

**COMMISSIONERS OF PUBLIC WORKS
OF THE CITY OF CHARLESTON, SOUTH CAROLINA**

**CONTRACT DOCUMENTS FOR
CONSTRUCTION OF:**

**THOMAS ISLAND REGIONAL PUMP STATION
AND INTERCEPTOR – DIVISION I**



ISSUED FOR CONSTRUCTION

JANUARY 2020

**BID NO. 1947
CWS JOB NO. 0764-0006
EXTENSION NO. 3687-735**

Hazen

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**COMMISSIONERS OF PUBLIC WORKS
OF THE CITY OF CHARLESTON, SOUTH CAROLINA**

**THOMAS ISLAND REGIONAL PUMP STATION
AND INTERCEPTOR – DIVISION I**

JANUARY 2020

Professional Engineer Certifications



Jared Hartwig, PE

License No. 30379

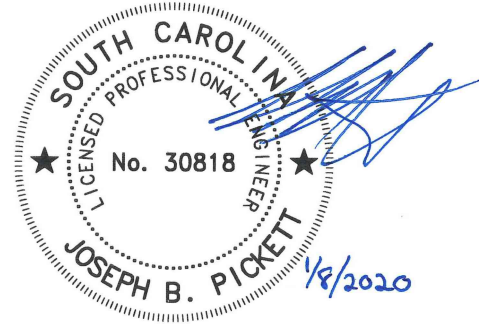
Divisions: Civil/Mechanical



Chris Phillips, PE

License No. 30617

Divisions: Structural



Brad Pickett, PE

License No. 30818

Divisions: Electrical

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INVITATION TO BID

Sealed Bids for the construction of **Thomas Island Regional Pump Station and Interceptor - Division I** will be received by the Commissioners of Public Works of the City of Charleston, South Carolina, until **2:00 pm local time, Thursday, February 6th, 2020**. Please address all Bids to Chad Atwater, Commissioners of Public Works, 103 St. Philip Street, Charleston, South Carolina 29403. Bids will be publicly opened in the **3rd Floor Conference Room** at this time and location.

The Work to be performed consists of the **construction of a new 400 gallon per minute (gpm) submersible pump station to convey wastewater from Thomas Island Regional Pump Station site to the Daniel Island WWTP, Shell Ring Pump Station demolition and Improvements, miscellaneous pump station piping & valves, 10" restrained joint force main, 8" restrained joint force main, 18" gravity sewer, 15" gravity sewer, 12" gravity sewer, 10" gravity sewer, 4 manholes, control panel with pre-engineered canopy & standby generator, electrical switch gear, motor control center & variable frequency drives, instrumentation & control hardware & software** and all associated appurtenances.

The Contractor shall provide all labor, equipment, and materials necessary to complete the Work as described herein and indicated on the Contract Drawings.

To be eligible to bid this project, Contractors must be prequalified for this project by the Commissioners of Public Works and must attend a mandatory Pre-Bid Meeting. A mandatory Pre-Bid Meeting will be held at **10:00 am, Tuesday, January 16th, 2020** in the **3rd Floor Conference Room** at the **Commissioners of Public Works, 103 St. Philip Street, Charleston, South Carolina**. Representatives of the Owner and Engineer will be available to answer questions. Contractors will be afforded a site visit during this time.

Plans, specifications, and Contract Documents are open for public inspection at the following location(s):

Engineer:

Hazen and Sawyer
735 Johnnie Dodds Blvd., Suite 102
Mt. Pleasant, SC 29410
(843) 744-6467

Owner:

Charleston Water System
103 St. Philip St.
Charleston, SC, 29403
(843) 727-6800

CWS' Pre-Qualified Jack and Bore Sub-contractors:

Paragon Pipeline, Inc.

Horizontal Unlimited, Inc.

Razorback Boring, Inc.

Bore Company, LLC

Bids must be accompanied by a certified check or bid bond in an amount equal to at least five percent (5%) of the total amount of the bid for the completed work.

Both a Performance Bond and a labor and materials Payment Bond, each in an amount equal to at least one hundred percent (100%) of the total amount of the bid for the completed work, will be required of the successful bidder concurrent with execution of the contract.

For work consisting of \$5,000 or more, the Bidder must be licensed by the South Carolina Contractor's Licensing Board under the provisions of the most current South Carolina Code of Laws. The Contractor's license number must appear on the front of the envelope containing his bid.

No Bids may be withdrawn for a period of ninety (90) calendar days after the scheduled closing time for receiving bids.

The Commissioners of Public Works reserves the right to reject any and all bids and any part of a bid, and to waive informalities and technicalities in the bid.

Any questions concerning the plans and specifications should be brought to the Commissioners of Public Works' attention immediately. In order not to provide an unfair advantage to a particular Bidder, all questions must be brought to the Commissioners of Public Works' attention at least seven (7) calendar days prior to the bid date. Questions received after this date cannot be considered. All responses to questions will be presented in the form of a written addendum.

Electronic copies (.pdf) of the plans, specifications, and Contract Documents may be obtained from **Hazen and Sawyer**. Send an email request to **Jared Hartwig, P.E.** jhartwig@hazenandsawyer.com or by phone at **(843) 414-1402**, for each set of documents.

Neither the Owner nor Engineer has any responsibility for the accuracy, completeness or sufficiency of any bid documents obtained from any source other than the source indicated in these documents. Obtaining these documents from any other source(s) may result in obtaining incomplete and inaccurate information. Obtaining these documents from any source other than directly from the source listed herein may also result in failure to receive any addenda, corrections, or other revisions to these documents that may be issued.

- END OF SECTION -

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INFORMATION FOR BIDDERS

2-01 RECEIPT AND OPENING OF BIDS

Bids will be received and opened as specified in the Invitation to Bid.

The Owner may reject any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. Any bid may be withdrawn prior to the scheduled bid opening time, or postponement time, as may be authorized by the Commissioners of Public Works. Any bids received after the time and date specified for the bid opening cannot be considered. After bids are opened, no bid may be withdrawn for a period of ninety (90) calendar days.

2-02 PREPARATION OF BIDS

All bids shall be on the Bid Form included herein and shall be for materials and work shown on the drawings and/or specified. The Bid shall be completed in ink or be typewritten. All blank spaces within the Bid Form must be filled in. The total bid amount must be filled in, in both figures and words.

The correct total amount bid for the complete work is defined as the correct sum total of the amount bid for the individual items in the Bid. The correct amount bid for each unit price item is defined as the correct product of the quantity listed for the item and the unit price bid.

Each Bidder shall acknowledge receipt of all addenda in the appropriate spaces on the Bid Form. **It shall be the Bidder's responsibility to assure himself that all addenda have been received. No claim for failure to receive addenda will be considered.**

The Bidder shall indicate on the Bid Form his company's name and address and South Carolina Contractor's License Number.

Each Bid must be signed and dated by the Bidder and must be submitted in a sealed envelope addressed to the Commissioners of Public Works along with the name of the project for which the Bid is being submitted. The Bidder shall also indicate on the outside of the envelope his company name, address, South Carolina Contractor's License Number and CPW Bid Number. **Failure to indicate any or all information may result in rejection of the bid. If forwarded by mail the Bid must be enclosed in another envelope.**

2-03 UNBALANCED BIDS

Bids with extreme variations from the engineer's estimate or where obvious unbalancing of the unit prices has occurred will be thoroughly evaluated by the Owner. If, in the opinion of the Owner, the award of the contract would result in an advantage to the contractor with a corresponding disadvantage to the Owner, then appropriate action, to include rejecting the bid, will be taken to protect the public interest.

2-04 BIDDER'S QUALIFICATIONS

Bids will only be accepted from Bidders who are eligible to bid this project as specified in the Invitation to Bid.

To be acceptable to the Commissioners of Public Works, Bidders must be skilled in the class of work on which they bid, and no bid will be considered from any bidder who is unable to show that he has actually performed considerable work of similar character to that on which he is bidding.

Any time after receiving bids, the Commissioners of Public Works may make such investigation as they deem necessary to determine the ability of the Bidder to perform the work, and the Bidder shall furnish to the Commissioners of Public Works, if requested, all such information and data for this purpose. The Commissioners of Public Works reserves the right to reject any bid if evidence submitted by, or investigations of, such Bidder fails to satisfy the Commissioners of Public Works that such Bidder is properly qualified to carry out the obligations of the Contract Documents.

2-05 EXECUTION OF THE CONTRACT

The Bidder to whom an award is made shall execute and deliver to the Commissioners of Public Works a written contract as bound in the specifications within fourteen (14) calendar days after award of the Contract. If a written contract is not received within fourteen (14) calendar days after the contract award, the Commissioners of Public Works reserves the right to reject the Bid.

2-06 LICENSES AND PERMITS

In addition to the licenses required by the Invitation to Bid, the successful Bidder is required to secure building permits as may be required for each particular contract and type of work as well as any other licenses, permits, approvals, encroachments, etc. that may be applicable to complete the work. See the Supplemental Conditions for project specific details.

2-07 EXAMINATION OF PROJECT SITE

Each of the Bidders shall fully familiarize himself with the Contract Documents and other conditions relating to the project so as to develop a complete understanding of all details involved. He shall satisfy himself as to the actual conditions and requirements of the work by personal examination of the project location or by any other means as may be necessary including but not limited to soil borings and other site investigative work he may deem necessary as referenced herein and in section 4.02 of the General Conditions so as to enable him to develop his bid accurately. Failure to do so will not relieve a successful Bidder of his obligation to furnish all materials (except as noted in the Supplemental Conditions) and labor necessary to complete the provisions of the Contract Documents. No allowance will be made for any claim that a bid was based on incomplete information as to the nature, character and condition of the site and work involved.

2-08 METHOD OF AWARD

The Contract will be awarded to the low Bidder whose base bid, in conjunction with any combination of alternate bid items selected at the sole discretion of the Owner (if applicable), appears to serve the best interest of the Commissioners of Public Works; provided that such low Bidder is considered by the Commissioners of Public Works to be responsible and capable of performing the work.

2-09 OBLIGATION OF BIDDERS

At the time of the opening of bids, each Bidder will be presumed to have visited and inspected the project site as outlined in "Examination of Project Site" and to have read and is thoroughly familiar with the Contract Documents. The failing to examine properly any form or other part of the Contract Documents shall not relieve any bidder from his obligations in respect to his Bid.

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BID FORM

PROJECT NAME: **Thomas Island Regional Pump Station and Interceptor –
Division I**
CPW JOB NUMBER: **0764-0006**
BID NUMBER: **1947**

TO: Commissioners of Public Works
of the City of Charleston, South Carolina
103 Saint Philip Street
Charleston, South Carolina 29403

FROM:

(Bidder)

(Address)

(City, State & Zip Code)

Gentlemen:

The undersigned, as Bidder, hereby declares that the only person or persons interested in the Proposal as principal or principals is or are named herein and that no other person than herein mentioned has any interest in this Proposal or in the Contract to be entered into; that this Proposal is made without connection with any other person, company or parties making a bid or Proposal; and that it is in all respects fair and made in good faith without collusion or fraud.

The Bidder further declares that he has examined the site of the work and informed himself fully in regard to all conditions pertaining to the place where the work is to be done; that he has examined the Drawings and the Specifications for the work and contractual documents relative thereto; that he has satisfied himself relative to the work to be performed; that he has contacted the owner and engineer concerning addenda to these documents and is familiar with the following addenda.

Addendum Number: _____

Date: _____

Having closely examined these documents, the Bidder proposes to furnish all services, labor, materials and equipment called for in the Contract Documents for the entire work for the lump sum prices indicated on the attached schedule, which is hereafter called the Bid.

The Bidder proposes and agrees, if this bid is accepted, to contract with the CPW, in the form of contract specified, to furnish all necessary products, machinery, tools, apparatus, means of transportation and labor necessary to complete the construction of the work in full and complete accordance with the shown, noted, and reasonably intended requirements of the Specifications and Contract Documents to the full and entire satisfaction of the CPW with a definite understanding that no money will be allowed for extra work except as set forth in the attached General Conditions and Contract Documents, for the prices as listed in the Bid Schedule.

The Bidder understands that the Commissioners of Public Works reserves the right to reject any and all bids and to waive any informality in the bidding.

The Bidder further agrees that this Bid shall be good and may not be withdrawn for a period of ninety (90) calendar days after the scheduled closing time for receiving bids.

The Bidder declares that he understands that the quantities shown for unit price items are subject to either increase or decrease, and that should the quantities of any of the items of work be increased, the Bidder proposes to do the additional work at the unit prices stated herein; and should the quantities be decreased, the Bidder also understands that payment will be made on the basis of actual quantities at the Unit Bid Price and will make no claim for anticipated profits for any decrease in quantities; and that actual quantities will be determined upon completion of work, at which time adjustment will be made to the contract amount by direct increase or decrease.

Upon receipt of a written notice of the acceptance of this Bid, the Bidder will execute the formal contract attached hereto within fourteen (14) calendar days of his receipt of such notice. If the Contractor fails to execute a Contract within the fourteen (14) calendar day period, the Commissioners of Public Works reserves the right to reject his Bid.

BID SCHEDULE

PROJECT NAME: Thomas Island Regional Pump Station and Interceptor –
Division I
CPW JOB NUMBER: 0764-0006
BID NUMBER: 1947

BASE BID

Description		Bid Amount		
- A. LUMP SUM ITEMS -				
A.1	New Thomas Island Regional Pump Station and All Work Not Included in Items Below (See 01025 – Measurement and Payment)	\$		
A.2	Mobilization and Demobilization (Max. of 3% of Total Construction Cost)	\$		
A.3	Shell Ring Pump Station Demolition and Improvements	\$		
- B. UNIT PRICE ITEMS -				
	Unit	Quantity	Unit Price	Bid Amount
B.1.	18" PVC Gravity Sewer (16’– 18’)	LF	21	\$
B.2.	15" PVC Gravity Sewer (16’-18’)	LF	331	\$
B.3.	15" PVC Gravity Sewer (14’-16’)	LF	227	\$
B.4.	12" PVC Gravity Sewer (14’-16’)	LF	95	\$
B.5.	12" PVC Gravity Sewer (12’-14’)	LF	140	\$
B.6.	10" PVC Gravity Sewer (14’-16’)	LF	20	\$

B.7.	5' Diameter Manhole (16'-18')	<u>EA</u>	<u>4</u>	<u>\$</u>
B.8.	Manhole Vent Pipe	<u>EA</u>	<u>1</u>	<u>\$</u>
B.9.	Raven 405 Coating for Manhole	<u>VF</u>	<u>35.2</u>	<u>\$</u>
B.10.	10" Restrained Joint Force Main	<u>LF</u>	<u>69</u>	<u>\$</u>
B.11.	8" Restrained Joint Force Main	<u>LF</u>	<u>292</u>	<u>\$</u>
B.12.	Fittings	<u>TON</u>	<u>0.3</u>	<u>\$</u>
B.13.	8" Plug Valve with Box	<u>EA</u>	<u>1</u>	<u>\$</u>
B.14.	Cut-in to Existing Force Main	<u>LS</u>	<u>1</u>	<u>\$</u>
B.15.	Erosion and Sedimentation Control	<u>LS</u>	<u>1</u>	<u>\$</u>
B.16.	Grassing	<u>LS</u>	<u>1</u>	<u>\$</u>
B.17	Clearing and Grubbing	<u>AC</u>	<u>0.6</u>	<u>\$</u>
B.18	Galvanized Steel Conduit for Utility Service	<u>LF</u>	<u>650</u>	<u>\$</u>

- C. ALLOWANCE ITEMS -

C.1	Electrical 3-way underground service by Dominion Energy	<u>\$ 45,000</u>
C.2	Natural Gas underground service by Dominion Energy	<u>\$ 15,000</u>

C.3 Contingency Cash Allowance \$ 200,000

Total Base Bid Amount, Items A – C Inclusive \$

(DOLLARS AND CENTS)

Indicate the Total Base Bid Amount above in both figures and words. In case of a discrepancy, the amount shown in words will govern.

