Cleaning Return (BY OTHERS)
8" PVC 1st St Cleaning Return (BY OTHERS)
12" PVC Concentrate Line (BY OTHERS)
12" MOTORIZED RAW WATER BUTTERFLY VALVE
7'-0"
24" Permeate to Post-treatment (BY OTHERS)
4" PVC Permeate Flush Return (BY OTHERS)
4" PVC Permeate Flush Supply (BY OTHERS)
24" Feed Water (BY OTHERS)
7'-8"
12"
5'-8"

NOTES:

1. PIPING AND EQUIPMENT SHOWN IN BOLD LINEWEIGHT SHALL BE PROVIDED BY THE R.O. EQUIPMENT MANUFACTURER.
2. PIPING AND EQUIPMENT SHOWN IN LIGHT LINEWEIGHT SHALL BE PROVIDED BY OTHERS.

2 / PR-3 R.O. TREATMENT TRAIN - PUMP SIDE ELEVATION
SCALE: 3/8" = 1'-0"

3/8"=1'-0"
12" 0 1' 2' 4'

ISSUED FOR BID 03/13/2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERS PLANNERS ARCHITECTS
120 North Boylan Avenue Raleigh, NC 27603-1423
919.828.0531 fax 919.834.3289
License Number: F-0125

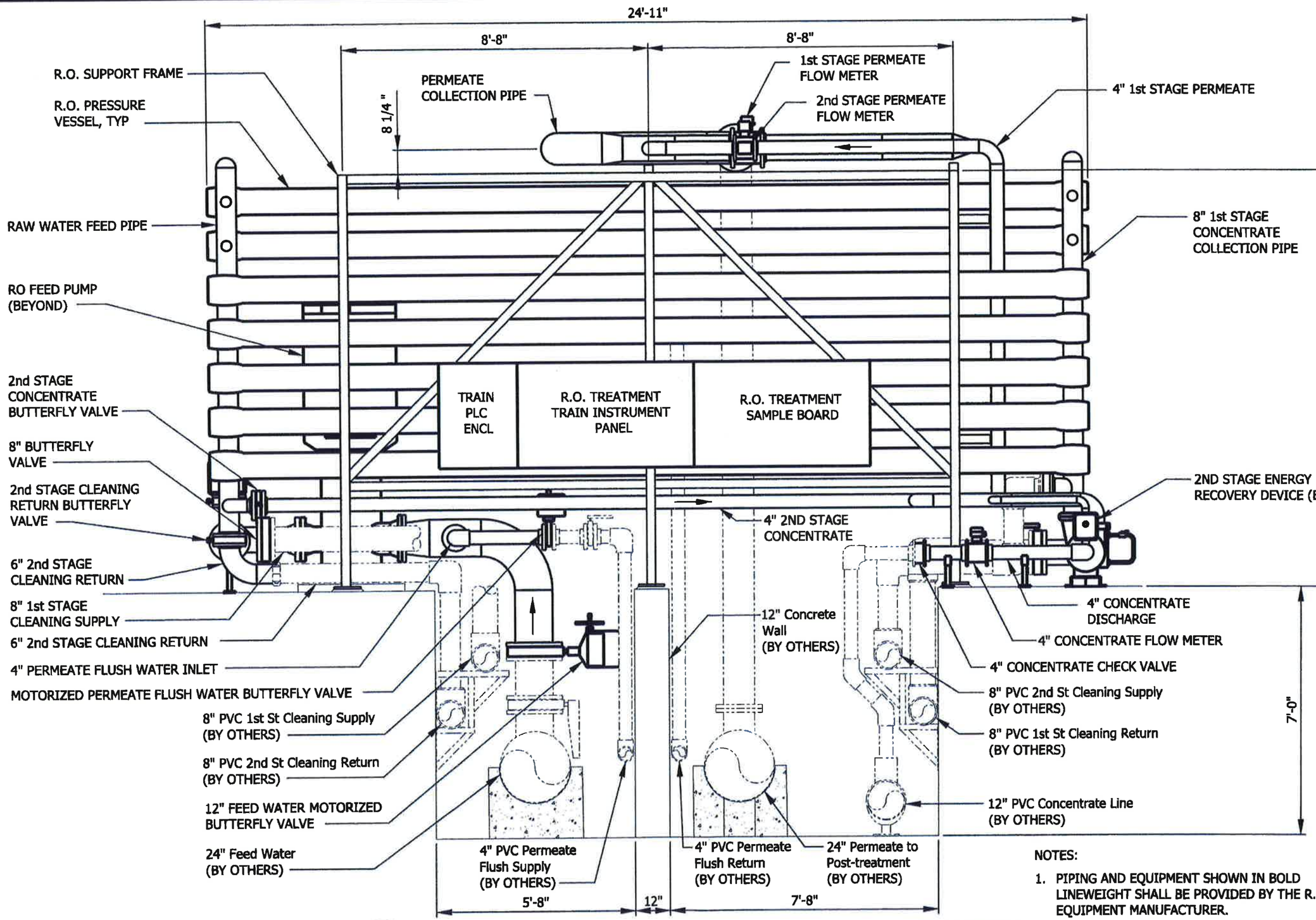
BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA
REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT
R.O. TREATMENT TRAIN LAYOUT - PUMP SIDE ELEVATION

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHARFF 3-13-2017

DESIGNED BY: CWS
DRAWN BY: PMO/EMI
CHECKED BY: CWS
PROJECT NO: 3081-AB
DATE: MARCH 2017
SCALE: AS NOTED

SHEET 6 OF 17
PR-4

T:\Projects\Brunswick_Regional_W&S_H2GO-3081\AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-4-skid layout.dgn
print2pdf.plt
2.6667 - /: in.
topography
3/10/2017 1:45:33 PM



NOTES:

1. PIPING AND EQUIPMENT SHOWN IN BOLD LINEWEIGHT SHALL BE PROVIDED BY THE R.O. EQUIPMENT MANUFACTURER.
2. PIPING AND EQUIPMENT SHOWN IN LIGHT LINEWEIGHT SHALL BE PROVIDED BY OTHERS.

3/8"=1'-0"

12" 0 1' 2' 4'

3 / PR-3

R.O. TREATMENT TRAIN - CONTROL SIDE ELEVATION

SCALE: 3/8" = 1'-0"

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
120 North Boylan Avenue Raleigh, NC 27603-1423
919 828 0531 fax 919 834 3589
Licence Number: F-0115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