Notes:

1. Contingency Cash Allowance shall be used at OWNER'S discretion for project overruns or changes in scope of work. Contingency shall not be used at BIDDER'S discretion. Contingency shall only be used with approval and authorization by OWNER or OWNER'S REPRESENTATIVE.

Signed: _____ Date: _____

Contractor: _____

S.C. Contractor's License Number: _____

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BID BOND

KNOW ALL MEN BY THESE PRESENTS, THAT WE, the undersigned, _____, as Principal, and _____, as Surety, are hereby held and firmly bound unto Commissioners of Public Works of the City of Charleston, South Carolina, as Owner, in the penal sum of _____ (\$_____), for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

Signed, this _____ day of _____, 20_____.

The condition of the above obligation is such that whereas the Bidder has submitted to the Commissioners of Public Works of the City of Charleston, South Carolina, a certain Bid, attached hereto and hereby made a part hereof to enter into a contract in writing, for the construction of the:

Thomas Island Regional Pump Station and Interceptor - Division I

NOW THEREFORE,

- a) If said Bid shall be rejected, or in the alternate.
- b) If said Bid shall be accepted and the Bidder within fourteen (14) calendar days of the Notice of Award shall execute and deliver a contract in the Form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a bond for his faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement caused by the acceptance of said Bid, then this obligation shall be void, otherwise the same shall remain in force and in effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its bond shall be in no way impaired or affected by any extension of the time within which the Owner may accept such Bid; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Bidder and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

(SEAL if Contractor is a Corporation)

CONTRACTOR AS PRINCIPAL

Contractor's Name

By: _____

Signature

Print Name

Title

Attest: _____

Signature

Title

(SEAL)

SURETY

Surety's Name

By: _____

Signature (Attach Power of Attorney)

Print Name

Title

Attest: _____

Signature

Title

IMPORTANT: Surety companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

BB-2

NOTICE OF AWARD

TO: _____

PROJECT NAME: **Thomas Island Regional Pump Station and Interceptor - Division I**
CPW JOB NUMBER: **0764-0006**

The CPW has considered the BID submitted by you on _____, 20____ in response to its Invitation to Bid for the described WORK for the referenced project.

You are hereby notified that your BID has been accepted in the amount of _____ (\$_____).

You are required by the Information for Bidders to execute the Contract and furnish the required Contractor's Performance Bond and Payment Bond within fourteen (14) calendar days from the date of this Notice to you.

If you fail to execute said Contract and to furnish said bonds within fourteen (14) calendar days from the date of this Notice, the CPW will be entitled to consider all your rights arising out of the CPW's acceptance of your BID as abandoned and a forfeiture of your Bid Bond or certified check. The CPW will be entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of this NOTICE OF AWARD to the CPW, dated this _____ day of _____, 20____.

Commissioners of Public Works
of the City of Charleston, South Carolina

By: _____
Russell L. Huggins, Jr., PE
Capital Projects Officer

ACCEPTANCE OF NOTICE

Receipt of this NOTICE OF AWARD is hereby
acknowledged:

Contractor's Name

By: _____
Signature

Print Name

Title: _____

Date: _____

NA-1

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CONTRACT FOR CONSTRUCTION

PROJECT NAME: **Thomas Island Regional Pump Station and Interceptor - Division I**

CPW PROJECT NUMBER: **0764-0006**

THIS CONTRACT made this _____ day of _____, 20____, by and between _____, a corporation organized and existing under the laws of the State of South Carolina, hereinafter called the "CONTRACTOR", and the COMMISSIONERS OF PUBLIC WORKS OF THE CITY OF CHARLESTON, SOUTH CAROLINA, hereinafter called the "CPW".

AGREEMENT

WITNESSETH, that the Contractor and the CPW for the considerations stated herein mutually agree as follows:

1. The Contractor shall furnish all supervision, technical personnel, labor, materials other than those furnished by CPW, machinery tools, equipment, and services, including utility services and transportation, and perform and complete the work required for the construction of the **Thomas Island Regional Pump Station and Interceptor - Division I**, CPW Job Number **0764-0006**, all in strict accordance with the Contract Documents consisting of this Owner-Contractor Contract, the General Conditions, the Technical Specifications, the Drawings, all Addenda issued prior to execution of this Contract, and all Change Orders issued after execution of this Contract, as prepared by the Commissioners of Public Works of the City of Charleston, South Carolina.
2. The CPW will pay the Contractor for the performance of the contract in current funds, for the prices stipulated in the Contractor's Bid of \$ _____. Retainage will be 10% of the amount earned until at least 50% of the work has been completed and consent of Surety obtained at which time the retainage may be reduced by the CPW to 5% of the amount earned. The CPW reserves the right to implement 10% retainage at any time during the course of the contract should conditions warrant.
3. **RIGHT TO INCREASE OR DECREASE THE AMOUNT OF WORK:** The work comprises approximately the quantities shown in the Bid Form, which will be used as a basis for comparison of bids and not for final estimate. The CPW does not, by expression or by implication, agree that the actual amount of work shall correspond with the estimated quantities.
4. The work to be performed under this Contract shall commence within fourteen (14) calendar days of the Notice to Proceed, and the Contractor shall agree to complete all work within **three hundred sixty-five (365)** consecutive calendar days of the date of the Notice to Proceed. The Contractor further agrees to pay as liquidated

damages the sum of **Five Hundred Dollars (\$500.00)** for each consecutive calendar day thereafter. The Contractor shall insure that the work is prosecuted regularly, diligently and uninterrupted at such a rate of progress as will insure a timely completion of the work.

IN WITNESS WHEREOF, the Parties hereto have caused this Contract to be executed on the day and year first above written.

(SEAL if Contractor is a Corporation)

CONTRACTOR AS PRINCIPAL

Contractor's Name

Contractor's Address

By: _____
Signature

Print Name

Title

Attest: _____
Signature

Title

(SEAL)

**COMMISSIONERS OF PUBLIC WORKS
OF THE CITY OF CHARLESTON,
SOUTH CAROLINA**

**103 Saint Philip Street
Charleston, South Carolina 20403**

By: _____
F. K. Hill, Jr., PE
Chief Executive Officer

Attest: _____
Signature

Title

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS: that

(Name of Contractor)

(Address of Contractor)

a _____, hereinafter called Principal,
(Corporation, Partnership, or Individual)

and _____
(Name and Address of Surety)

hereinafter called Surety, are held and firmly bound unto the Commissioners of Public Works of the City of Charleston, South Carolina hereinafter called CPW, in the penal sum of _____ Dollars, (\$ _____) in lawful money of the United States for the payment of which sum well and truly to be made, we bind ourselves, successors, and assigns, jointly and severally, firmly by these presents. THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain Contract with the CPW, dated the _____ day of _____, 20 _____, a copy of which is hereto attached and made a part hereof for the construction of:

Thomas Island Regional Pump Station and Interceptor - Division I

NOW THEREFORE, if the Principal shall well, truly and faithfully perform its duties, all the undertakings, covenants, terms, conditions, and agreements of said Contract during the original term thereof, and any extensions thereof which may be granted by the CPW, with or without notice to the Surety and during the one year guaranty period and if he shall satisfy all claims and demands incurred under such Contract, and shall fully indemnify and save harmless the CPW from all costs and damages which it may suffer by reason of failure to do so, and shall reimburse and repay the CPW all outlay and expense, including attorney's fees, which the CPW may incur in making good any default, then this obligation shall be void; otherwise to remain in full force and effect.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by any extension of the time within which the CPW may accept such BID; and said Surety does hereby waive notice of any such extension.

PB-1

IN WITNESS WHEREOF, said _____, as Principal and Contractor hereunder, has caused these presents to be signed in _____ (_____) original counterparts in his name, and witnessed by two attesting and subscribing witnesses and the said _____, as Surety, has caused these presents to be signed in _____ (_____) original counterparts in its name by its _____ under its corporate seal, this _____ day of _____ A.D., 20____.

(SEAL if Contractor is a Corporation)

CONTRACTOR AS PRINCIPAL

Contractor's Name

By:

Signature

Print Name

Title

Attest:

Signature

Title

(SEAL)

SURETY

Surety's Name

By:

Signature (Attach Power of Attorney)

Print Name

Title

Attest:

Signature

Title

IMPORTANT: Surety Companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS: that

(Name of Contractor)

(Address of Contractor)

a _____, hereinafter called Principal,
(Corporation, Partnership, or Individual)

and _____
(Name and Address of Surety)

hereinafter called Surety, are held and firmly bound unto the Commissioners of Public Works of the City of Charleston, South Carolina hereinafter called CPW, in the penal sum of _____ Dollars, (\$ _____) in lawful money of the United States for the payment of which sum well and truly to be made, we bind ourselves, successors, and assigns, jointly and severally, firmly by these presents. THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain Contract with the CPW, dated the _____ day of _____, 20 _____, a copy of which is hereto attached and made a part hereof for the construction of:

Thomas Island Regional Pump Station and Interceptor - Division I

NOW THEREFORE, if the Principal shall promptly make payment to all persons, firms, SUBCONTRACTORS, and corporations furnishing materials for or performing labor in the prosecution of the WORK provided for in such Contract, and any authorized extension of modification thereof, including all amounts due for materials, lubricants, oil, gasoline, coal and coke, repairs on machinery, equipment and tools, consumed or used in connection with the construction of such WORK, and all insurance premiums on said WORK, and for all labor, performed in such WORK whether by SUBCONTRACTOR or otherwise, then this obligation shall be void; otherwise to remain in full force and effect.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by an extension of the time within which the CPW may accept such BID; and said Surety does hereby waive notice of any such extension.

PmB-1

IN WITNESS WHEREOF, said _____, as Principal and Contractor hereunder, has caused these presents to be signed in _____ (_____) original counterparts in his name, and witnessed by two attesting and subscribing witnesses and the said _____, as Surety, has caused these presents to be signed in _____ (_____) original counterparts in its name by its _____ under its corporate seal, this _____ day of _____ A.D., 20_____.

(SEAL if Contractor is a Corporation)

CONTRACTOR AS PRINCIPAL

Contractor's Name

By: _____

Signature

Print Name

Title

Attest: _____

Signature

Title

(SEAL)

SURETY

Surety's Name

By: _____

Signature (Attach Power of Attorney)

Print Name

Title

Attest: _____

Signature

Title

IMPORTANT: Surety Companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

PmB-2

NOTICE TO PROCEED

TO: _____

DATE: _____

PROJECT: **Thomas Island Regional Pump Station and Interceptor - Division I**
CPW JOB NUMBER: **0764-0006**

In accordance with the Contract dated _____, 20 ____, you are hereby notified to commence work on _____, 20 ____, and you are to complete the WORK within **three hundred sixty-five (365)** consecutive calendar days thereafter. The date of completion of all WORK is therefore _____, 20 ____.

Commissioners of Public Works
of the City of Charleston, South Carolina

By: _____
Russell L. Huggins, Jr., PE
Capital Projects Officer

ACCEPTANCE OF NOTICE

Receipt of this NOTICE TO PROCEED is
hereby acknowledged:

Contractor's Name

By: _____
Signature

Print Name

Title: _____

Date: _____

NP-1

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**COMMISSIONERS OF PUBLIC WORKS
OF THE CITY OF CHARLESTON, SOUTH CAROLINA**

PAYMENT REQUEST FORM

Contractor: _____ Date: _____

Monthly Payment Request Number: _____

Pay Period: _____

Project Name: **Thomas Island Regional Pump Station and Interceptor - Division I**

CPW Job #: **0764-0006**

Total Value of Work Completed to Date \$ _____
(See Attached Sheets)

Total Value of Materials Stored for Project \$ _____
(See Attached Sheets)

SUB-TOTAL \$ _____

LESS 10% RETAINED \$ _____

TOTAL \$ _____

Previous Payments:

1. _____	8. _____	15. _____
2. _____	9. _____	16. _____
3. _____	10. _____	17. _____
4. _____	11. _____	18. _____
5. _____	12. _____	19. _____
6. _____	13. _____	20. _____
7. _____	14. _____	21. _____

LESS TOTAL OF PREVIOUS PAYMENTS: \$ _____

OTHER CHANGES, ETC. \$ _____

TOTAL AMOUNT DUE THIS PAYMENT: \$ _____

I hereby certify that the above work performed and materials stored are as per the terms of the Contract Agreement.

Contractor:

Approved for Engineer:

Approved for Owner:

By: _____ By: _____ By: _____

Date: _____ Date: _____ Date: _____

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**COMMISSIONERS OF PUBLIC WORKS
OF THE CITY OF CHARLESTON, SOUTH CAROLINA**

CONTRACT CHANGE ORDER

Date of Issuance: _____ Change Order Number: _____
Project Name: **Thomas Island Regional Pump Station and Interceptor - Division I**
CPW Job Number: **0764-0006** CPW P. O. Number: _____
CPW Extension Number: **3687-735**

Original Contract Amount: \$ _____
Amount of Previous Change Orders: \$ _____
Amount of this Change Order: \$ _____
New Contract Amount: \$ _____
Additional Contract Time: _____
New Completion Date of All Work: _____

By executing this Change Order, the Commissioners of Public Works (CPW) and the CONTRACTOR agree that the attached items be incorporated into the work at the price as noted above. The CONTRACTOR further agrees that the price quoted above includes all costs, both direct and indirect, and that the CONTRACTOR, in accordance with the terms of the Contract, specifically waives its right, if any, to any additional adjustments, including but not limited to, adjustment arising out of delays or disruptions or both caused by this change. This Change Order shall not change any other provisions of the contract documents except as stated above.