R.O. TREATMENT TRAIN LAYOUT
CONTROL SIDE ELEVATION

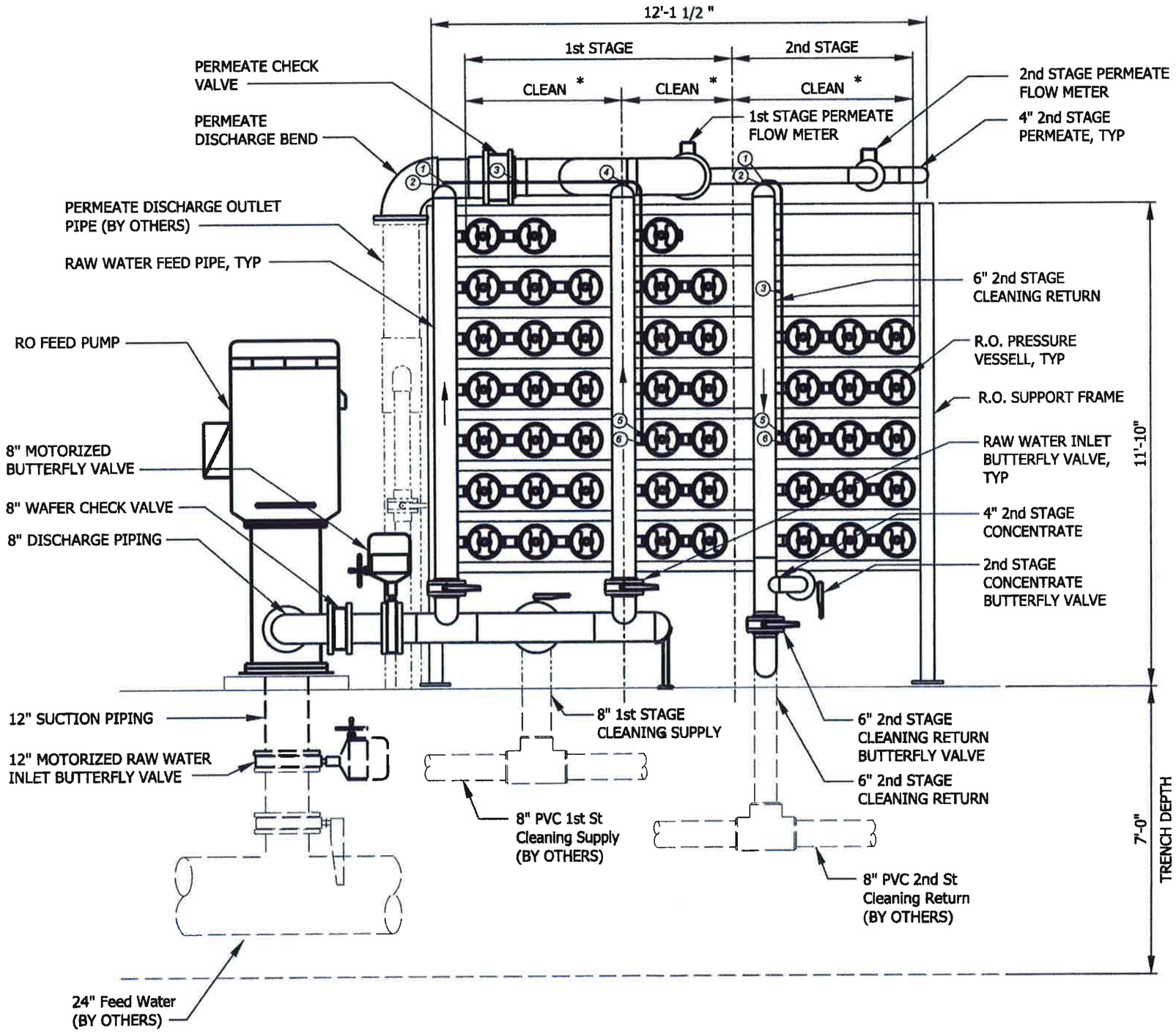
NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHAFER 3-13-2017

DESIGNED BY:	CWD
DRAWN BY:	PMD/EMB
CHECKED BY:	CWD
PROJECT NO:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 8 OF 17

PR-5

T:\Projects\Brunswick_Regional_WS\H200-3081\AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-5-skid layout.dgn
Wednesday, March 15, 2017 11:46:12 PM
Bentley PowerInt2pdfx.pit
Version 8.11.07.663
Microstation V8i (SELECTseries 3)



12" 0 1' 2' 4'

3/8"=1'-0"

4 PR-3 R.O. TREATMENT TRAIN - FEED END ELEVATION

SCALE: 3/8" = 1'-0"

AIR RELEIF SYSTEM

1. 1/2" 316L SS Swagelok tube x male NPT 90deg Ell
2. 1/2" 316L SS #3000 half coupling (typ)
3. 1/2" 316L SS Tubing
4. 1/2" 316L SS Tubing run Tee, 1/2" male NPT Branch
5. 1/2" 316L SS 300# Ball Valve
6. 1/2" 316L SS Tubing to Drain

NOTES:

1. PIPING AND EQUIPMENT SHOWN IN BOLD LINEWEIGHT SHALL BE PROVIDED BY THE R.O. EQUIPMENT MANUFACTURER (ROEM).
2. PIPING AND EQUIPMENT SHOWN IN LIGHT LINEWEIGHT SHALL BE PROVIDED BY THE WATER TREATMENT PLANT CONTRACTOR.

* R.O. TREATMENT TRAIN SHALL BE CLEANED IN SECTIONS PER THE VESSEL GROUPINGS.

ISSUED FOR BID 03/13/2017

REVISIONS

THE WOOTEN COMPANY
Architecture Engineering Interiors
320 North Front Street, Wilmington, NC 28401-3423
910 251 0531 fax 910 343 1548
License Number: P-1115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

R.O. TREATMENT TRAIN LAYOUT - FEED END ELEVATION

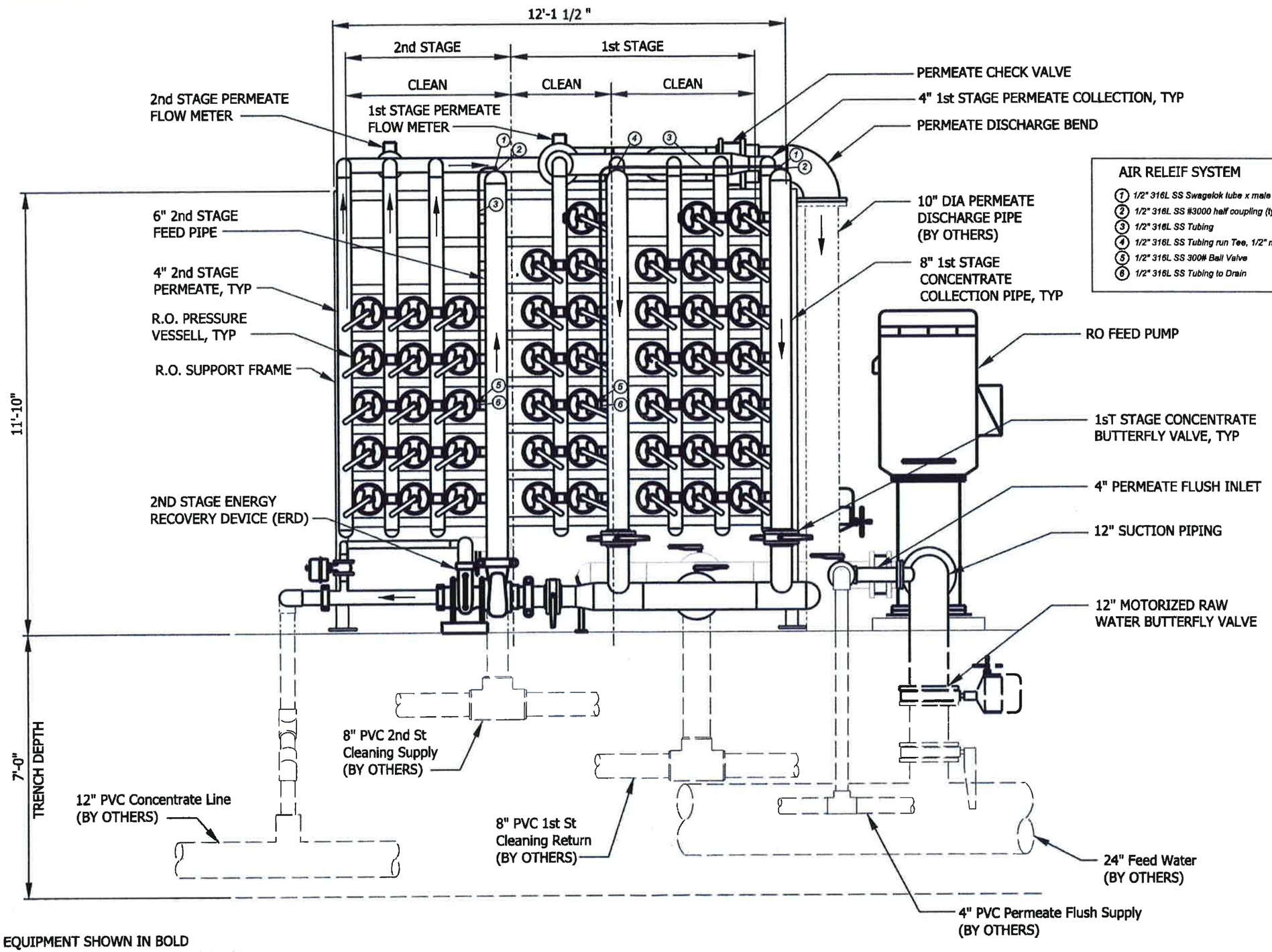
NORTH CAROLINA PROFESSIONAL SEAL 040628 ENGINEER CARLOW. SCHARFF 3-13-2017

DESIGNED BY: CWS
DRAWN BY: PM/DEM/MJ
CHECKED BY: CWS
PROJECT NO.: 3081-AB
DATE: MARCH 2017
SCALE: AS NOTED

SHEET 7 OF 17

PR-6

Plotted: 3/10/2017 1:46:47 PM
Xrefs: T:\Projects\Brunswick_Regional_WS_H2O-3081AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-6-skid layout.dgn
T:\Projects\Brunswick_Regional_WS_H2O-3081AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-6-skid layout_print2pdf.plt
Scale: 2.6667 / in.
Topography
3/10/2017



AIR RELEIF SYSTEM

1. 1/2" 316L SS Swagelok tube x male NPT 90deg Ell
2. 1/2" 316L SS #3000 half coupling (typ)
3. 1/2" 316L SS Tubing
4. 1/2" 316L SS Tubing run Tee, 1/2" male NPT Branch
5. 1/2" 316L SS 300# Ball Valve
6. 1/2" 316L SS Tubing to Drain

NOTES:

1. PIPING AND EQUIPMENT SHOWN IN BOLD LINEWEIGHT SHALL BE PROVIDED BY THE R.O.E.M.
2. PIPING AND EQUIPMENT SHOWN IN LIGHT LINEWEIGHT SHALL BE PROVIDED BY THE WATER TREATMENT PLANT CONTRACTOR.

5 / PR-3 R.O. TREATMENT TRAIN - INTERSTAGE END ELEVATION

SCALE: 3/8" = 1'-0"

3/8"=1'-0"

12" 0 1' 2' 4'

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERS PLANNERS ARCHITECTS
120 North Boylan Avenue Raleigh, NC 27603-1423
(919) 833-8991 FAX (919) 832-3330
Licence Number: P-0315

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

R.O. TREATMENT TRAIN LAYOUT
INTERSTAGE END ELEVATION

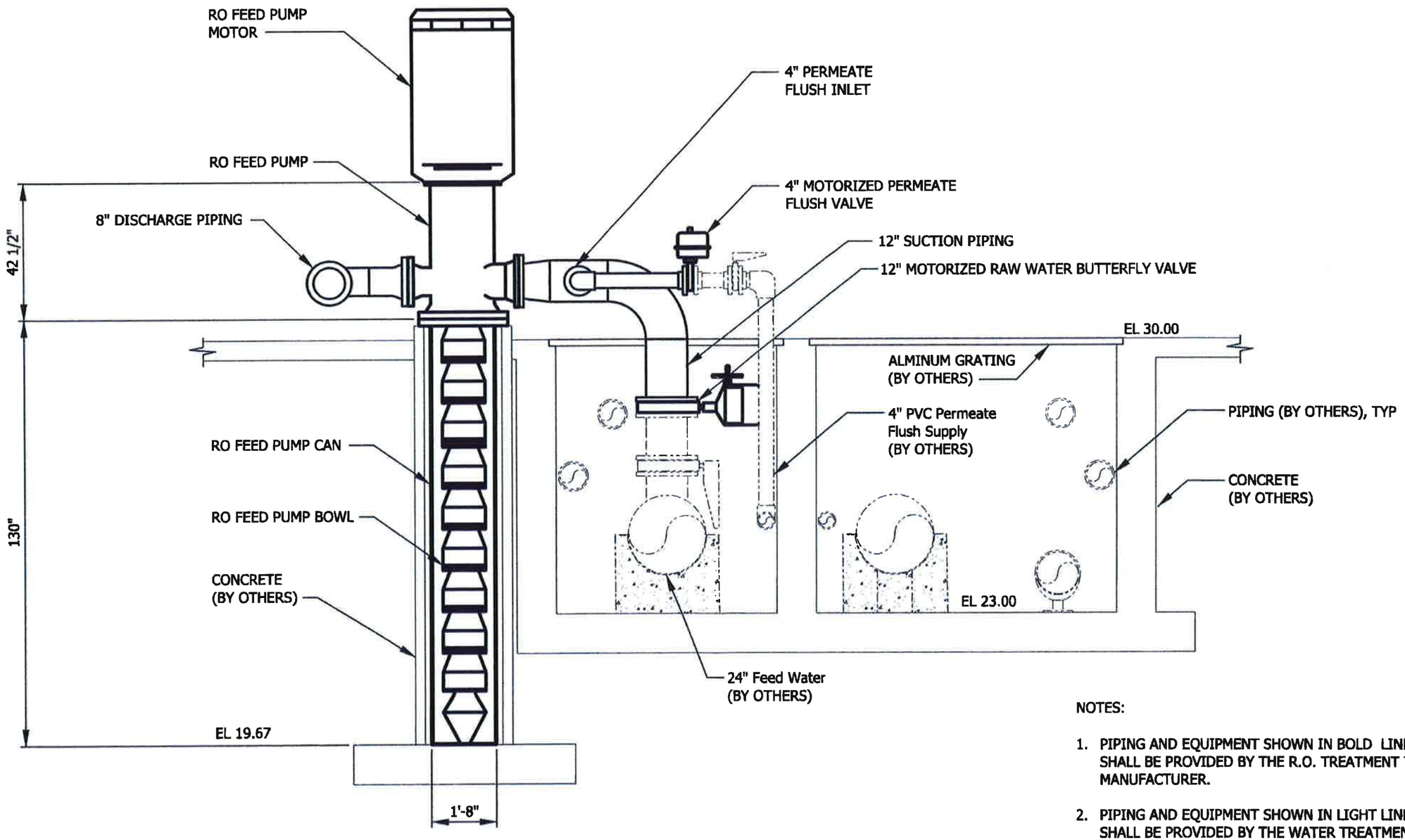
NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHAFER 3-13-2017

DESIGNED BY:	CWD
DRAWN BY:	PMD/EML
CHECKED BY:	CWD
PROJECT NO.:	5081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 8 OF 17

PR-7

C:\Projects\Brunswick_Regional_WSS_H2O-30#\AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-T-skid layout.dgn
3/10/2017 1:47:06 PM
topography
2.5667
printpdf.plt



3/8"=1'-0"

12" 0 1' 2' 4'

6 PR-8 R.O. FEED PUMP ELEVATION

SCALE: 3/8" = 1'-0"

NOTES:

1. PIPING AND EQUIPMENT SHOWN IN BOLD LINEWEIGHT SHALL BE PROVIDED BY THE R.O. TREATMENT TRAIN MANUFACTURER.
2. PIPING AND EQUIPMENT SHOWN IN LIGHT LINEWEIGHT SHALL BE PROVIDED BY THE WATER TREATMENT PLANT CONTRACTOR.