COMMISSIONERS OF PUBLIC WORKS

Christopher E. Troutman, PE
Assistant Director of
Engineering & Construction

Russell L. Huggins, Jr., PE
Capital Projects Officer

F. K. Hill, Jr., PE
Chief Executive Officer

ENGINEER

Company Name

Printed Name

Signature

CONTRACTOR

Company Name

Printed Name

Signature

CCO-1

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**GENERAL CONDITIONS OF THE CONTRACT
COMMISSIONERS OF PUBLIC WORKS
OF THE CITY OF CHARLESTON, SOUTH CAROLINA**

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1.00 DEFINITION OF TERMS:

- (a) CONTRACT shall mean this Contract executed between the OWNER and the CONTRACTOR as defined herein and shall consist of the CONTRACT DOCUMENTS as defined below.
- (b) The CONTRACT DOCUMENTS are the Invitation to Bid, Instructions to Bidders, Bid Forms, Sample Forms, CONTRACTOR'S Bid Proposal, OWNER-CONTRACTOR CONTRACT, the General, Supplemental and Special Conditions of this CONTRACT, the Permits, the Technical Specifications, the Drawings, all Addenda issued prior to execution of this CONTRACT; and all Change Orders issued after execution of this CONTRACT.
- (c) CONTRACTOR shall mean person or persons, partnership or corporation designated as such in the contract agreement, acting directly or through his, their, or its agents or employees.
- (d) The CONTRACT PRICE is stated in the CONTRACT and is the total amount payable by the OWNER to the CONTRACTOR for the performance of THE WORK outlined in the CONTRACT DOCUMENTS.
- (e) CONTRACT TIME shall be measured in calendar days and shall be in accordance with Notice to Proceed.
- (f) DEFECTIVE: an adjective which, when modifying the word "WORK", refers to WORK that is unsatisfactory, faulty, or deficient, or does not conform to the CONTRACT DOCUMENTS, or does not meet the requirements of any inspection, referenced standard, test, or approval referred to in the CONTRACT DOCUMENTS, or has been damaged prior to the final Payment.
- (g) CHANGE ORDER - A written directive issued by the OWNER which must be documented on the CPW contract change order form which orders changes in THE WORK which may or may not involve a change in the CONTRACT PRICE or the CONTRACT TIME.
- (h) DAY - shall mean calendar day.
- (i) FURNISHED BY OWNER shall mean that OWNER shall pre-purchase and have delivered to Charleston, South Carolina to a place mutually agreed upon by the supplier, OWNER and the CONTRACTOR, at no cost to the CONTRACTOR.
- (j) INSTALL shall mean to take delivery of materials, off-load and transport to the site, store as necessary, and install according to the Drawings and Specifications. This shall apply to both materials purchased by the CONTRACTOR and materials furnished by the OWNER.

- (k) LIQUIDATED DAMAGES shall be in the amount specified in the CONTRACT AGREEMENT and applied per day after the CONTRACT TIME, and any extensions granted pursuant to the CONTRACT, have expired.
- (l) LUMP SUM PRICE - Lump Sum Price means the lump sum bid for the completed WORK or any one of the several lump sum items on the proposal.
- (m) NOTICE OF AWARD - A written notice given by the OWNER to the contractor fixing the amount of the contract along with obligations under the Bid Bond.
- (n) NONRESIDENT TAXPAYER REGISTRATION AFFIDAVIT - is an affidavit certifying that a CONTRACTOR not a resident of South Carolina is registered with either the South Carolina Secretary of State or the South Carolina Department of Revenue.
- (o) NONRESIDENT WITHHOLDING BOND - is a bond, which must be provided by any contractor not a resident of South Carolina and not registered with either the South Carolina Secretary of State or State of South Carolina Department of Revenue.
- (p) NOTICE TO PROCEED - A written Notice given by the OWNER to the CONTRACTOR fixing the date on which the CONTRACT TIME will commence to run and on which the CONTRACTOR shall start to perform the CONTRACTOR'S obligations under the CONTRACT DOCUMENTS.
- (q) OWNER shall mean the Commissioners of Public Works of the City of Charleston, South Carolina.
- (r) PRODUCTS shall mean materials or equipment permanently incorporated into THE WORK.
- (s) THE PROJECT shall mean the construction and installation of the work as identified in the CONTRACT DOCUMENTS.
- (t) PROVIDE shall be to furnish and install.
- (u) SUBSTANTIAL COMPLETION: THE WORK (or a specified part thereof) has progressed to the point where it is sufficiently complete, in accordance with the CONTRACT DOCUMENTS, so that THE WORK (or specified part) can be utilized for the purposes for which it is intended; or if there be no such certificate issued, when final payment is made in accordance with paragraph 7.05. The terms "substantially complete" and "substantially completed" as applied to any WORK refer to Substantial Completion thereof.
- (v) UNIT PRICE is the price per unit quoted by the CONTRACTOR for each item noted in the BID.

- (w) THE WORK shall mean the construction required by the CONTRACT DOCUMENTS to complete THE PROJECT and shall include all labor necessary to produce such construction, and all materials (other than OWNER furnished materials), and equipment as necessary to complete construction.

2.00 CONTRACT DOCUMENTS: INTENT AND AMENDMENTS:

- 2.01 The CONTRACT DOCUMENTS comprise the entire agreement between OWNER and CONTRACTOR concerning THE WORK. The CONTRACT DOCUMENTS are complementary; what is called for by one is as binding as if called for by all. The CONTRACT DOCUMENTS will be construed in accordance with the law of the place of THE PROJECT.
- 2.02 By executing the CONTRACT, the CONTRACTOR states he has reviewed the CONTRACT DOCUMENTS and has, familiarized himself with the requirements thereof and THE WORK to be performed.
- 2.03 The intent of the CONTRACT DOCUMENTS is to include all items necessary for the proper execution and completion of THE WORK. It is the intent of the CONTRACT DOCUMENTS that one shall supplement the other, but not necessarily duplicate one another. WORK required by one part of the CONTRACT DOCUMENTS shall be as binding as if required by all parts of the CONTRACT DOCUMENTS. WORK not covered in the CONTRACT DOCUMENTS that is reasonably inferable there from as being necessary to produce the intended results shall be part of this CONTRACT.
- 2.04 Materials or methods described by words which have a well-known technical or trade name meaning will be considered to refer to such recognized standards. Standard specifications or manufacturer's literature, when referenced, are intended to establish the minimum acceptable standard. Brand names where used in the technical specifications are intended to denote the standard or quality required for a particular material or product.
- 2.05 CONTRACT DOCUMENTS shall be followed exactly in construction of THE PROJECT.
- 2.06 In case of conflict between the DRAWINGS and SPECIFICATIONS, the SPECIFICATIONS shall govern. Figure dimensions on DRAWINGS shall govern over general DRAWINGS. SUPPLEMENTAL CONDITIONS shall govern over GENERAL CONDITIONS.
- 2.07 If, during the performance of THE WORK, CONTRACTOR finds a conflict, error or discrepancy in the CONTRACT DOCUMENTS, CONTRACTOR shall so report to OWNER in writing at once and before proceeding with THE WORK affected thereby shall obtain a written interpretation or clarification from OWNER; however, CONTRACTOR shall not be liable to OWNER for failure to report any conflict, error

or discrepancy in the CONTRACT DOCUMENTS unless CONTRACTOR has actual knowledge thereof or should reasonably have known thereof.

2.08 The CONTRACT DOCUMENTS may be amended to provide for additions, deletions and revisions in THE WORK or to modify the terms and conditions thereof in one or more of the following ways:

- (A) A formal Written Amendment,
- (B) A Change Order,
- (C) A WORK Directive Change,

2.09 As indicated in paragraph 9, CONTRACT PRICE and CONTRACT TIME may only be changed by a Change Order or a Written Amendment.

3.00 NOTICES AND COMMUNICATIONS:

3.01 NOTICES

- (A) Notices, demands, requests, instructions, approvals, and claims shall be in writing.
- (B) Any notice to or demand upon the CONTRACTOR shall be sufficiently given if delivered at the office of the CONTRACTOR specified in the Bid (or at such other office as the CONTRACTOR may from time to time designate to the OWNER in writing), or if deposited in the United States Mail in a sealed, postage-prepaid envelope, in each case addressed to such office.
- (C) All papers required to be delivered to the OWNER shall be delivered to the OWNER'S Representative (thence forwarded to the OWNER) or directly to the OWNER and/or as otherwise instructed during the Pre-Construction Conference with the CONTRACTOR. Any notice to or demand upon the OWNER shall be sufficiently given, if hand delivered to the OWNER or the OWNER'S Representative or if deposited in the United States Mail in a sealed, postage-prepaid envelope, in each case addressed to the OWNER or the OWNER'S Representative or to such other address as the OWNER may subsequently specify in writing to the CONTRACTOR for such purposes.
- (D) Any such notice or demand shall be deemed to have been given or made as of the time of actual delivery or (in the case of mailing) when the same should have been received in due course of post, as the case may be.

3.02 COMMUNICATIONS

- (A) The CONTRACTOR shall forward all written communications to the OWNER'S

Representative or directly to the OWNER and/or as otherwise instructed during the Pre-Construction Conference with the CONTRACTOR.

- (B) The OWNER'S Representative and/or the OWNER shall forward all written communications to the CONTRACTOR at the address as indicated on the Bid Form.

4.00 AVAILABILITY OF LANDS: PHYSICAL CONDITIONS: REFERENCE POINTS:

4.01 AVAILABILITY OF LANDS

The OWNER shall furnish, as indicated in the CONTRACT DOCUMENTS, the lands upon which the WORK is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of the CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by the OWNER, unless otherwise provided in the CONTRACT DOCUMENTS. If the CONTRACTOR believes that any delay in the OWNER'S furnishing these lands, rights-of-way or easements entitles the CONTRACTOR to an extension of the CONTRACT TIME, the CONTRACTOR may make a claim therefore as provided in Paragraph 9. The 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 PHYSICAL CONDITIONS

- (A) Explorations and Reports: Reference is made to the Supplementary Conditions for identification of those reports of explorations and tests of subsurface conditions at the site that have been utilized by the OWNER in preparation of the CONTRACT DOCUMENTS. These are supplied for information purposes only. Boring logs and other records of subsurface investigations and tests are available for inspections of bidders. It is understood and agreed that such subsurface information, whether included in the plans, specifications, or otherwise made available to the bidder, was obtained and is intended for OWNER'S design and estimating purposes only. Such information has been made available for the convenience of all bidders. It is further understood and agreed that each bidder is solely responsible for all assumptions, deductions, or conclusions which he may make or obtain from his examination of the boring logs and other records of subsurface investigations and tests that are furnished by the OWNER. Neither the Engineer nor the OWNER guarantees or warranties their accuracy. The Contractor shall have full responsibility with respect to subsurface conditions at the site including but not limited to soil borings and other site investigative work He/She may deem necessary to develop His/Her Bid and/or necessary to complete the provisions of the CONTRACT DOCUMENTS as referenced herein and in paragraph 2-06.

- (B) Existing Structures: Reference is made to the Supplementary Conditions for identification of those drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground Facilities referred to in sub-paragraph (H) below) which are at or contiguous to the site that have been utilized by the OWNER in preparation of the CONTRACT DOCUMENTS. The CONTRACTOR may rely upon the accuracy of the technical data in such drawings, but not for the completeness thereof for CONTRACTOR'S purposes. Except as indicated in the immediately preceding sentence and in sub-paragraph (H) below, the CONTRACTOR shall have full responsibility with respect to physical conditions in or relating to such structures.
- (C) Differing Conditions: If the CONTRACTOR believes that any technical data on which the CONTRACTOR is entitled to rely as provided in sub-paragraph (B) above is inaccurate, or any physical condition uncovered or revealed at the site differs materially from that indicated, reflected or referred to in the CONTRACT DOCUMENTS, the CONTRACTOR shall, promptly (within 5 days) after becoming aware thereof and before performing any WORK in connection therewith or otherwise disturbing the differing condition (except in an emergency), notify the OWNER and the ENGINEER in writing about the inaccuracy or difference. The OWNER will promptly review the permanent conditions, determine the necessity of obtaining additional explorations or tests with respect thereto and advise the CONTRACTOR in writing of the OWNER'S findings and conclusions. If the OWNER concludes that there is a material error in the CONTRACT DOCUMENTS or that because of newly discovered conditions a change in the CONTRACT DOCUMENTS is required, a WORK Directive Change or a Change Order will be issued to reflect and document the consequences of the inaccuracy or difference. In each such case, an increase or decrease in the CONTRACT PRICE or an extension or shortening of the CONTRACT TIME, or any combination thereof, will be allowable to the extent that they are attributable to any such inaccuracy or difference. If the OWNER and the CONTRACTOR are unable to agree as to the amount of length thereof, a claim may be made therefore as provided in paragraph 9.00.

4.03 PHYSICAL CONDITIONS - 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 the OWNER by the OWNER'S of such Underground Facilities or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:
 - (1) The OWNER shall not be responsible for the accuracy or completeness of any such information or data; and
 - (2) The CONTRACTOR shall have full responsibility for reviewing and checking all such information and data, for locating all Underground

Facilities shown or indicated in the CONTRACT DOCUMENTS, for coordination of THE WORK with the OWNER'S of such Underground Facilities during construction, for the safety and protection thereof, and repairing any damage thereto resulting from THE WORK, the cost of all of which will be considered has having been included in the CONTRACT PRICE.

- (B) Not Shown or Indicated: If an Underground Facility is uncovered or revealed at or contiguous to the site which was not shown or indicated in the CONTRACT DOCUMENTS and which the CONTRACTOR could not reasonably have been expected to be aware of, the CONTRACTOR shall, promptly after becoming aware thereof and before performing any WORK affected thereby (except in an emergency), identify the OWNER of such Underground Facility and give written notice thereof to that OWNER and to the OWNER . The OWNER will promptly review the Underground Facility to determine the extent to which the CONTRACT DOCUMENTS should be modified to reflect and document the consequences of the existence of the Underground Facility, and the CONTRACT DOCUMENTS will be amended or supplemented to the extent necessary. During such time, the CONTRACTOR shall be responsible for the safety and protection of such Underground Facility. The CONTRACTOR, subject to the limitations in paragraph 9, shall be allowed an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, to the extent that they are attributable to the existence of any Underground Facility that was not shown or indicated in the CONTRACT DOCUMENTS and which the CONTRACTOR could not reasonably have been expected to be aware of. If the parties are unable to agree as to the amount of length thereof, the CONTRACTOR may make a claim therefor as provided in paragraph 9.

4.04 REFERENCE POINTS

The OWNER shall provide engineering surveys to establish reference points for construction, which in the OWNER'S judgment are necessary to enable the CONTRACTOR to proceed with THE WORK. The CONTRACTOR is responsible for verifying the established reference points and existing structures prior to laying out the work but no later than 90 days after the Notice to Proceed. The CONTRACTOR shall be responsible for laying out THE WORK (unless otherwise specified in the General Requirements), shall protect and preserve the established reference points and shall make no changes or relocations without the prior written approval of the OWNER. The CONTRACTOR shall report to the OWNER whenever any reference point 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 by professionally qualified personnel.

5.00 OWNER'S RESPONSIBILITIES:

5.01 OWNER'S REPRESENTATIVE

The OWNER will provide as necessary construction administration and field inspection of THE PROJECT from THE PROJECT'S inception to its completion.

The OWNER'S representative during the construction period shall be the Construction Manager or an inspector appointed by him. The Construction Manager or his inspector will not be responsible for and will not have control or charge of construction means, methods, techniques, sequences or procedures, or for safety precautions. They will not be responsible for the CONTRACTOR'S failure to carry out THE WORK in accordance with the CONTRACT DOCUMENTS.

5.02 VISITS TO SITE

The OWNER'S Representative shall conduct on-site observations of THE WORK in progress to confirm that THE WORK is proceeding in accordance with the CONTRACT DOCUMENTS. He will verify that tests, equipment and systems start-ups are conducted and operating and maintenance instructions are given as required by the CONTRACT DOCUMENTS. He will have the authority to disapprove or reject defective WORK and suspend any WORK that is being improperly performed, in accordance with this paragraph. Except upon written instructions of the OWNER, the OWNER'S Representative:

- (A) Shall not authorize any deviation from the CONTRACT DOCUMENTS or approve any substitute materials or equipment.
- (B) Shall not exceed limitations of OWNER'S authority as set forth in the CONTRACT DOCUMENTS.
- (C) Shall not undertake any of the responsibilities of the CONTRACTOR, Subcontractors or CONTRACTOR'S superintendent, or expedite THE WORK.
- (D) Shall not advise on or issue directions relative to any aspect of the means, methods, techniques, sequences or procedures of construction unless such is specifically called for in the CONTRACT DOCUMENTS.
- (E) Shall not advise on or issue directions as to safety precautions and programs in connection with THE WORK.

5.03 CLARIFICATIONS AND INTERPRETATIONS

OWNER will issue with reasonable promptness such written clarifications or interpretations of the requirements of the CONTRACT DOCUMENTS (in the form of Drawings or otherwise) as OWNER may determine necessary, which shall be

consistent with or reasonably inferable from the overall intent of the CONTRACT DOCUMENTS. If CONTRACTOR believes that a written clarification or interpretation justifies an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME and the parties are unable to agree to the amount or extent thereof, CONTRACTOR may make a claim therefore as provided in paragraph 9.00.

5.04 AUTHORIZED MINOR VARIATIONS

OWNER 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 TIME and are consistent with the overall intent of the CONTRACT DOCUMENTS. These may include OWNER'S Approval of Shop Drawings and product samples or OWNER'S written interpretation or clarification. These may be accomplished by a Change Order and will be binding on CONTRACTOR who shall perform THE WORK involved promptly. If CONTRACTOR believes that a Change Order justifies an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME and the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a claim therefore as provided in Paragraph 9.00. The CONTRACTOR will proceed with THE WORK ordered by the Change Order, even though the parties do not agree on the change in CONTRACT PRICE or the extension of CONTRACT TIME.

5.05 REJECTING DEFECTIVE WORK

OWNER will disapprove or reject WORK which OWNER believes to be defective, and can also require special inspection or testing of THE WORK, whether or not THE WORK is fabricated, installed or completed.

5.06 DECISIONS AND DISPUTES

(A) OWNER will be the interpreter of the requirements of the CONTRACT DOCUMENTS and judge of the acceptability of THE WORK there under. Claims, disputes and other matters relating to the acceptability of THE WORK or the interpretation of the requirements of the CONTRACT DOCUMENTS pertaining to the performance and furnishing of THE WORK and claims under paragraph 9.00 in respect of changes in the CONTRACT PRICE or CONTRACT TIME will be submitted to OWNER in writing with a request for a formal decision in accordance with this paragraph, which OWNER will render in writing within a reasonable time. Written notice of each such claim, dispute and other matter will be delivered by the claimant to OWNER promptly (but in no event later than thirty days) after the occurrence of the event giving rise thereto, and written supporting data will be submitted to OWNER and the other party within sixty days after such occurrence unless OWNER allows an additional period of time to ascertain more accurate or detailed data in support of the claim.

(B) The rendering of a decision by OWNER pursuant to paragraph 5.07(A) above

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 7.00) will be a condition precedent to any exercise by OWNER or CONTRACTOR 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.

6.00 CONTRACTOR'S RESPONSIBILITIES:

6.01 DELIVERY OF BONDS

When the CONTRACTOR delivers the executed Agreement to the OWNER, the CONTRACTOR shall also deliver to the OWNER such Bonds as the CONTRACTOR may be required to furnish as set forth in paragraph 8 herein.

6.02 COPIES OF DOCUMENTS

The OWNER shall furnish to the CONTRACTOR, up to five (5) copies of the CONTRACT DOCUMENTS as necessary for the execution of THE WORK.

6.03 COMMENCEMENT OF CONTRACT TIME - NOTICE TO PROCEED

The CONTRACT TIME will commence to run on the 30th day after the effective date of the CONTRACT, 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 thirty (30) days after the effective date of the CONTRACT.

6.04 STARTING THE PROJECT

The CONTRACTOR shall start to perform THE WORK on the date when the CONTRACT TIME commences to run, but no WORK shall be done at the site prior to the date on which the CONTRACT TIME commences to run.

6.05 BEFORE STARTING CONSTRUCTION

Before undertaking such part of THE WORK, the CONTRACTOR shall carefully study and compare the CONTRACT DOCUMENTS and check and verify pertinent figures shown thereon and all applicable field measurements. The CONTRACTOR shall promptly report in writing to the OWNER any conflict, error or discrepancy which the CONTRACTOR may discover and shall obtain a written interpretation or clarification from the OWNER before proceeding with any WORK affected thereby; however, the CONTRACTOR shall not be liable to the OWNER for failure to report any conflict, error or discrepancy in the CONTRACT DOCUMENTS, unless the CONTRACTOR had actual knowledge thereof or should reasonably have known thereof.

6.06 SUBMITTALS PRIOR TO PAYMENT

- (A) Within 20 days after the CONTRACTOR has received the NOTICE TO PROCEED, and before the first payment, the CONTRACTOR shall submit to the OWNER for approval a SCHEDULE OF VALUES which shows the allocated value of various portions of THE WORK and shall be prepared in a manner acceptable to the OWNER. This schedule will be the sole basis of payment to the CONTRACTOR it must be tied to the Construction Progress Schedule and it must be approved in writing by the OWNER prior to requests for any payments by the CONTRACTOR.
- (B) Within 20 days after the CONTRACTOR has received the NOTICE TO PROCEED, and before the first payment, the CONTRACTOR shall submit A CONSTRUCTION PROGRESS SCHEDULE in satisfactory form, showing the proposed dates of commencement and completion of each of the various subdivisions of WORK required under the CONTRACT DOCUMENTS and the anticipated amount of each monthly payment that will become due the CONTRACTOR in accordance with the progress schedule. The Construction Progress Schedule must include/address: sufficient detail of the activities, maximum length of any one activity, procurement and approval activities, mobilization and general conditions, normal inclement weather, work performed by others, milestone and dates.
The Construction Progress Schedule and any revisions thereafter must be approved in writing by the OWNER. Any construction schedule submitted by the CONTRACTOR having a completion date earlier than that in the CONTRACT DOCUMENTS will not warrant any claims by the CONTRACTOR should the CONTRACTOR not complete THE WORK by the earlier date, for whatever reason.
- (C) Prior to execution of the contract, the CONTRACTOR shall deliver to the OWNER certificates of insurance and copies of the insurance policies evidenced on the certificates of insurance, which the CONTRACTOR is required to purchase and maintain in accordance with the terms of this CONTRACT.

6.07 PRECONSTRUCTION CONFERENCE

Should the OWNER deem it necessary, a preconstruction conference will be held within 30 days after the effective date of the CONTRACT, but before the CONTRACTOR starts THE WORK at the site. This conference will be attended by the CONTRACTOR, as well as a representative of all His / hers subcontractors and others as appropriate, to discuss the schedules referred to above, to discuss procedures for handling shop drawings, and other submittals, and for processing applications for payment, and to establish a working understanding among the parties as to THE WORK.

6.08 SUPERVISION AND CONSTRUCTION PROCEDURES

- (A) THE CONTRACTOR shall supervise and direct THE WORK using His / Her best

skill and attention. He / She shall be solely responsible for all construction means, methods, techniques, sequences, and procedures and for coordinating all portions of THE WORK under the CONTRACT. CONTRACTOR shall be responsible to see that the finished WORK complies accurately with the CONTRACT DOCUMENTS.

- (B) The CONTRACTOR shall be wholly responsible to the OWNER for the acts, omissions, and errors of his employees, subcontractors and their employees and others performing THE WORK under the CONTRACT DOCUMENTS.
- (C) If the CONTRACTOR is not employing sufficient labor or equipment to complete this CONTRACT within the time specified, the CONTRACTOR shall employ such additional labor and equipment as may be necessary to enable THE WORK to progress properly.
- (D) The Contractor shall not work at night requiring the presence of an engineer or inspector except in the case of an emergency or when restricted by a permitting agency directive, and then only to such extent as is absolutely necessary, provided that this clause shall not operate in case of a crew organized for regular and continuous night work, and only on work which can be satisfactorily performed at night.
- (E) The CONTRACTOR shall not allow any work to be done under this CONTRACT on weekends or holidays except in the case of an emergency or upon written notification to the OWNER. Any request by the CONTRACTOR to work on a holiday shall be submitted in writing at least 48 hours in advance.

6.09 CONTRACTOR'S PERSONNEL

- (A) The CONTRACTOR shall employ for THE WORK, during its progress, a competent supervisor and any necessary foremen and assistants, all satisfactory to the ENGINEER. The supervisor shall be fully experienced in THE WORK of the kind under this CONTRACT, and shall be the CONTRACTOR'S representative on the job site. All communications given to the supervisor shall be binding on the CONTRACTOR. He shall be capable of organizing and directing THE WORK, and interpreting plans and specifications. The foremen shall be experienced in the type of work assigned them.
- (B) The supervisor shall not be changed except with the consent of the OWNER, unless the supervisor proves to be unsatisfactory to the CONTRACTOR and ceases to be in his/her employ. The CONTRACTOR shall properly supervise THE WORK, using his/her best skill and attention. Disorderly, incompetent or intemperate persons must not be retained or allowed upon the WORK. If, in the opinion of the OWNER, the CONTRACTOR'S supervisor or any workers on THE PROJECT prove to be incompetent, negligent in the performance of his/her or their duties, or neglects, or refuses to comply with directions given, or is

otherwise unsatisfactory, he/she shall be replaced. Should the CONTRACTOR continue to employ or again employ such person or persons, the OWNER may withhold all payments which are or may become due. No minors shall be employed by the CONTRACTOR.

6.10 LABOR, MATERIALS AND EQUIPMENT

- (A) Unless otherwise provided in the CONTRACT DOCUMENTS, the CONTRACTOR shall provide, in a good workmanlike manner, and pay for all labor, materials, machinery, equipment, tools, water, heat, utilities, transportation, temporary facilities and utilities, and any other facilities or services necessary to properly complete THE WORK. The CONTRACTOR shall furnish, erect, maintain and remove such construction plants and temporary work as may be required to properly complete THE WORK.
- (B) The CONTRACTOR shall have made himself/herself familiar with all applicable codes, laws, ordinances and regulations which in any way may affect THE WORK, those employees engaged in performing THE WORK, or materials or equipment used in THE WORK.
- (C) Unless otherwise specifically provided in the specifications, all equipment, materials and articles incorporated in THE WORK shall be new and of the best grade of their respective kinds for the purpose. No materials or supplies for THE WORK shall be purchased by the CONTRACTOR or by any subcontractor subject to any chattel mortgage or under a conditional sale or other agreement by which an interest is retained by the seller. The CONTRACTOR warrants that he/she has good title to all materials and supplies used by him/her in THE WORK.
- (D) The CONTRACTOR warrants to the OWNER that all materials and equipment furnished by the CONTRACTOR under this contract will be new unless specified otherwise, and that THE WORK will be of good quality, free from faults and defects and in conformity with the CONTRACT DOCUMENTS. All work not conforming to these requirements, including substitutions not allowed by the OWNER, may be considered defective. If requested by the OWNER, the CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment used in THE WORK.
- (E) Disorderly, incompetent, or intemperate persons must not be retained or allowed upon THE WORK. Supervisors, foremen or workers who neglect or refuse to comply with instructions of the OWNER shall be promptly removed from the Project, and not thereafter be allowed to return without the OWNER'S consent.

6.11 PERMITS, TAXES, FEES, AND NOTICES

- (A) The OWNER will provide EPA permits, SC DHEC permits, City, County Encroachment permits, South Carolina Department of Transportation permits, Army Corps of Engineers permits, and other related railroad and utility permits and easements, as may be applicable. The CONTRACTOR shall secure and pay for all remaining permits as needed to execute THE WORK properly.
- (B) The CONTRACTOR shall be responsible for making all necessary arrangements with governmental departments, public utilities, public carriers, service companies and corporations owning or controlling roadways, railways, water, sewer, gas, electrical, telephone and telegraph facilities such as pavements, tracks, piping, wires, cables, conduits, poles, guys, etc., including incidental structures connected therewith, that are encountered in THE WORK in order that such items may be properly shored, supported and protected, or the CONTRACTOR may relocate them if he/she so desires. He/She shall give all proper notices, shall comply with requirements of such parties in the performance of THE WORK, shall permit entrance of such parties on THE PROJECT in order that they may perform their necessary work, and shall pay all charges and fees made by such parties for this work.
- (C) The CONTRACTOR shall be responsible for procuring any permits or rights-of-way for the use of property beyond the limits of the project.
- (D) Licenses needed to execute THE WORK properly shall be secured and paid for by the CONTRACTOR. The CONTRACTOR is responsible for compliance with local laws.
- (E) The cost of all sales and other applicable taxes for which the CONTRACTOR is liable under the CONTRACT shall be included in the PRICE bid.