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERS PLANNERS ARCHITECTS
120 North Dobbs Avenue Raeford, NC 28376-1413
910.205.0521 fax 910.904.3549
License Number: P-0115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA
REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

R.O. FEED PUMP ELEVATION

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHARF 3/13/2017

DESIGNED BY:	CWD
DRAWN BY:	PMD/EML
CHECKED BY:	CWD
PROJECT NO:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 9 OF 17

PR-8

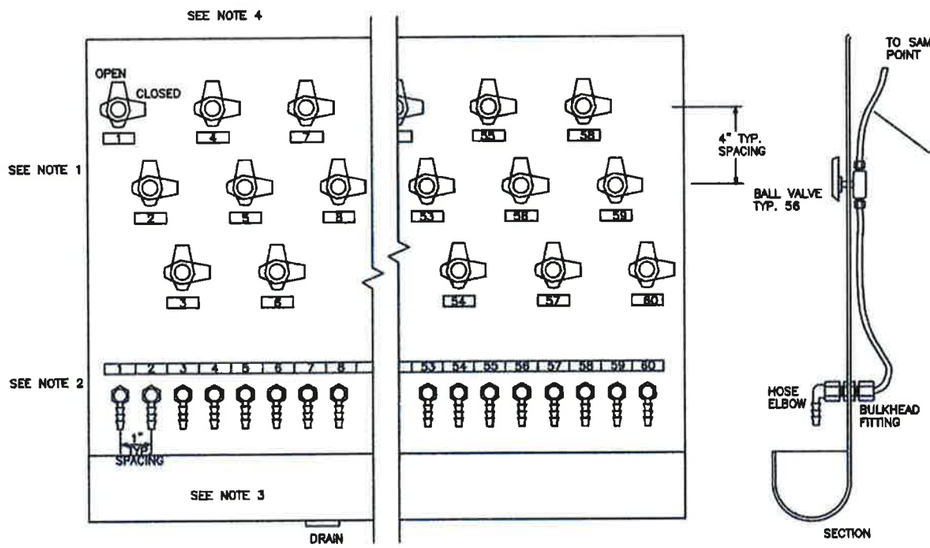
print2pdf.plt
2.66b1 - /. in.
pdanagny
3/10/2017 1:41:30 PM
I:\Projects\Brunswick_Regional_WAS_H2GO-3081AB-Water-Supply&Treatment_Plant\Sheets\Equipment procurement\PR-8-Pump layout.dgn

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

SAMPLE PANEL

ITEM	NAME PLATE TOP LINE	NAME PLATE BOTTOM LINE
1	FEED	FIRST STAGE
2	FEED	SECOND STAGE
3	CONCENTRATE	TOTAL
4	PERMEATE	FIRST STAGE
5	PERMEATE	SECOND STAGE
6	PERMEATE	TOTAL
7	PERMEATE	VESSEL 1-1
8	PERMEATE	VESSEL 1-2
9	PERMEATE	VESSEL 1-3
10	PERMEATE	VESSEL 1-4
11	PERMEATE	VESSEL 1-5
12	PERMEATE	VESSEL 1-6
13	PERMEATE	VESSEL 1-7
14	PERMEATE	VESSEL 1-8
15	PERMEATE	VESSEL 1-9
16	PERMEATE	VESSEL 1-10
17	PERMEATE	VESSEL 1-11
18	PERMEATE	VESSEL 1-12
19	PERMEATE	VESSEL 1-13
20	PERMEATE	VESSEL 1-14
21	PERMEATE	VESSEL 1-15
22	PERMEATE	VESSEL 1-16
23	PERMEATE	VESSEL 1-17
24	PERMEATE	VESSEL 1-18
25	PERMEATE	VESSEL 1-19
26	PERMEATE	VESSEL 1-20
27	PERMEATE	VESSEL 1-21
28	PERMEATE	VESSEL 1-22
29	PERMEATE	VESSEL 1-23
30	PERMEATE	VESSEL 1-24
31	PERMEATE	VESSEL 1-25
32	PERMEATE	VESSEL 1-26
33	PERMEATE	VESSEL 1-27
34	PERMEATE	VESSEL 1-28
35	PERMEATE	VESSEL 1-29
36	PERMEATE	VESSEL 1-30
37	PERMEATE	VESSEL 1-31
38	PERMEATE	VESSEL 1-32
39	PERMEATE	VESSEL 1-33
40	PERMEATE	SPARE
41	PERMEATE	SPARE
42	PERMEATE	VESSEL 2-1
43	PERMEATE	VESSEL 2-2
44	PERMEATE	VESSEL 2-3
45	PERMEATE	VESSEL 2-4
46	PERMEATE	VESSEL 2-5
47	PERMEATE	VESSEL 2-6
48	PERMEATE	VESSEL 2-7
49	PERMEATE	VESSEL 2-8
50	PERMEATE	VESSEL 2-9
51	PERMEATE	VESSEL 2-10
52	PERMEATE	VESSEL 2-11
53	PERMEATE	VESSEL 2-12
54	PERMEATE	VESSEL 2-13
55	PERMEATE	VESSEL 2-14
56	PERMEATE	VESSEL 2-15
57	PERMEATE	SPARE
58	PERMEATE	SPARE
59	PERMEATE	SPARE
60	PERMEATE	SPARE



NOTES:
1. UNIT SAMPLE VALVES (TYP)
2. SAMPLE HOSE ELBOW (TYP)
3. SAMPLE DRAIN TRAY
4. FRP PANEL

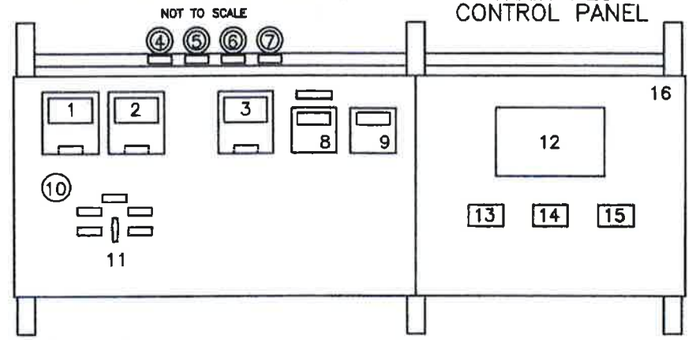
TRAIN SAMPLE PANEL

NOT TO SCALE

TRAIN INSTRUMENT PANEL

NOT TO SCALE

TRAIN PLC CONTROL PANEL



1. 1ST STAGE PERMEATE FLOW
2. 2ND STAGE PERMEATE FLOW
3. CONCENTRATE FLOW
4. 1ST STAGE FEED PIT
5. 1ST STAGE CONCENTRATE PIT
6. 2ND STAGE FEED PIT
7. 2ND STAGE CONCENTRATE PIT
8. TOTAL PERMEATE CONDUCTIVITY
9. CONCENTRATE CONDUCTIVITY
10. PRESSURE GAUGE
11. SELECTOR 5-WAY VALVE (FEED, 1st STAGE CONC, 2ND STAGE FEED, CONC, CONC TO WASTE.)
12. OPERATOR TOUCH SCREEN INTERFACE
13. TOTAL PERMEATE FLOW DISPLAY
14. 1st STAGE dP
15. 2nd STAGE dP
16. PLC ENCLOSURE WITH I/O CABINET

7 PR-9 R.O. TRAIN SAMPLE AND INSTRUMENTATION PANELS

NO SCALE

THE WOOTEN COMPANY
ENGINEERS | PLANNERS | ARCHITECTS
128 West Hargett Street, Suite 300, Raleigh, NC 27601-1425
919 828 0531 | fax 919 834 5685
License Number: F-0115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY, NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

R.O. TRAIN SAMPLE AND INSTRUMENTATION PANELS

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHAFFER 3-13-2017

DESIGNED BY:	CWD
DRAWN BY:	PMD/EML
CHECKED BY:	CWD
PROJECT NO:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 10 OF 17