6.12 LAWS AND REGULATIONS

- (A) The CONTRACTOR is responsible for insuring THE WORK is being performed in compliance with applicable codes and safety standards.
- (B) It is not the responsibility of the CONTRACTOR to make certain that the CONTRACT DOCUMENTS are in accordance with applicable laws, statutes, codes and regulations. If the CONTRACTOR observes that any of the CONTRACT DOCUMENTS are not in conformity therewith in any respect, he/she shall promptly notify the OWNER.
- (C) If the CONTRACTOR knowingly performs work contrary to such laws, ordinances, rules and regulations, or without notice to the OWNER, he/she shall assume full responsibility thereof and shall bear all costs attributable thereto.

- (D) Reference to standard specifications, national codes, local or state codes or laws and ordinances shall be held to mean the latest standard, code, specification, tentative specification, law or ordinance or revision thereof adopted and published at the time bids are taken.

6.13 REQUIRED PROJECT RECORDS

The CONTRACTOR shall maintain and make readily available to the OWNER certain project records which shall include: bid estimates, payment records, payroll records, job meeting minutes, daily reports, logs and diaries.

6.14 SITE DOCUMENTS

- (A) The CONTRACTOR shall clearly display all permits so they may be easily reviewed by the OWNER and agencies having jurisdiction over THE PROJECT.
- (B) The CONTRACTOR shall maintain at the site for the OWNER a record copy of THE PROJECT drawings and modifications thereto, marked to record all changes made during construction; such drawings will show all dimensions necessary to determine locations of all items placed during the performance of THE WORK.

6.15 RIGHT OF AUDIT

CONTRACTOR'S records which shall include but not be limited to accounting records (hard copy, as well as computer readable data if it can be made available), written policies and procedures; subcontract files (including proposals of successful and unsuccessful bidders, bid recaps, etc.); original estimates; estimating work sheets; correspondence; change order files; (including documentation covering negotiated settlements); back charge logs and supporting documentation; general ledger entries detailing cash and trade discounts earned, insurance policies, rebates and dividends; and any other supporting evidence deemed necessary by the OWNER to substantiate charges related to this Contract (all foregoing hereinafter referred to as "records") shall be open to inspection and subject to audit and/or reproduction by OWNER'S agent or its authorized representative to the extent necessary to adequately permit evaluation and verification of (a) Contractor compliance with Contract Documents, (b) compliance with OWNER'S business ethics policies, and (c) compliance with provisions for pricing change orders, payments or claims submitted by the Contractor or any of their payees. Such audits may require inspection and copying from time to time at reasonable times and places, of any and all information, materials and data of every kind and character, including without limitation, records, books, papers, documents, subscriptions, recordings, agreements, purchase orders, leases, contracts, commitments, arrangements, notes, daily diaries, superintendent reports, drawings, receipts, vouchers, and memoranda, and any and all other agreements, sources of information and matters that may in the OWNER'S judgment, have bearing on or pertain to any matters, rights, duties or obligations under or covered by any Contract Document. Such

records subject to audit shall also include, but not be limited to, those records necessary to evaluate and verify direct and indirect costs, (including overhead allocations) as they may apply to costs associated with this Contract.

The OWNER or its designee shall be afforded access to all of the Contractor's records, and shall be allowed to interview any of the Contractor's employees, pursuant to the provisions of this article throughout the term of this Contract and for a period of three (3) years after final payment or longer if required by law.

Contractor shall require all subcontractors, insurance agents, and material suppliers (payees) to comply with the provisions of this article by insertion of the requirements hereof in a written Contract agreement between Contractor and payee. Such requirements will also apply to Subcontractors and Sub-Subcontractors, etc. Contractor will cooperate fully and will cause all Related Parties and all of Contractor's subcontractors (including those entering into lump sum subcontracts) to cooperate fully in furnishing or in making available to OWNER from time to time whenever requested in an expeditious manner any and all such information, materials and data.

OWNER'S agent or its authorized representative shall have access to the Contractor's facilities, shall have access to the Subcontractor's facilities, shall have access to all necessary records, and shall be provided adequate and appropriate work space, in order to conduct audits in compliance with this article.

If an audit inspection or examination in accordance with this article, discloses overcharges (of any nature) by the Contractor to the OWNER in excess of one percent (1%) of the total Contract billings, the actual cost of the OWNER'S audit shall be reimbursed to the OWNER by the Contractor. Any adjustments and/or payments which must be made as a result of any such audit or inspection of the Contractor's invoices and/or records shall be made within a reasonable amount of time (not to exceed 90 days) from presentation of OWNER'S findings to Contractor.

6.16 USE OF SITE

(A) The CONTRACTOR shall confine his/her operations at the site to areas permitted by law, ordinances, permits and the CONTRACT DOCUMENTS and shall not unnecessarily encumber any part of the site.

(B) The CONTRACTOR will be responsible for routing of automobiles and equipment so as not to interfere with the smooth performance of THE WORK

and will be responsible for providing all safety equipment as may be needed to adhere to laws, ordinances or permits.

(C) The CONTRACTOR at all times shall keep the premises and site free from accumulation of waste materials or rubbish caused by his/her operations. At the completion of THE WORK he/she shall remove all his/her waste materials or

rubbish from and about THE PROJECT as well as his/her tools, equipment and machinery. Surplus materials remain the OWNER'S property and should be neatly stockpiled at the site for pickup by the OWNER'S personnel. If the CONTRACTOR fails to clean up at the completion of THE WORK, the OWNER may do so and deduct the total cost from the CONTRACT.

- (D) If necessary, the CONTRACTOR shall furnish toilet conveniences, secluded from public observation, for use by all personnel on THE WORK, whether or not in his/her employ. They shall be kept in a clean and sanitary condition and shall comply with the requirements of the Public Authorities having jurisdiction. He/she shall neither create nor allow a public nuisance. Temporary sanitary facilities shall be removed upon completion of THE WORK and the premises shall be left clean. Workers shall not use permanent washroom facilities in existing facilities or new work.

6.17 DIMENSIONS, ELEVATIONS, BASELINES, AND SURVEYS

CONTRACTOR shall verify all Dimensions, Elevations, Baselines and Surveys in accordance with subparagraphs 6.17 (A), (B), (C), (D) and (E) below as well as paragraph 4.02.

- (A) Dimensions and elevations indicated on individual project drawings in reference to existing structures, location of utilities, sewer inverts, or other information on existing facilities, are the best available data obtainable but are not guaranteed by the OWNER. The OWNER will not be responsible for their accuracy.
- (B) The base lines for locating the principal components of THE WORK and a suitable number of bench marks adjacent to THE WORK are shown on the CONTRACT DRAWINGS. Base lines shall be defined as the line to which the location of THE WORK is referenced, i.e. edge of pavement, road centerline, property line, right-of-way or survey line. The CONTRACTOR shall be responsible for performing all survey work required for the construction, including the establishment of base lines and any detail surveys needed for construction. This work shall include the staking out of the permanent and temporary easements to insure that the CONTRACTOR is not deviating from the designated easements.
- (C) The level of detail of survey required shall be that which the correct location of THE WORK can be established for construction and verified by the OWNER. Where the location of components of THE WORK and fittings are not dimensioned, the establishment of the location of these components shall be based upon scaling these locations of the Contract Drawings with relation to readily identifiable land marks, e.g. survey reference points, power poles, manholes, etc.
- (D) The OWNER has prepared a document which compiles the available data and

easement plats for establishing horizontal and vertical control. This document will be provided to the CONTRACTOR.

- (E) Before proceeding with any work dependent upon the data involved, in accordance with paragraph 4.4 the CONTRACTOR shall field check and verify all dimensions, grades, inverts, lines, elevations or other conditions of limitations at the site of THE WORK to avoid construction errors or damage to existing facilities. If any work is performed by the CONTRACTOR, or any subcontractors, prior to adequate verification of applicable data, any resultant extra cost for adjustment of work necessary to conform to existing conditions, or damage to existing facilities, shall be assumed by the CONTRACTOR without reimbursement or compensation by the OWNER.
- (F) If necessary, the CONTRACTOR shall furnish necessary toilet conveniences, secluded from public observation, for use of all personnel on THE WORK, whether or not in his/her employ. They shall be kept in a clean and sanitary condition and shall comply with the requirements and regulations of the Public Authorities having jurisdiction. He/she shall neither create nor allow a public nuisance. Temporary sanitary facilities shall be removed upon completion of THE WORK and the premises shall be left clean. Workers shall not use permanent washroom facilities in existing facilities or new work.

6.18 ROYALTIES AND PATENTS

The CONTRACTOR shall pay all royalties and license fees. He / She shall defend all suits or claims for infringement of any patent rights and shall hold the OWNER harmless from loss or account thereof, except if the OWNER will be responsible for all such loss when a particular decision, process or the product of a particular manufacturer is specified in the CONTRACT DOCUMENTS. However, if the CONTRACTOR has reason to believe that the design, process, or product specified is an infringement of a patent, he/she shall be responsible for such loss unless he/she promptly informs the OWNER in writing of the infringement.

6.19 INDEMNIFICATION

- (A) To the fullest extent permitted by law, the CONTRACTOR shall indemnify and hold harmless, the OWNER, its agents and its employees from and against all claims, damages, losses and expenses, including but not limited to attorney's fees, arising out of or resulting from the performance of the work, provided that any such claim, damage, loss or expense 1) 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 there from, and 2) is caused in whole or part by any negligent act or omission of the CONTRACTOR, any subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, regardless whether or not it is caused in part by a party indemnified hereunder. Such

obligation shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this section.

- (B) In any and all claims against the OWNER or any of their agents or employees by any employee of the CONTRACTOR, any subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation under this section shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the CONTRACTOR or any subcontractor under workmen's compensation acts, disability benefit acts, or other employee benefit acts.
- (C) The obligation of the CONTRACTOR under this Section shall not extend to the liability of the OWNER, its agents or employees, arising out of 1) the preparation or approval of maps, drawings, opinions, reports, surveys, change orders, designs or specifications, or 2) the giving of or the failure to give directions or instructions by the OWNER, its agents or employees provided such giving or failure to give directions or instructions is the primary cause of the injury or damage.

6.20 SAFETY PRECAUTIONS AND PROGRAMS

- (A) The CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with THE WORK.
- (B) The CONTRACTOR shall take all reasonable precautions for the safety of, and shall provide all reasonable protection to prevent damage, injury or loss to:
 - (1) All employees on THE PROJECT and all other persons who may be affected thereby;
 - (2) Any part of the completed project and all materials and equipment to be incorporated therein, whether in storage on or off the site, under the care, custody or control of the CONTRACTOR or any of his/her Subcontractors;
 - (3) Other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.
- (C) The CONTRACTOR shall comply with all applicable Laws and Regulations of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. The CONTRACTOR shall

notify OWNERS of adjacent property and of Underground Facilities and the utility OWNER'S when prosecution of THE WORK may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property. All damage, injury or loss to any property referred to above, caused directly or indirectly, in whole or in part, by the CONTRACTOR, any Subcontractor, supplier, or any other person or organization directly or indirectly employed by any of them to perform or furnish any of THE WORK, or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR. The CONTRACTOR'S duties and responsibilities for the safety and protection of THE WORK shall continue until such time as THE WORK is completed and is acceptable to OWNER. The CONTRACTOR shall designate a responsible representative at the site whose duty shall be the prevention of accidents. This person shall be the CONTRACTOR'S Superintendent, unless otherwise designated in writing by the CONTRACTOR to the OWNER.

- (D) The CONTRACTOR and/or his/her subcontractors shall obtain written permission from the OWNER prior to bringing hazardous substances onto the OWNER'S property or project site. A "Hazardous Substance" as defined by the Occupational Safety and Health Administration (OSHA), is any substance which, by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful, is likely to cause death, injury, or illness. When a hazardous substance is required in the execution of the WORK, the CONTRACTOR shall submit a copy of the Material Safety Data Sheet (MSDS) to the OWNER and comply with its guidelines and any other special handling instructions that the OWNER may require. Likewise, the OWNER will make available MSDS's for hazardous materials present, when work will be performed on the OWNER'S property.

All CONTRACTOR personnel shall read the MSDS sheet for each product to be utilized by the CONTRACTOR as well as those made available by the OWNER. The CONTRACTOR shall certify in writing that all His / Her personnel has read both the OWNER AND CONTRACTOR'S MSDS and that he/she has warned and/or trained all of his/her personnel about any known hazards and how to correctly handle the products and properly protect themselves. The CONTRACTOR is responsible that all his/her employees have and utilize all required protective gear, equipment and training, including but not limited to: clothing, glasses, masks, and hats, as well as tools, materials, supplies, and equipment necessary to be within compliance of all Laws, Acts, Ordinances, Rules and Regulations, Codes and Standards.

6.21 EMERGENCIES

In any emergency affecting safety or persons or property, the CONTRACTOR shall act, at his/her discretion, to prevent threatened damage, injury or loss. Any additional compensation claimed by the CONTRACTOR on account of emergency work shall be determined as provided in Paragraph 9, changes in the CONTRACT.

6.22 SUBCONTRACTOR

- (A) A Subcontractor is a person or entity who has a direct contract with the CONTRACTOR to perform any of THE WORK.
- (B) The CONTRACTOR shall not award any work to any subcontractor without prior written approval of the OWNER.
- (C) The CONTRACTOR shall not contract with any such proposed person or entity to whom the OWNER has made reasonable objection to. The CONTRACTOR shall not be required to contract with anyone to whom he has a reasonable objection.
- (D) If the OWNER has reasonable objection to any such proposed person or entity, the CONTRACTOR shall submit a substitute for approval by the OWNER.
- (E) The CONTRACTOR shall make no substitution for any subcontractor previously selected without first gaining the approval of the OWNER for the substitution.
- (F) By an appropriate agreement, written where legally required for validity, the CONTRACTOR shall require each Subcontractor, to the extent of the work to be performed by the Subcontractor, to be bound to the CONTRACTOR by the terms of the CONTRACT DOCUMENTS, and to assume toward the CONTRACTOR all the obligations and responsibilities which the CONTRACTOR, by these Documents, assumes toward the OWNER. Said agreement shall preserve and protect the rights of the OWNER under the CONTRACT DOCUMENTS with respect to the work to be performed by the Subcontractor so that the subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the Contractor-Subcontractor agreement, the benefit of all rights, remedies and redress against the CONTRACTOR that the CONTRACTOR, by these Documents, has against the OWNER. The OWNER will be furnished a copy of any and all agreements between the CONTRACTOR and its subcontractors. Where appropriate, the CONTRACTOR shall require each Subcontractor to enter into similar agreements with his Sub-Contractors. The CONTRACTOR shall make available to each proposed Subcontractor, prior to the execution of the Subcontract, copies of the CONTRACT DOCUMENTS to which the Subcontractor will be bound by this paragraph, and identify to the Subcontractor any terms and conditions of the proposed Subcontract which may be at variance with the

CONTRACT DOCUMENTS. Each Subcontractor shall similarly make copies of such Documents available to his Sub-Contractors.