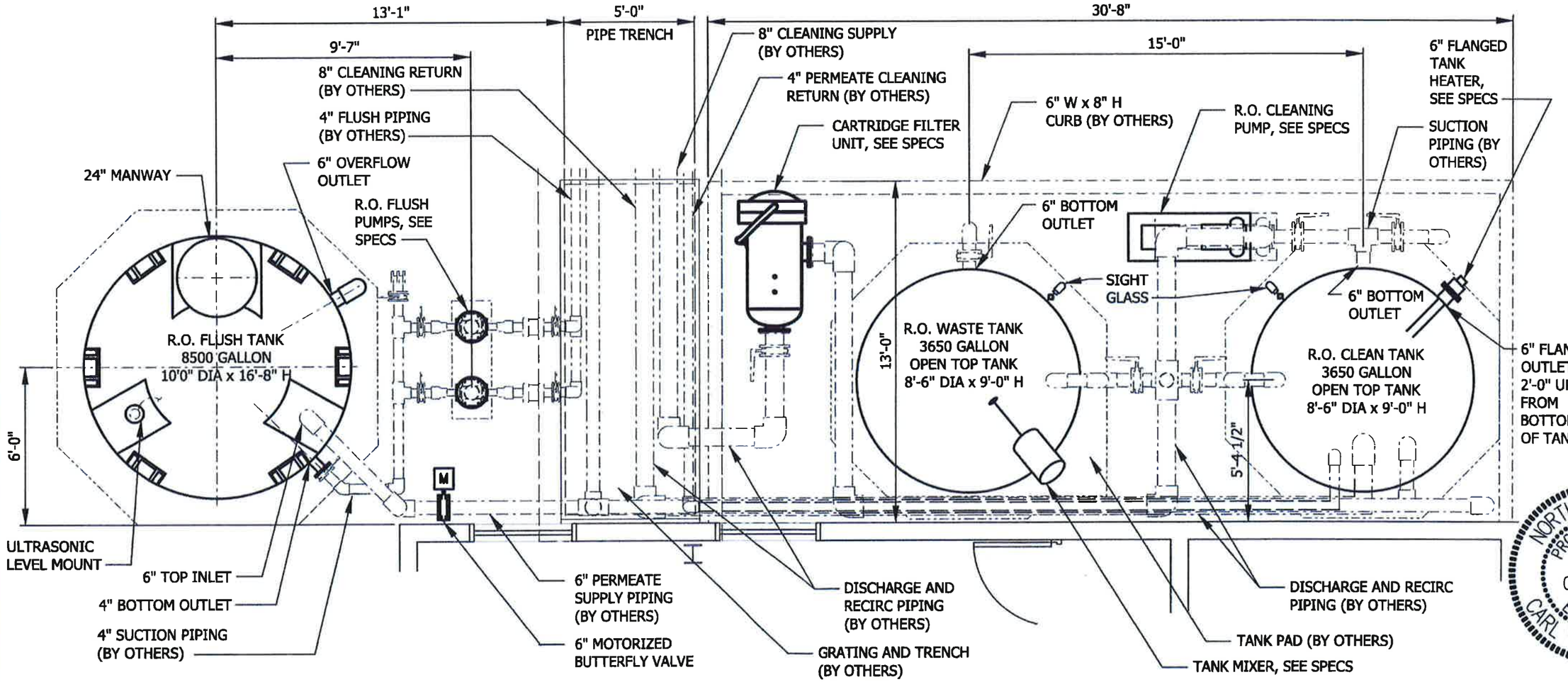
PR-9

J:\Projects\Brunswick_Regional_WWS_H2GO-3081-AB-Water_Supply&Treatment_Plant\Sheets\Equipment procurement\PR-9-panels.dgn
Plotted: 13-Mar-2017 11:26 AM
By: Paul Dempsey
Xrefs: 3-14-17WT
Plot Scale: 2.0000 '/ in.
Plot Driver: DWG To PDF.pc3
Paper Size: print2pdfx.plt

NOTES:

1. BUILDING LAYOUT SHOWN FOR PURPOSE OF REVERSE OSMOSIS EQUIPMENT PROCUREMENT. BUILDING LAYOUT SHOULD NOT BE CONSIDERED FINAL. REVERSE OSMOSIS EQUIPMENT MANUFACTURERS (ROEM) SHOULD NOTE CHANGES TO ENGINEER REQUIRED TO BUILDING FOR INSTALLATION, OPERATION AND MAINTENANCE OF R.O. EQUIPMENT.

2. SEE SPECIFICATIONS FOR COMPLETE LIST OF TREATMENT EQUIPMENT FOR PROCUREMENT UNDER BID PACKAGE.



1 PR-10 R.O. FLUSH AND CLEAN SYSTEM PLAN

SCALE: 1/4" = 1'-0"

1/4"=1'-0"

2' 1' 0 1' 2' 6'

ISSUED FOR BID 03/13/2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERS PLANNERS ARCHITECTS
220 North Boylan Avenue Raleigh, NC 27603-1423
Phone (919) 828-0531 Fax (919) 828-8593
License Number: P-0113

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA
REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT
R.O. FLUSH AND CLEAN SYSTEM - PLAN VIEW

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHAFER 3-13-2017

DESIGNED BY:	CWD
DRAWN BY:	PMD/EMB
CHECKED BY:	CWD
PROJECT NO.:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 11 OF 17

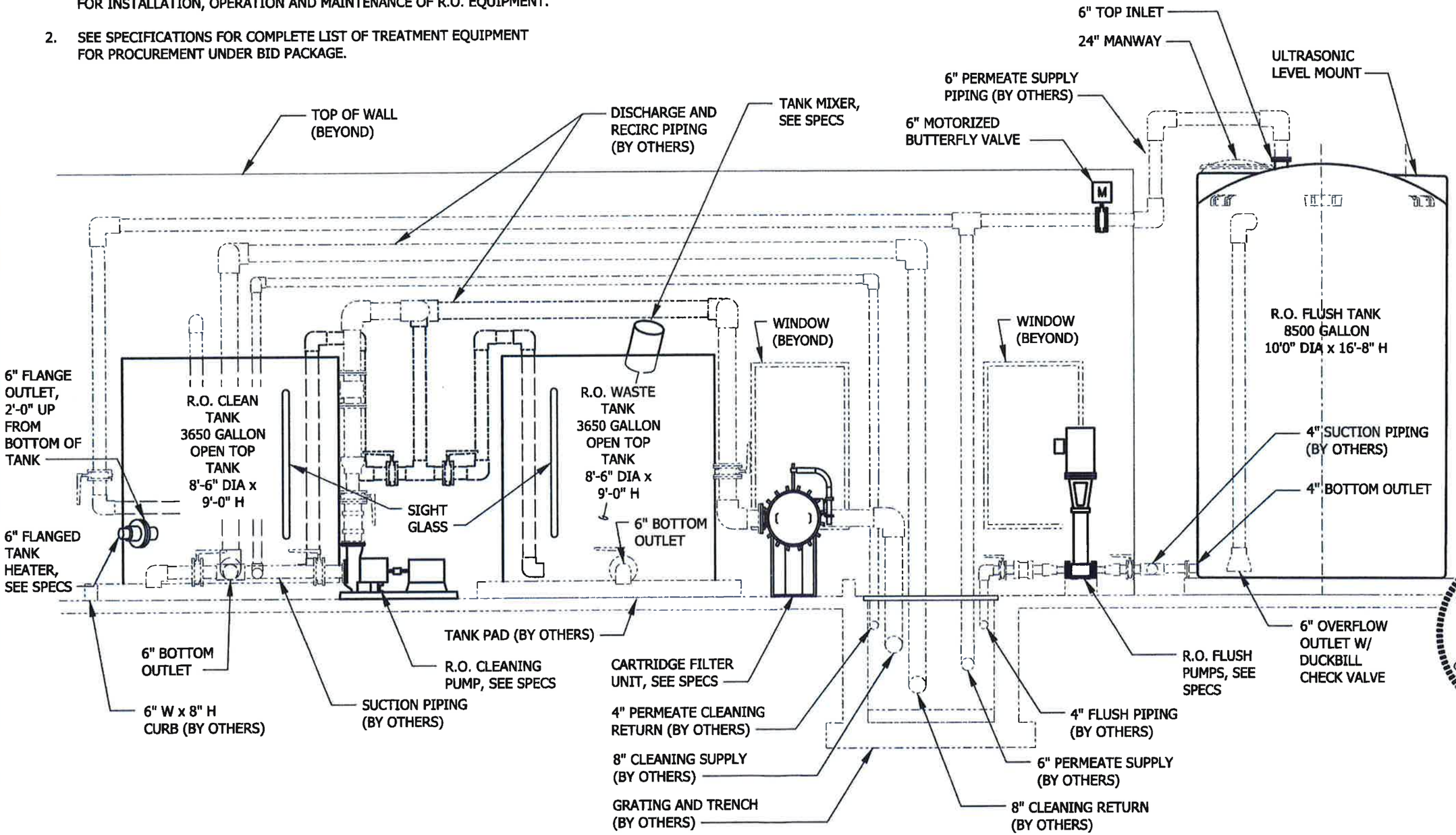
PR-10

...FLUSH AND CLEAN PLAN.dgn
...\Projects\Brunswick_Regional_WAS-H2GO 3081\AB Water_Supply\Treatment...Plant\Sheets\Equipment procurement\PR-10 - FLUSH AND CLEAN PLAN.dgn
11:53:53 AM
3/14/2017
...arlintapatapit
...4.0000 " = in.
...adamsgary

NOTES:

1. BUILDING LAYOUT SHOWN FOR PURPOSE OF REVERSE OSMOSIS EQUIPMENT PROCUREMENT. BUILDING LAYOUT SHOULD NOT BE CONSIDERED FINAL. REVERSE OSMOSIS EQUIPMENT MANUFACTURERS (ROEM) SHOULD NOTE CHANGES TO ENGINEER REQUIRED TO BUILDING FOR INSTALLATION, OPERATION AND MAINTENANCE OF R.O. EQUIPMENT.

2. SEE SPECIFICATIONS FOR COMPLETE LIST OF TREATMENT EQUIPMENT FOR PROCUREMENT UNDER BID PACKAGE.



1 / PR-10 **R.O. FLUSH AND CLEAN SYSTEM ELEVATION**

SCALE: 1/4" = 1'-0"

1/4"=1'-0"

2' 1' 0 1' 2' 6'

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

THE WOOTEN COMPANY

ENGINEERING PLANNING ARCHITECTURE

120 North 3rd Street, Wilmington, NC 28401-1425
910.763.5011 fax 910.763.5489
License Number: P-1013

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

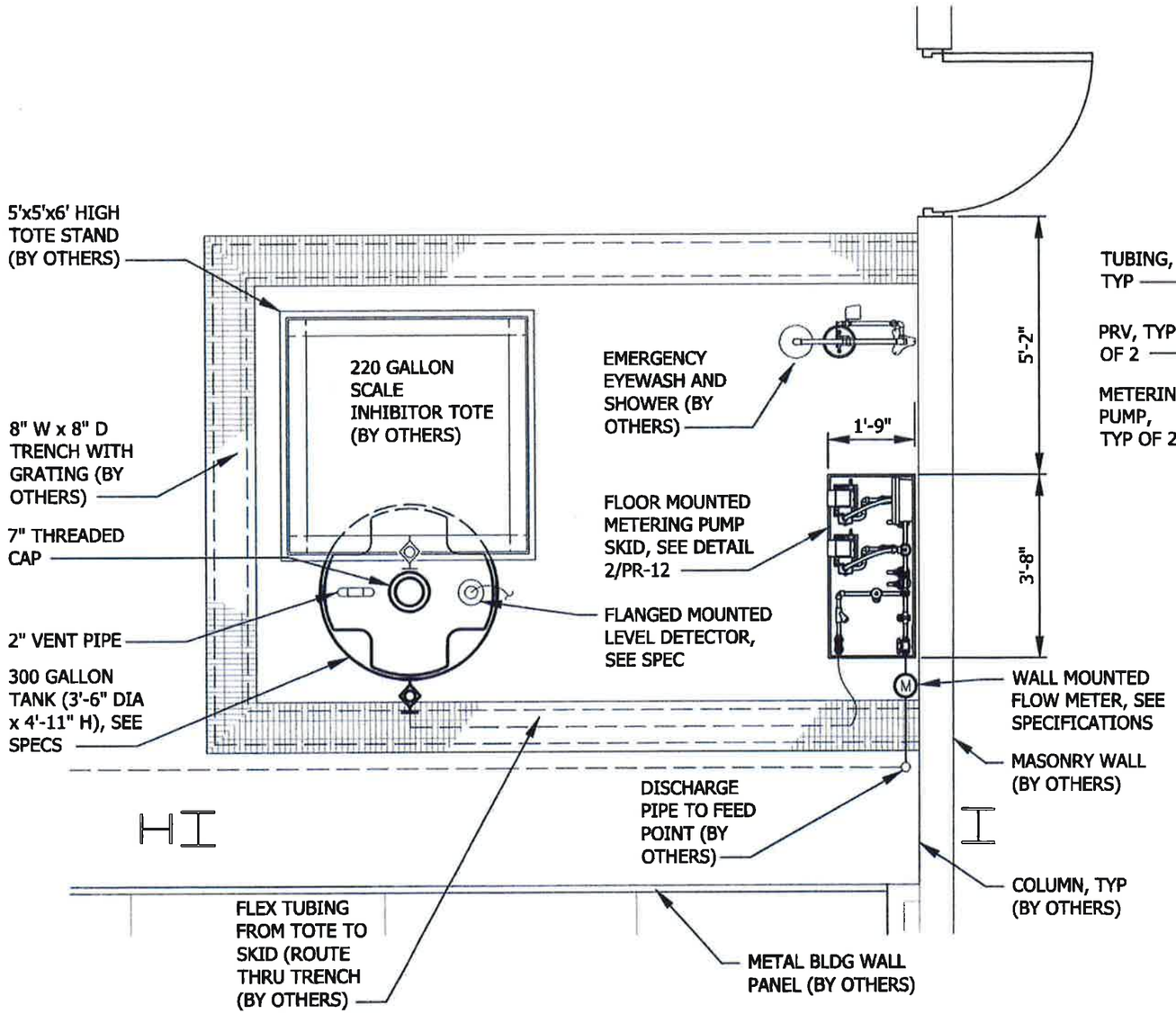
R.O. FLUSH AND CLEAN SYSTEM - ELEVATION

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHARFF 3-13-2017

DESIGNED BY:	CWO
DRAWN BY:	PMD/EMI
CHECKED BY:	CWO
PROJECT NO:	3081-NE
DATE:	MARCH 2017
SCALE:	AS NOTED

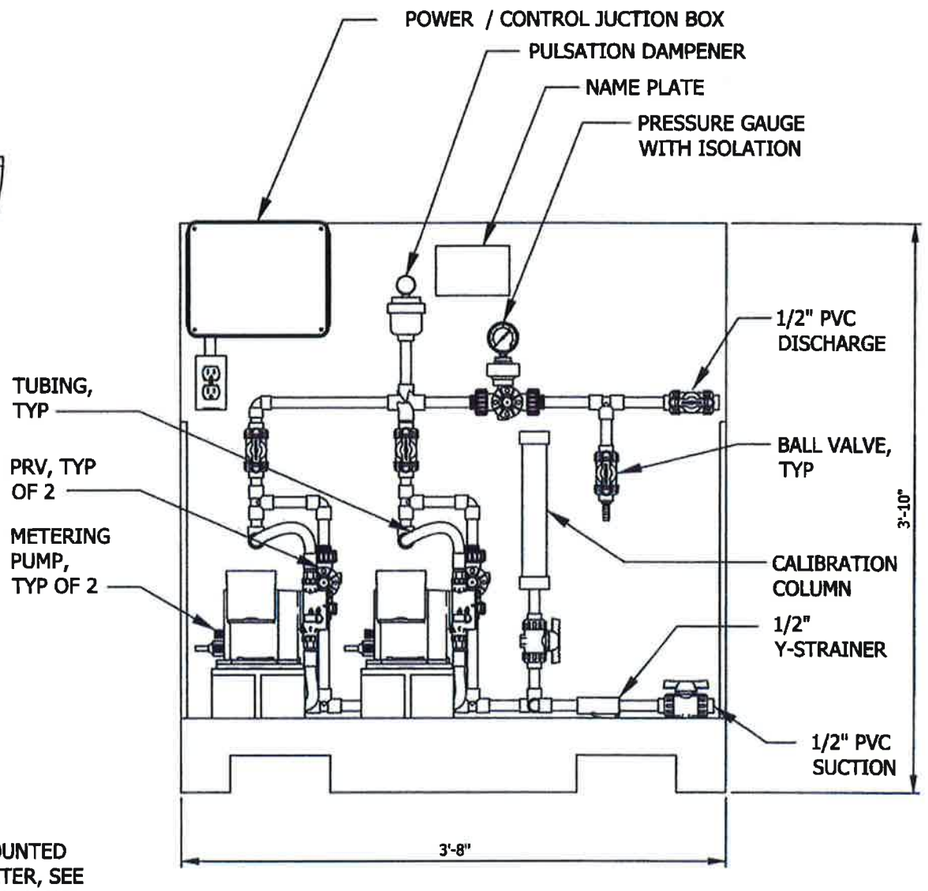
SHEET 12 OF 17

PR-11



1 / PR-12 SCALE INHIBITOR SYSTEM PLAN

SCALE: 3/8" = 1'-0"



2 / PR-12 SCALE INHIBITOR PUMP SKID

SCALE: 1/2" = 1'-0"

NOTES:

1. CHEMICAL FEED SKID SYSTEM SHOWN AS EXAMPLE OF SKID MOUNTED PUMP SYTEM. REVERSE OSMOSIS EQUIPMENT MANUFACTURERS (ROEM) SHALL PROVIDE SIMILAR SYSTEM FOR SCALE INHIBITOR FEED SYSTEM.
2. SEE SPECIFICATIONS FOR COMPLETE LIST OF TREATMENT EQUIPMENT FOR PROCUREMENT UNDER BID PACKAGE.

3/8"=1'-0" 12" 0 1' 2' 4'

1/2"=1'-0" 12" 0 1' 3'

ISSUED FOR BID 03/13/2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
120 North Boylan Avenue, Raleigh, NC 27603-1423
919 828 0531 fax 919 834 3380
License No. C-0317

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY, NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

SCALE INHIBITOR FEED SYSTEM

NORTH CAROLINA PROFESSIONAL SEAL 040525 ENGINEER CARL W. SCHARFF 3/13/17

DESIGNED BY: CWS
DRAWN BY: PMD/EML
CHECKED BY: CWS
PROJECT NO: 3081-AB
DATE: MARCH 2017
SCALE: AS NOTED

SHEET 13 OF 17

PR-12

Plotted: 3/14/2017 11:25:08 AM
T:\Projects\Brunswick_Regional_W&S_n50\0-3081\AB Water Supply Treatment Plant\Sheets\Equipment Procurement\PR-12 - SCALE INHIBITOR.dgn

procurement

GENERAL INSTRUMENT SYMBOLS

FIELD MOUNTED	COMMON HOUSING	PANEL MOUNTED DEVICE (LOCAL CONTROL PANEL)	FURNISHED BY EQUIPMENT SUPPLIER
MOTOR SYMBOL	PROGRAMMABLE LOGIC CONTROLLER SYSTEM FUNCTION BLOCK	DEVICE MOUNTED ON MCC CUBICLE FRONT	INDICATING LIGHT CONTROL PANEL FRONT
		OPERATIONAL INTERLOCK	

VALVE SYMBOLS

GATE VALVE	PLUG VALVE	GLOBE VALVE	BALL VALVE
BALL VALVE (3 WAY)	3-WAY VALVE (GENERAL)	PINCH VALVE	COMBINATION VACUUM AND PRESSURE RELIEF VALVE