6.23 CONTINUING THE WORK

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, unless the CONTRACTOR and OWNER agree in writing.

6.24 NO PASS-THROUGH CLAIMS

CONTRACTOR shall defend and deal with all claims by his / her subcontractors in the first instance.

6.25 FINANCIAL ABILITY

The Contractor is expected to have the financial ability to perform his / her contract; lack of sufficient working capital does not constitute an excusable cause for delay.

6.26 ADJUSTING PROGRESS SCHEDULE

Within 14 days after receipt of written request from the OWNER, the CONTRACTOR shall submit to OWNER for written approval adjustments in the progress schedule (as per paragraph 6.06B) to effect the impact thereon of new developments; these will conform generally to the progress schedule then in effect and additionally will comply with any provisions of the General Requirements applicable thereto. Upon written approval of the OWNER, the CONTRACTOR shall make such modifications to his/her prosecution of THE WORK as required by the adjustments to the progress schedule. Nothing in this paragraph shall be construed as limiting, restricting, or abridging the CONTRACTOR'S sole responsibility for the timely completion of THE WORK.

7.00 PAYMENTS TO CONTRACTOR AND COMPLETION:

7.01 SCHEDULE OF VALUES

The schedule of values established by the CONTRACTOR and the OWNER will serve as the basis for progress payments and will be incorporated into a form of Application for Payment only when acceptable and approved in writing by the OWNER. Progress payments on account of Unit Price Work will be based on the number of units completed in full conformance and compliance with the CONTRACT DOCUMENTS as determined by the OWNER.

7.02 REQUESTS FOR PROGRESS PAYMENT

At least twenty (20) days before each progress payment is scheduled (but not more often than once a month), the CONTRACTOR shall submit to the OWNER for review a Request for Payment filled out and signed by the CONTRACTOR covering THE WORK completed as of the date of the Request and accompanied by such supporting documentation as is required by the Contract Documents. Form PR-1, Pay Request Form, as provided in these documents must be used when requesting payment or said request will be denied. 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 Request for Payment shall also be accompanied by a bill of sale, invoice or other documentation warranting that the OWNER has received the materials and equipment free and clear of all liens, charges, security interests and encumbrances (which are hereinafter in these General Conditions referred to as "Liens") and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect the OWNER'S interest therein, all of which will be satisfactory to the OWNER. The amount retained with respect to progress payments will be as stipulated in the agreement.

7.03 CONTRACTOR'S WARRANTY OF TITLE

The 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 the OWNER no later than the time of payment free and clear of all Liens.

7.04 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

(A) The OWNER will, within THIRTY days after receipt of each Application for Payment, either make payment to CONTRACTOR or return the Application to the CONTRACTOR indicating in writing the OWNER'S reasons for refusing to recommend payment. In the latter case, the CONTRACTOR may make the necessary corrections and resubmit the Application. Twenty days after presentation of the Application for Payment, with the OWNER'S approval, the amount approved (subject to the provisions of subparagraph (B) below) become due and when due will be paid by the OWNER to the CONTRACTOR.

(C) The OWNER may refuse to make the whole or any part of any payment because of subsequently discovered evidence or the results of subsequent inspections or tests that nullify any such payment previously recommended to

such extent as may be necessary in the OWNER'S opinion to protect the OWNER from loss because:

(1) THE WORK is defective, or completed WORK has been damaged requiring correction or replacement,

- (2) The CONTRACT PRICE has been reduced by Written Amendment or Change Order,
 - (3) The OWNER has been required to correct defective WORK or complete WORK in accordance with paragraph 12.02, or
 - (4) Of the OWNER'S actual knowledge of the occurrence of any of the events enumerated in paragraph 10.02.
- (C) The OWNER may refuse to make payment of the full amount because claims have been made against the OWNER on account of the CONTRACTOR's performance or furnishing of THE WORK or Liens have been filed in connection with THE WORK or there are other items entitling the OWNER to a set-off against the amount recommended, but the OWNER must give the CONTRACTOR immediate written notice stating the reasons for such action.

7.05 SUBSTANTIAL COMPLETION

- (A) When the CONTRACTOR considers the entire WORK ready for its intended use, the CONTRACTOR shall notify the OWNER in writing that the entire WORK is substantially complete (except for items specifically listed by the CONTRACTOR as incomplete). Within a reasonable time thereafter, the OWNER and the CONTRACTOR shall make an inspection of THE WORK to determine the status of completion. If the OWNER does not consider THE WORK substantially complete, the OWNER will notify the CONTRACTOR in writing giving the reasons therefor. If the OWNER considers THE WORK substantially complete, the OWNER will notify CONTRACTOR of OWNER'S acceptance of THE WORK (except for items specifically listed by CONTRACTOR as incomplete).
- (B) The OWNER shall have the right to exclude the CONTRACTOR from THE WORK after the date of Substantial Completion, but the OWNER shall allow the CONTRACTOR reasonable access to complete or correct items on the tentative list.

7.06 PARTIAL UTILIZATION

- (A) Use by the OWNER of any finished part of THE WORK which has specifically been identified in the Contract Documents, or which the OWNER and the CONTRACTOR agree constitutes a separately functioning and usable part of THE WORK that can be used by the OWNER without significant interference with the CONTRACTOR's performance of the remainder of THE WORK, may be accomplished prior to Substantial Completion of all THE WORK subject to the following:

- (1) The OWNER at any time may request the CONTRACTOR in writing to permit the OWNER to use any such part of THE WORK which the OWNER believes to be ready for its intended use and substantially complete. If the CONTRACTOR agrees, the CONTRACTOR will certify to the OWNER that said part of THE WORK is substantially complete. The CONTRACTOR at any time may notify the OWNER in writing that the CONTRACTOR considers any such part of THE WORK ready for its intended use and substantially complete and request the OWNER to accept that part of THE WORK as being substantially complete. Within a reasonable time after either such request, the OWNER and the CONTRACTOR shall make an inspection of that part of THE WORK to determine its status of completion. If the OWNER does not consider that part of THE WORK to be substantially complete, the OWNER will notify the CONTRACTOR in writing giving the reasons therefor. If the OWNER considers that part of THE WORK to be substantially complete, the provisions of paragraphs 7.5 (A) and (B) above will apply with respect to of substantial completion of that part of THE WORK and the division of responsibility in respect thereof and access thereto.
- (2) The OWNER may at any time request the CONTRACTOR in writing to permit the OWNER to take over operation of any such part of THE WORK although it is not substantially complete. Within a reasonable time thereafter the OWNER and the CONTRACTOR shall make an inspection of that part of THE WORK to determine its status of completion and will prepare a list of the items remaining to be completed or corrected thereon before final payment. If the CONTRACTOR does not object in writing to the OWNER that such part of THE WORK is not ready for separate operation by the OWNER, the OWNER will finalize the list of items to be completed or corrected and will deliver such list to the CONTRACTOR together with a written division of responsibilities pending final payment between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, utilities, insurance, warranties and guarantees for that part of THE WORK which will become binding upon the OWNER and the CONTRACTOR at the time when the OWNER takes over such operation. During such operation and prior to Substantial Completion of such part of THE WORK, the OWNER shall allow the CONTRACTOR reasonable access to complete or correct items on said list and to complete other related WORK.
- (3) No occupancy or separate operation of part of THE WORK will be accomplished prior to compliance with the requirements of paragraph 8 in respect of property insurance.

7.07 FINAL INSPECTION

Upon written notice from the CONTRACTOR that the entire WORK or an agreed portion thereof is complete, the OWNER will make a final inspection with the CONTRACTOR and will notify the CONTRACTOR in writing of all particulars in which this inspection reveals that THE WORK is incomplete or defective. The CONTRACTOR shall immediately take such measures as are necessary to remedy such deficiencies.

7.08 FINAL APPLICATION FOR PAYMENT

After the CONTRACTOR has completed all such corrections to the satisfaction of the OWNER and delivered all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, marked-up record documents and other documents - all as required by the Contract Documents, and after the OWNER has indicated that THE WORK is acceptable (subject to the provisions of subparagraph 7.09 below), the CONTRACTOR may make application for final payment following the procedure for progress payments. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents, together with complete and legally effective releases or waivers (satisfactory to the OWNER) of all Liens arising out of or filed in connection with THE WORK. In lieu thereof and as approved by the OWNER, the CONTRACTOR may furnish receipts or releases in full; an affidavit of the CONTRACTOR that the releases and receipts include all labor, services, material and equipment for which a Lien could be filed, and that all payrolls, material and equipment bills, and other indebtedness connected with THE WORK for which the OWNER or the OWNER'S property might in any way be responsible, have been paid or otherwise satisfied; and consent of the surety, if any, to final payment. If any Subcontractor or Supplier fails to furnish a Release or receipt in full, the CONTRACTOR may furnish a Bond or other collateral satisfactory to the OWNER to indemnify the OWNER against any Lien.

7.09 FINAL PAYMENT AND ACCEPTANCE

- (A) If, on the basis of the OWNER'S observation of THE WORK during construction and final inspection, and the OWNER'S review of the final Application for Payment and accompanying documentation - all as required by the Contract Documents - the OWNER is satisfied that THE WORK has been completed and the CONTRACTOR's other obligations under the Contract Documents have been fulfilled, final payment will be made, subject to the provisions of subparagraph 7.11 below. Otherwise, the OWNER will return the Application to the CONTRACTOR, indicating in writing the reasons for refusing to make final payment, in which case the CONTRACTOR shall make the necessary corrections and resubmit the Application. Thirty days after presentation to the OWNER of the Application and accompanying documentation, in appropriate form and substance, the final payment will become due and will be paid by the OWNER to the CONTRACTOR.

- (D) If, through no fault of the CONTRACTOR, final completion of THE WORK is significantly delayed and if the OWNER so confirms, the OWNER shall, upon receipt of the CONTRACTOR's final Application for Payment and without terminating the Agreement, make payment of the balance due for that portion of THE WORK fully completed and accepted. If the remaining balance to be held by the OWNER for WORK not fully completed or corrected is less than the retainment stipulated in the Agreement, and if Bonds have been furnished as required in paragraph 8, 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 the CONTRACTOR to the OWNER 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.

7.10 CONTRACTOR'S CONTINUING OBLIGATION

The CONTRACTOR's obligation to perform and complete THE WORK in accordance with the Contract Documents shall be absolute. Neither any progress or final payment by the OWNER to the CONTRACTOR under the Contract Documents, nor any use or occupancy of THE WORK or any part thereof by the OWNER, nor any act of acceptance by the OWNER nor any failure to do so, nor any review and approval of a Shop Drawing or sample submission, nor the issuance of a notice of acceptability by the OWNER pursuant to sub-paragraph 7.9 (A) above, nor any correction of defective WORK by the OWNER will constitute an acceptance of WORK not in accordance with the Contract Documents or a release of the CONTRACTOR's obligation to perform THE WORK in accordance with the Contract Documents.

7.11 WAIVER OF CLAIMS

The making and acceptance of final payment will constitute:

- (A) A waiver of all claims by the OWNER against the CONTRACTOR, except claims arising from unsettled Liens, from defective WORK appearing after final inspection pursuant to sub-paragraph 7.07 above or from failure to comply with the Contract Documents or the terms of any special guarantee specified therein; however, it will not constitute a waiver by the OWNER of any right in respect of the CONTRACTOR's continuing obligations under the Contract Documents; and
- (B) A waiver of all claims by the CONTRACTOR against the OWNER other than those previously made in writing and still unsettled.

8.00 BONDS AND INSURANCE:

8.01 BONDS

Performance and Payment Bonds: Concurrent with the execution of the Agreement and within 14 calendar days of the Notice of Award, the successful CONTRACTOR

shall procure, execute and deliver to the OWNER and maintain, at his/her own cost and expense, the following bonds, in the forms attached, of a surety company authorized and approved by the State of South Carolina as a Surety:

- (A) Performance Bond - in an amount not less than 100% of the total amount payable to the CONTRACTOR by the terms of the CONTRACT as security for the faithful performance of THE WORK. Bond must be valid until one year after the date of issuance of the Certificate of Substantial Completion.
- (B) Payment Bond - in an amount not less than 100% of the total amount payable to the CONTRACTOR by the terms of the CONTRACT as security for the payment of all persons performing labor and furnishing material in connection with THE WORK. Bond must be valid until one year after date of issuance of the Certificate of Substantial Completion.

All Bonds signed by an agent must be accompanied by a certified copy of the authority to act.

If the Surety on any Bond furnished by the CONTRACTOR is declared bankrupt or becomes insolvent or its right to do business in the State of South Carolina is revoked, the CONTRACTOR shall within five (5) days thereafter substitute another Bond or Surety, both of which shall be acceptable to the OWNER.

8.02 INSURANCE

- (A) The CONTRACT shall not be executed until the CONTRACTOR has obtained all the insurance required under this paragraph and such insurance has been approved by the OWNER, nor shall the CONTRACTOR allow any subcontractor to commence work on his subcontract until the insurance required of the subcontractor has been so obtained. The CONTRACTOR shall not commence work under this CONTRACT until the OWNER has been furnished with copies of the proposed insurance policies and has approved the same.
- (B) The CONTRACTOR shall purchase and maintain such insurance as will protect him/her from claims set forth below which may arise out of or result from the CONTRACTOR'S operations under the CONTRACT, whether such operations be by himself/herself or by any Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:
 - (1) Claims under workers' or workmen's compensation disability benefit and other similar employee benefit acts;
 - (2) Claims for damages because of bodily injury, occupational sickness or disease, or death of his/her employees;

- (3) Claims for damages because of bodily injury, sickness or disease, or death of any person other than his/her employees;
 - (4) Claims for damages insured by usual personal injury liability coverage which are sustained 1) by any person as a result of an offense directly or indirectly related to the employment of such person by the CONTRACTOR, or 2) by any other person;
 - (5) Claims for damages, other than to THE WORK itself, because of injury to or destruction of tangible property, including loss of use there from; 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;
 - (7) Claims for damages or theft of any materials supplied by the OWNER.
- (C) The insurance required by this Section shall be written for not less than the following or greater if required by law:

(1) Worker's Compensation:

The CONTRACTOR shall procure and maintain, during the life of the CONTRACT, Workers Compensation Insurance under the provisions of the South Carolina Workers Compensation Act. Alternative insurance or rejection of the S.C. Workers Compensation Act is **not** allowed. The amounts shall be as follows:

Employers' Liability:

Each Accident	\$ 500,000.00
Disease - Policy Limit	\$ 500,000.00
Disease - Each Employee	\$ 500,000.00

- (2) Commercial General Liability ("Occurrence Form CG 00 01, Edition 11/88 or 10/93): The CONTRACTOR shall procure and shall maintain during the life of the CONTRACT, such Commercial General Liability insurance as shall protect him/her and any subcontractor performing work covered by this CONTRACT from claims for damages for Bodily injury, including accidental death, as well as from claims for property damages, which may arise from operations under the CONTRACT, whether such operations are by himself/herself or by any subcontractor or by anyone directly or indirectly employed by either of them. Any exclusionary endorsements must be shown on the Certificate of Insurance and must be approved by the OWNER prior to executing the CONTRACT. The amount of insurance shall not be less than the following:

- (a) General Aggregate per Project: \$ 2,000,000.00
- (b) Products/Complete Operations Aggregate: \$ 2,000,000.00
- (c) Personal & Advertising Injury: \$ 1,000,000.00
- (d) Each Occurrence: \$ 1,000,000.00
- (e) Fire Damage: \$ 50,000.00
- (f) Medical Expense: \$ 5,000.00

(3) Automobile Liability (Symbol 1 "Any Auto", Form CA 00 01, Edition 06/92 or 12/93):

Combined Single Limit: \$ 1,000,000.00

(4) Umbrella Liability (Excess of Commercial General Liability, Automobile Liability and Employers' Liability):

- (a) Each Occurrence: \$ 1,000,000.00
- (b) Aggregate: \$ 1,000,000.00

- (D) The insurance required hereof, shall provide adequate protection for the CONTRACTOR and his/her subcontractors, respectively, as well as the OWNER, against damage claims which may arise from operations under this CONTRACT, whether such operations be by the insured or by anyone directly or indirectly employed by him/her and, also, against any special hazards which may be encountered in the performance of this CONTRACT.
- (E) The CONTRACTOR shall maintain "All-Risk", or equivalent form, of installation coverage including Wind, Theft, and Earthquake, Vandalism and Malicious Mischief Insurance on insurable items of construction, while in the course of construction, including foundations, attachments and all permanent fixtures belonging to and constituting a part of said structures. The policy or policies shall also cover material, machinery and equipment installed or stored at the site if the cost of these items is included in the CONTRACT. The amount of insurance must, at all times, be at least equal to the actual cash value of the insured property. The policy shall be in the name of the OWNER and the CONTRACTOR, as their interests may appear.
- (F) The CONTRACTOR shall furnish to the OWNER the certificates of insurance in effect and copies of the insurance policies evidenced by the certificates of

insurance by companies acceptable to the OWNER covering the above specified items and including an endorsement incorporating the Hold Harmless Agreement assumed by the CONTRACTOR. The certificates shall contain a provision that the policies certified will not be canceled without thirty days written notice to the OWNER. The OWNER shall be named Additional Insured on the General Liability (Form CG 20 10, edition 10/93) and the Insurance Company shall have an A.M. Best Company Rating of A- or Better and shall be Licensed in South Carolina. The CONTRACTOR shall be solely responsible for securing certificates of insurance coverage as heretofore specified from all subcontractors engaged in THE WORK, and will provide the OWNER with copies of the same prior to said subcontractors commencing work.

- (G) The CONTRACTOR shall be held responsible for all injuries to his/her employees or other persons, and all damages to OWNER or any others caused by or resulting from the negligence, alleged negligence, or act or omission of himself/herself, his/her employees or agents, subcontractors or their employees or agents, or any one directly or indirectly employed by the CONTRACTOR, during the progress of, or connected with the prosecution of the work, whether within the limits of the work, or elsewhere, as arising out of any act or omission incident to the inspection or supervision by the OWNER or their representatives, of the work included in this CONTRACT.
- (H) The CONTRACTOR shall indemnify and hold harmless the OWNER, and OWNER'S representatives or agents of and from all suits, losses, damages, cost, expense, judgments or decrees whatever arising out of such action or suit that may be brought as aforesaid, including all of the OWNER'S costs, expenses and attorney's fees incurred in the defense of said claim.
- (I) The CONTRACTOR must restore all injured property of any kind to a condition as good as that found when he entered upon THE WORK. He/she shall assume all risk and bear any loss or injury to property or persons occasioned by neglect or accident during the progress of work, until the same shall have been completed and accepted. He/she shall also assume all blame or loss by reason of neglect or violation of any local, State or Federal law, rule, regulation or order. The CONTRACTOR shall give to the proper authorities all required notices relating to THE WORK, obtain all official permits and licenses and pay all proper fees. He/she shall make good any injury that may have occurred to any adjoining building, structure or utility in consequence of this work.
- (J) The CONTRACTOR shall provide adequate protection against injury or loss arising in connection with this CONTRACT for all his/her work and the property of the OWNER. He/she shall make good any such damage, injury or loss, except such as may be due directly to errors in the drawings or specifications or caused by agents or employees of the OWNER. He/she shall adequately protect adjacent property as provided by law and by the specifications and drawings. He/she shall provide passageways, guard fences, lights, watchmen and other

facilities for protection as required by public authority and local conditions.

- (K) In an emergency affecting the safety of life or of the work, the CONTRACTOR without special instruction or authorization from the OWNER is hereby permitted to act, at his/her discretion to prevent such threatened loss or injury and he/she shall act without appeal, if so instructed or authorized. Any compensation claimed by the CONTRACTOR on account of emergency work shall be determined in accordance with the terms of the CONTRACT DOCUMENTS.

9.00 CHANGES IN THE CONTRACT:

9.01 CHANGES IN THE WORK

- (A) Without invalidating the Agreement and without notice to any surety, the OWNER may, at any time or from time to time, order additions, deletions or revisions in THE WORK; these will be authorized by a Written Amendment, a Change Order, or a Work Directive Change. Upon receipt of any such document, the 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 the OWNER and the CONTRACTOR are unable to agree as to the extent, if any, of an increase or decrease in the CONTRACT PRICE or an extension or shortening of the CONTRACT TIME that should be allowed as a result of a Work Directive Change, a claim may be made therefore as provided herein. The CONTRACTOR will proceed with the work pending contract price and time adjustment.
- (C) The CONTRACTOR shall not be entitled to an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME with respect to any WORK performed that is not required by the Contract Documents as amended, modified and supplemented as provided in paragraph 2, except in the case of an emergency as provided in paragraph 6 and except in the case of uncovering WORK as provided in paragraph 12.
- (D) The OWNER and the CONTRACTOR shall execute appropriate Change Orders (or Written Amendments) covering:
 - (1) Changes in THE WORK which are ordered by the OWNER and are required because of acceptance of defective WORK and/or correcting defective WORK, or are agreed to by the parties;
 - (2) Changes in the CONTRACT PRICE or CONTRACT TIME which are agreed to by the parties; and/or
 - (3) Changes in the CONTRACT PRICE or CONTRACT TIME which embody the substance of any written decision rendered by the OWNER; 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, the CONTRACTOR shall carry on THE WORK and adhere to the progress schedule.

- (E) If notice 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 TIME) is required by the provisions of any Bond to be given to a surety, the giving of any such notice will be the CONTRACTOR's responsibility, and the amount of each applicable Bond will be adjusted accordingly.

9.02 CHANGE OF CONTRACT PRICE

- (A) The CONTRACT PRICE constitutes the total compensation (subject to authorized adjustments) payable to the CONTRACTOR for performing THE WORK. All duties, responsibilities and obligations assigned to or undertaken by the CONTRACTOR shall be at his/her expense without change in the CONTRACT PRICE.
- (B) The CONTRACT PRICE may only be changed by a Change Order or by a Written Amendment. Any claim for an increase or decrease in the CONTRACT PRICE shall be based on written notice delivered by the party making the claim to the other party promptly (but in no event later than fourteen (14) calendar days after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered within thirty days after such occurrence (unless within said thirty days, the CONTRACTOR submits a written request for a longer period of time in which to prepare the amount of the claim with supporting data and the OWNER allows in writing such additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by claimant's written statement that the amount claimed covers all known amounts (direct, indirect and consequential) to which the claimant is entitled as a result of the occurrence of said event. No claim for an adjustment in the CONTRACT PRICE will be valid if not submitted in accordance with this paragraph. All claims and/or requests for Change Order from the CONTRACTOR shall be subject to Audit by the OWNER, pursuant to the provisions of paragraph 6.13.
- (C) The value of any WORK covered by a Change Order or of any claim for an increase or decrease in the CONTRACT PRICE shall be determined in one of the following ways:
 - (1) Where THE WORK involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved.

- (2) By mutual acceptance of a lump sum.
- (3) On the basis of the Cost of THE WORK (determined as provided in sub-paragraph 9.03A below) plus a CONTRACTOR's Fee for overhead and profit (determined as provided in paragraphs 9.04 below).

9.03 COST OF THE WORK

- (A) The term Cost of THE WORK means the sum of all costs* necessarily incurred and paid by the CONTRACTOR in the proper performance of THE WORK. Except as may otherwise be agreed to in writing by the OWNER, such costs* shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in sub-paragraph (G) below:

*Cost of all equipment shall be in conformity with the latest edition of the rental rate blue book as published by Dataquest Inc., of San Jose, California.

- (B) Payroll costs for employees in the direct employ of the CONTRACTOR in the performance of THE WORK under schedules of job classifications agreed upon by the OWNER and the CONTRACTOR. 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' or workmen's compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. Such employees shall include superintendents and foremen at the site. The expenses of performing WORK after regular working hours, on Saturday, Sunday or legal holidays shall be included in the above to the extent authorized by the OWNER.
- (C) Cost of all materials and equipment (mechanical and electrical such as pumps, electrical panels, etc.) 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 the CONTRACTOR unless the OWNER deposits funds with the CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to the OWNER. All trade discounts, rebates and refunds and all returns from sale of surplus material and equipment shall accrue to the OWNER, and the CONTRACTOR shall make provisions so that they may be obtained.
- (D) Payments made by the CONTRACTOR to the Subcontractors for WORK performed by Subcontractors. If required by the OWNER, the CONTRACTOR shall obtain competitive bids from Subcontractors acceptable to the

CONTRACTOR and shall deliver such bids to the OWNER who will then determine, with the advice of the ENGINEER, which bids will be accepted. If a 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 shall be determined in the same manner as the CONTRACTOR's Cost of THE WORK. All subcontracts shall be subject to the other provisions of the Contract Documents insofar as applicable.

- (E) 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.
- (F) Supplemental costs including the following:
 - (1) The proportion of necessary transportation, travel and subsistence expenses of the CONTRACTOR's employees incurred in discharge of duties connected with THE WORK.
 - (2) 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 the CONTRACTOR.
 - (3) Cost for rentals of all construction equipment and machinery and the parts thereof whether rented from the CONTRACTOR or others will be in accordance with the latest edition of the Rental Rate Blue Book, published by Dataquest, Inc. of San Jose, California. To determine the payment to the CONTRACTOR, the base monthly rate will be adjusted as per the Rate Adjustment Tables and Regional Adjustment Factor for each equipment type. The adjustment factors are contained in the Blue Book. The Hourly Rate will be the monthly rate divided by 176; weekly and daily rates will not be used. After the above adjustments are made to the base rates, the Estimated Operating Cost shown in the Blue Book shall be added based on the number of hours the equipment was actually operated. The above shall be full compensation for all equipment costs except operator cost. Payment for operators will be in accordance with paragraph 9.03(B) above. Payment will be made for the actual time that authorized equipment is in operation (on the change order extra work). No percentage will be added to rental sum (other than CONTRACTOR's Fee as per paragraph 9.04 below), and no increase in rate will be allowed for overtime. The rental of any such equipment, machinery or parts shall cease when the use thereof is no longer necessary for THE WORK.
 - (4) Sales, consumer, use or similar taxes related to THE WORK, and for which the CONTRACTOR is liable, imposed by Laws and Regulations.

- (5) Deposits lost for causes other than negligence of the 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.
 - (6) Losses and damages (and related expenses), not compensated by insurance or otherwise, to THE WORK or otherwise sustained by the CONTRACTOR in connection with the performance and furnishing of THE WORK (except losses and damages within the deductible amounts of property insurance established by the OWNER in accordance with paragraph 8), provided they have resulted from causes other than the negligence of the 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 the OWNER. No such losses, damages and expenses shall be included in the Cost of THE WORK for the purpose of determining the CONTRACTOR's Fee. If, however, any such loss or damage requires reconstruction and the CONTRACTOR is placed in charge thereof, the CONTRACTOR shall be paid for services a fee proportionate to that stated in sub-paragraph 9.04 below.
 - (7) The cost of utilities, fuel and sanitary facilities at the site.
 - (8) Minor expenses such as telegrams, long distance telephone calls, telephone service at the site, expressage and similar petty cash items in connection with THE WORK.
 - (9) Cost of premiums for additional Bonds and insurance required because of changes in THE WORK and premiums for property insurance coverage within the limits of the deductible amounts established by the OWNER in accordance with paragraph 8.00.
- (G) The term Cost of THE WORK shall not include any of the following:
- (1) Payroll costs and other compensation of the CONTRACTOR's officers, executives, principals (of partnership and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks and other personnel employed by the CONTRACTOR whether at the site or in the CONTRACTOR's principal or a branch office for general administration of THE WORK and not specifically included in the agreed upon schedule of job classifications referred to in sub- paragraph 9.03 (F)(9) above - all of which are to be considered administrative costs covered by CONTRACTOR's Fee.

- (2) Expenses of the CONTRACTOR's principal and branch offices other than the CONTRACTOR's office at the site.
- (3) Any part of the CONTRACTOR's capital expenses, including interest on the CONTRACTOR's capital employed for THE WORK and charges against the CONTRACTOR for delinquent payments.
- (4) Cost of premiums for all Bonds and for all insurance whether or not the CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except for the cost of premiums covered by subparagraph 9.03 (F)(9) (above).
- (5) Costs due to the negligence of the 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 limited to, the correction of defective WORK, disposal of materials or equipment wrongly supplied and making good any damage to property.
- (6) Other over head or general expense costs of any kind and the costs of any item not specifically and expressly included in sub-paragraph 9.3 above.