BUTTERFLY VALVE	SWING CHECK VALVE	BALL CHECK VALVE	DIAPHRAGM VALVE
NEEDLE VALVE	ANGLE VALVE	ROTARY VALVE	THROUGH PLUG VALVE
PRESSURE RELIEF OR SAFETY VALVE	VACUUM RELIEF VALVE	PRESSURE-REDUCING REGULATOR	BACKPRESSURE REGULATOR
BACKFLOW PREVENTOR	SLUICE GATE	STOP/SLIDE GATE	STRAINER
MOTOR OPERATED VALVE	AIR RELEASE VALVE		

FLOW METERS

MAGNETIC FLOWMETER	VORTEX SENSOR	PADDLE WHEEL	FLUME
SONIC FLOW METER "DOPPLER" OR "TRANSIT TIME" TEXT MAY BE ADDED	ORIFICE PLATE (MOUNTED IN FLANGE UNION)	VENTURI/INSERT TYPE FLOW TUBE	WEIR
VARIABLE AREA INDICATING ROTAMETER(R)	POSITIVE-DISPLACEMENT TYPE	THERMAL DISPERSION	TURBINE-OR PROPELLER TYPE

VALVE ACTUATORS

SOLENOID	ROTARY MOTOR	VALVE ACTUATOR ELECTRO-PNEUMATIC CONVERTER	ELECTROHYDRAULIC
PNEUMATIC	HAND WHEEL		

PUMP AND COMPRESSOR SYMBOLS

CENTRIFUGAL PUMP	PROGRESSIVE CAVITY PUMP	CENTRIFUGAL WET PIT PUMP	COMPRESSOR (CENTRIFUGAL), OR TURBINE
SCREW PUMP	PISTON PUMP	DIAPHRAGM PUMP	COMPRESSOR (PISTON)
ROTARY LOBE PUMP	VERTICAL PUMP	SUBMERSIBLE VERTICAL PUMP	BLOWER (CENTRIFUGAL)
CHEMICAL FEED PUMP			

MISCELLANEOUS SYMBOLS

DIAPHRAGM SEAL	BLIND FLANGE	FILTER	MIXER	ROTARY FEEDER
ELECTRIC MOTOR	VENT TO ATMOSPHERE	AIR GAP	DRAIN	PIPE MATERIAL CHANGE
HORN	ANNULAR DIAPHRAGM SEAL	EXPANSION TANK	REDUCER	RUPTURE DISK
CALIBRATION CYLINDER	PULSATION DAMPENER	INJECTOR	LOOP AND CONTROL STRATEGIES	EQUIPMENT TAG
AIR FILTER	STATIC MIXER	HORN/STROBE LIGHT	QUICK CONNECT	ULTRASONIC SENSOR

ISSUED FOR BID 03/13/2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
120 North Boylan Avenue Raleigh, NC 27603-1423
919.833.7183 FAX 919.833.8306
License Number: P-0105

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

SYMBOLOGY LEGEND

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 2351 CHARLES W. DAVIS 3/13/17

DESIGNED BY:	CWD
DRAWN BY:	PMD/EMI
CHECKED BY:	CWD
PROJECT NO:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 14 OF 17

1100

C:\Program Files\Bluebeam Software\Bluebeam Revu\12\Drivers\acrvr12dfx.plt
Scale: 1.50 = 1 in.
Plotted by: pconagry
Plot Time: 11:25:44 AM
Date: 3/14/2017
T:\Projects\Brunswick_Regional\W&S_H200-3081\AB-Water_Supply&Treatment_Plant\Sheets\WTP\1100_P&ID symbology.dgn

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

1	

* ADD PLY. MARK

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
120 North Boylan Avenue Raleigh NC 27603-1423
919.828.0531 fax 919.834.3589
License Number: F-0115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY
NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

RO PROCESS P & ID

NORTH CAROLINA PROFESSIONAL SEAL 22531 ENGINEER CHARLES W. DAVIS

DESIGNED BY:	CWD
DRAWN BY:	PMD/EML
CHECKED BY:	CWD
PROJECT NO.:	3081-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 15 OF 17

I102

LEGEND

PROVIDED BY ROEM

TRAIN MOUNTED WIRING BY ROEM

*** VFD PROVIDED BY OTHERS

procurement

print2pdf.plt
SD 1:1 in.
Loaded 2017 10:45:57 PM
C:\Projects\Brunswick_Regional_WS_M2017\3081-AB-Water_Supply_Treatment_Plant\Sheets\WTP\A102-RO process.dgn

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

SCADA

PERMEATE FILL VALVE

PERMEATE TANK LEVEL

RO FLUSH PUMPS

CLEANING PUMP

PLC-1

PCC-RO

PERMEATE FILL FROM PERMEATE HEADER

LOCAL CONTROL STATION

PERMEATE CLEANING RETURN FROM RO TRAIN

8" CLEANING RETURN FROM RO TRAINS

6" CLEANING RECIRCULATION FOR MIXING

MOV-112

FLUSH TANK

RO-1

RO-2

PERMEATE FLUSH SUPPLY TO RO TRAINS

SEE NOTE 1

CLEANING TANK

CP-1

CLEANING PUMP

SEE NOTE 2

8" CLEANING DELIVERY TO RO TRAINS

VENT

2"DRAIN

SEE NOTE 4

LOCAL CONTROL STATION

SPENT CLEANING SOLUTION TANK

6" PIPE TO DISPOSAL

RINSE STORAGE TANK

SEE NOTE 3

LEGEND

PROVIDED BY ROEM

NOTE 1 PUMP SUCTION LINES AND ISOLATION VALVES BY OTHERS

NOTE 2 PUMP SUCTION LINES AND ISOLATION VALVES BY OTHERS

NOTE 3 pH ANALYZER BY OTHERS

NOTE 4 INLET, OUTLET AND DRAIN PIPING AND ISOLATION VALVES BY OTHERS

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
125 Black Mountain Avenue Raleigh NC 27603-1423
919.834.5511 fax 919.834.5549
License Number P-0105

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY, NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

FLUSH AND CLEAN SYSTEM - P & ID

NORTH CAROLINA PROFESSIONAL SEAL 22581 ENGINEER CHARLES W. DAVIS

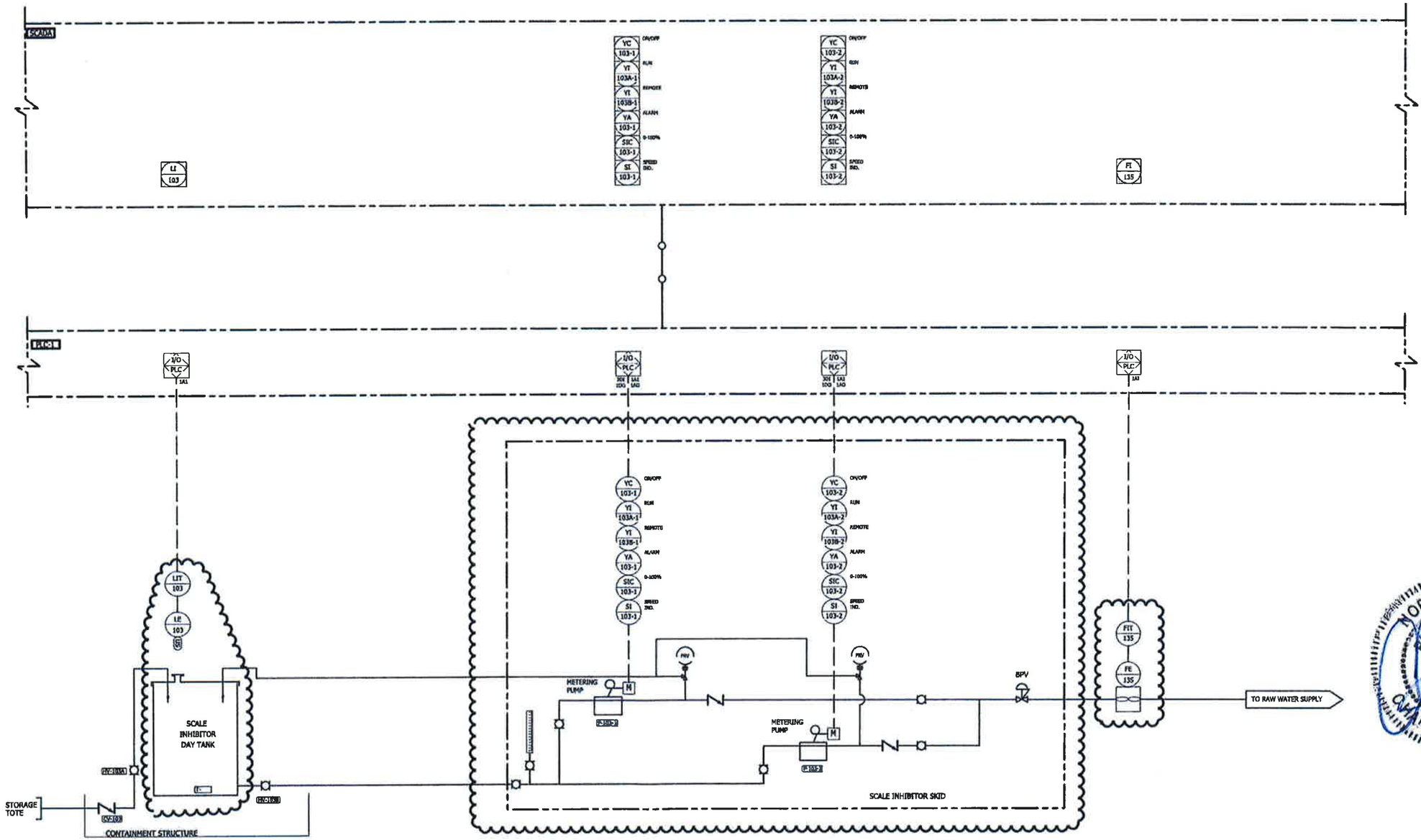
DESIGNED BY:	CWD
DRAWN BY:	PMD/EML
CHECKED BY:	CWD
PROJECT NO.:	3081-A8
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 16 OF 17

1103

print2pdf.plt
16.6666 / in.
monopoly
3/14/2017 10:27:06 AM
T:\projects\Carolina Regional #3\S_H202-3081\A8-Water - Supply & Treatment - Plant\Sheets\WTP-M03_CLEANINGFLUSH.dgn

PROCUREMENT



NOTES:
1. SHUT DOWN PUMPS ON SELECTED TANK LOW-LOW LEVEL.
2. PROVIDE INSTRUMENT SENSORS WITH MANUFACTURER CABLE WITHOUT SPLICES.

LEGEND

PROVIDED BY ROEM

ISSUED FOR BID 03 / 13 / 2017

REVISIONS

THE WOOTEN COMPANY
ENGINEERING PLANNING ARCHITECTURE
129 North Dickinson Avenue Raleigh, NC 27603-1423
919.828.0531 Fax 919.834.1589
License Number: P-0115

BRUNSWICK REGIONAL WATER AND SEWER AUTHORITY
BRUNSWICK COUNTY, NORTH CAROLINA

REVERSE OSMOSIS TREATMENT TRAIN EQUIPMENT PROCUREMENT

CHEMICAL SYSTEMS
SCALE INHIBITOR STORAGE & HANDLING
P & ID

NORTH CAROLINA PROFESSIONAL SEAL 22531 ENGINEER CHARLES W DAVIS 3/10/17

DESIGNED BY:	CWD
DRAWN BY:	PMD/EML
CHECKED BY:	CWD
PROJECT NO.:	3061-AB
DATE:	MARCH 2017
SCALE:	AS NOTED

SHEET 17 OF 17

1109

print2pdfx.plt
6.0000 / in.
2/28/2017 8:27:37 AM
T:\Projects\Eruna\Nick_Regional_WBS_H2OD-3081\AB-Water_Supply&Treatment_Plant\Sheets\WTP\N09_PID SCALE INHIBITOR.dgn