9.04 CONTRACTOR'S FEE

- (A) The CONTRACTOR's Fee allowed to the CONTRACTOR for overhead and profit shall be determined as follows:
 - (1) A mutually acceptable fixed fee; or if none can be agreed upon,
 - (2) A fee based on the following percentages of the various portions of the Cost of THE WORK:
 - (a) For costs incurred under sub-paragraph 9.03 (B) and (C) above, the CONTRACTOR's Fee shall be fifteen percent;
 - (b) For costs incurred, under sub-paragraphs 9.03 (D),(E) and (F) above on a subcontract, is on the basis of Cost of THE WORK Plus a Fee, the maximum allowable for the CONTRACTOR on account of overhead and profit on all Subcontractors shall be five percent;
 - (c) No fee shall be payable on the basis of costs itemized under sub-paragraph 9.03 above;
 - (d) The amount of credit to be allowed by the CONTRACTOR to the OWNER for any such change which results in a net decrease in

cost will be the amount of the actual net decrease plus a deduction in the CONTRACTOR's Fee by an amount equal to ten percent of the net decrease; and

- (e) When both additions and credits are involved in any one change, the adjustment in the CONTRACTOR's Fee shall be computed on the basis of the net change in accordance with this paragraph.
- (B) Whenever the cost of any WORK is to be determined pursuant to sub-paragraph 9.03, the CONTRACTOR will submit in form acceptable to the OWNER an itemized cost breakdown together with supporting data. All claims and/or requests for Change Order from the CONTRACTOR shall be subject to Audit by the OWNER, pursuant to the provisions of paragraph 6.15

9.05 CASH ALLOWANCES

- (A) It is understood that the CONTRACTOR has included in the CONTRACT PRICE all allowances so named in the Contract Documents and shall cause THE WORK so covered to be done by such Subcontractors or Suppliers and for such sums within the limit of the allowances as may be acceptable to the OWNER. The CONTRACTOR agrees that:
 - (1) The allowances include the cost to the 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
 - (2) The CONTRACTOR's costs for unloading and handling on the site, labor, installation costs, overhead, profit and other expenses contemplated for the allowances have been included in the CONTRACT PRICE and not in the allowances. No demand for additional payment on account of any thereof will be valid.
- (B) Prior to final payment, an appropriate Change Order will be issued to reflect actual amounts due the CONTRACTOR on account of WORK covered by allowances, and the CONTRACT PRICE shall be correspondingly adjusted.

9.06 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 the sum of the established unit prices for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement. 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 the CONTRACTOR will be made by the OWNER.

- (B) Each unit price will be deemed to include an amount considered by the CONTRACTOR to be adequate to cover the CONTRACTOR's overhead and profit for each separately identified item.
- (C) Where the quantity of any item of Unit Price Work performed by the CONTRACTOR differs materially and significantly from the estimated quantity of such item indicated in the Agreement and there is no corresponding adjustment with respect to any other item of WORK and if the CONTRACTOR believes that the CONTRACTOR has incurred additional expense as a result thereof, the CONTRACTOR may make a claim for an increase in the CONTRACT PRICE if the parties are unable to agree as to the amount of any such increase.

9.07 NO DAMAGES FOR DELAY

The CONTRACTOR shall be entitled to an appropriate extension of time if the OWNER fails to enable the CONTRACTOR to perform THE CONTRACT within the specified contract time. No payment, compensation or adjustment for any indirect cost (corporate overhead and profit) shall be made to the CONTRACTOR for damages because of hindrances or delays from any clause in the progress of THE WORK, whether such hindrances or delays be avoidable or unavoidable, and the CONTRACTOR agrees that he will make no claim for compensation, damages, or mitigation of liquidated damages for any such delays, and will accept in full satisfaction for such delays said extension of time and payment for direct costs as hereinafter set forth. OWNER will only consider paying compensation to the CONTRACTOR for direct costs associated with unavoidable or unanticipated delays for stoppage of work cause by, but not limited to, directives of regulatory agencies having jurisdiction over THE WORK.

9.08 EQUITABLE ADJUSTMENTS - WAIVER AND RELEASE OF CLAIMS

- (A) Whenever the CONTRACTOR, after receipt of notification of a change to be made pursuant to this Article, or after affirmation of a constructive change there under, submits any claim for equitable adjustment under that clause, such claim shall include all types of adjustments in the total amounts which that clause entitles the CONTRACTOR, including but not limited to adjustments arising out of delays or disruptions or both caused by such change. Except as the parties may otherwise expressly agree, the CONTRACTOR shall be deemed (1) to have waived any adjustment to which it otherwise might be entitled under the aforesaid clause where such claim fails to request such adjustment, and (2) to have waived any request in the amount of equitable adjustments additional to those requested in its claim.
- (B) Further, the CONTRACTOR agrees that, if required by the OWNER, he will execute a release, in form and substance satisfactory to the OWNER, as part of

the Change Order setting forth the aforesaid equitable adjustment, and that such release shall discharge the OWNER, its officers, agents, and employees from any further claims, including but not limited to further claims arising out of delays or disruptions or both, caused by the aforesaid change.

10.00 SUSPENSION OF WORK AND TERMINATION:

10.01 SUSPENSION OF WORK

OWNER may, at any time and without cause, suspend THE WORK or any portion thereof for a period of not more than ninety days by notice in writing to CONTRACTOR which will fix the date on which WORK will be resumed. CONTRACTOR shall resume THE WORK on the date so fixed. CONTRACTOR shall be allowed an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, directly attributable to any suspension if CONTRACTOR makes an approved claim therefore, subject to the limitations set forth in the General Conditions of the CONTRACT.

10.02 TERMINATION FOR CAUSE

(A) The OWNER may terminate the Contract upon the occurrence of any one or more of the following events:

- (1) If CONTRACTOR commences a voluntary case under any chapter of the Bankruptcy Code (Title 11, United States Code), as now or hereafter in effect, or if CONTRACTOR takes any equivalent or similar action by filing a petition or otherwise under any other federal or state law in effect at such time relating to the bankruptcy or insolvency; or
- (2) If a petition is filed against CONTRACTOR under any chapter of the Bankruptcy Code as now or hereafter in effect at the time of filing, or if a petition is filed seeking any such equivalent or similar relief against CONTRACTOR under any other federal or state law in effect at the time relating to bankruptcy or insolvency; or
- (3) If CONTRACTOR makes a general assignment for the benefit of creditors; or
- (4) If a trustee, receiver, custodian or agent of CONTRACTOR is appointed under applicable law or under contract, whose appointment or authority to take charge of property of CONTRACTOR is for the purpose of enforcing a lien against such property or for the purpose of general administration of such property for the benefit of CONTRACTOR'S creditors; or
- (5) If CONTRACTOR admits in writing an inability to pay its debts generally as they become due; or

- (6) If CONTRACTOR persistently fails 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 the CONTRACT DOCUMENTS as revised from time to time); or
 - (7) If CONTRACTOR disregards Laws or Regulations of any public body having jurisdiction; or
 - (8) If CONTRACTOR disregards the authority of OWNER; or
 - (9) If CONTRACTOR otherwise violates in any substantial way any provisions of the CONTRACT DOCUMENTS;
- (B) When any of the above listed reasons exist, the OWNER may without prejudice to any other rights or remedies of the OWNER, after giving CONTRACTOR (and the Surety) seven days' written notice and to the extent permitted by Laws and Regulations, terminate the services of CONTRACTOR, 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), 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 finish THE WORK as OWNER may deem expedient. In such case CONTRACTOR shall not be entitled to receive any further payment until THE WORK is finished. If the unpaid balance of the CONTRACT PRICE exceeds the direct, indirect and consequential costs of completing THE WORK (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and costs such excess will be paid to CONTRACTOR. If such costs exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such costs incurred by OWNER will be incorporated in a Change Order, but when exercising any rights or remedies under this paragraph, OWNER shall not be required to obtain the lowest price for THE WORK performed.
- (C) 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.
- (D) If, after notice of termination of the CONTRACTOR'S right to proceed under the provisions of this clause, it is determined for any reason that the Contractor was not in default under the provisions of this clause, or that the delay was excusable

under the provisions of this clause, the rights and obligations of the parties shall be, the same as if the notice of termination had been issued pursuant to termination for convenience of the OWNER clause. In the foregoing circumstances, the Contract shall be equitable adjusted to compensate for such termination and the Contract modified according to the paragraph 10.03 Termination for Convenience of OWNER.

10.03 TERMINATION FOR CONVENIENCE OF OWNER

Upon seven days' written notice to CONTRACTOR, OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon THE WORK and terminate the Agreement. In such case, CONTRACTOR shall be paid for all WORK executed and any expenses sustained plus reasonable termination expenses, which will include, but not be limited to, indirect and consequential costs (including, but not limited to, fees and charges of engineers, architects, attorneys and other professionals).

10.04 CONTRACTOR MAY STOP WORK OR TERMINATE

If, through no act or fault of CONTRACTOR, THE WORK is suspended for a period of more than ninety days by OWNER or under an order of court or other public authority, or OWNER fails for thirty days to pay CONTRACTOR any sum finally determined to be due, then CONTRACTOR may, upon seven days' written notice to OWNER, terminate the CONTRACT and recover from OWNER payment for all WORK executed and any expenses sustained plus reasonable termination expenses. In addition and in lieu of terminating the CONTRACT, if OWNER has failed to make any payment as aforesaid, CONTRACTOR may upon seven days' written notice to OWNER stop THE WORK until payment of all amounts then due. The provisions of this paragraph shall not relieve CONTRACTOR of the obligations under paragraph 6.00 to carry on THE WORK in accordance with the progress schedule and without delay during disputes and disagreements with OWNER.

11.00 LIQUIDATED DAMAGES FOR FAILURE TO COMPLETE WORK ON TIME:

If the CONTRACTOR shall fail to complete THE WORK within the CONTRACT TIME, or extension of time granted by the OWNER in accordance with Paragraph 9.00, then the CONTRACTOR will pay to the OWNER the amount for liquidated damages as specified in the CONTRACT for each calendar day that the CONTRACTOR shall be in default after the time stipulated in the CONTRACT DOCUMENTS.

The CONTRACTOR shall not be charged with liquidated damages or any excess cost when delay in completion of THE WORK is due to the following and the CONTRACTOR has given written notice within fourteen (14) calendar days of such delay to the OWNER.

- (A) To any preference, priority or allocation order duly issued by the OWNER.
- (B) To unforeseeable causes beyond the control and without the fault or negligence of the

CONTRACTOR, including but not restricted to, acts of God, or of the public enemy, acts of the OWNER, acts of another Contractor in the performance of a Contract with the OWNER, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes; and abnormal and unforeseeable weather; and

- (C) To any delays of Subcontractors occasioned by any of the causes specified above.

12.00 WARRANTY, TESTING AND GUARANTEE:

12.01 UNCOVERING OF WORK

- (A) If any portion of THE WORK should be covered contrary to the OWNER'S request or requirements of the CONTRACT DOCUMENTS, it must, if required in writing by the OWNER, be uncovered for the OWNER'S inspector's observation and shall be reconstructed as necessary at the CONTRACTOR'S expense.
- (B) If any portion of THE WORK has been covered which the OWNER has not specifically requested to observe prior to being covered, the OWNER may request to see such WORK and it shall be uncovered by the CONTRACTOR. If such WORK is found in accordance with the CONTRACT DOCUMENTS, the cost of uncovering and replacement shall be paid by the OWNER by change order. If such WORK is found not to be in accordance with the CONTRACT DOCUMENTS, the CONTRACTOR shall pay such costs.
- (C) The CONTRACTOR shall promptly correct all WORK rejected by the OWNER as defective or failing to conform to the CONTRACT DOCUMENTS, whether observed before or after the completion of THE PROJECT, and whether or not installed, fabricated or completed. The CONTRACTOR shall bear all costs of correcting such rejected WORK.
- (D) If, within one year after the completion date of THE WORK or a longer period if required by law or a special warranty provision of the CONTRACT DOCUMENTS, any of this WORK is found to be defective or not in conformity with the CONTRACT DOCUMENTS, the CONTRACTOR shall correct it promptly after receipt of a written notice from the OWNER to do so, unless the OWNER has previously given the CONTRACTOR written acceptance of such condition. This obligation shall survive termination of the CONTRACT. The OWNER shall give such notice promptly after discovery of the condition.

12.02 OWNER MAY CORRECT DEFECTIVE WORK

If the CONTRACTOR fails, within a reasonable time after written notice of the OWNER, to proceed to correct defective WORK, or to remove and replace rejected WORK as required by the OWNER, or if the CONTRACTOR fails to perform THE WORK in accordance with the CONTRACT DOCUMENTS, or if the CONTRACTOR fails to

comply with any other provision of the CONTRACT DOCUMENTS, the OWNER may, after seven days' written notice to the CONTRACTOR, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph, the OWNER shall proceed expeditiously. To the extent necessary to complete corrective and remedial action, the OWNER may exclude the CONTRACTOR from all or part of the site, take possession of all or part of THE WORK, and suspend the CONTRACTOR'S services related thereto, take possession of the 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 the OWNER has paid the CONTRACTOR, but which are stored elsewhere. The CONTRACTOR shall allow the OWNER, the OWNER'S representatives, agents and employees such access to the site as may be necessary to enable the OWNER to exercise the rights and remedies under this paragraph. All direct, indirect and consequential costs of the OWNER, in exercising such rights and remedies will be charged against the CONTRACTOR, and a Change Order will be issued incorporating the necessary revisions in the CONTRACT DOCUMENTS with respect to THE WORK; and the OWNER shall be entitled to an appropriate decrease in the CONTRACT PRICE, and, if the parties are unable to agree as to the amount thereof, the OWNER may make a claim therefor as provided in paragraph 9 herein. Such direct, indirect, and consequential costs will include, but not be limited to, fees and charges of engineers, architects, attorneys, and other professionals, all court costs and all costs of repair and replacement of work of others destroyed or damaged by correction, removal or replacement of the CONTRACTOR'S defective WORK. The CONTRACTOR shall not be allowed an extension of the CONTRACT TIME because of any delay in performance of THE WORK attributable to the exercise by the OWNER of the OWNER'S rights and remedies hereunder.

12.03 ACCEPTANCE OF DEFECTIVE WORK

If, instead of requiring correction or removal and replacement of defective work, the OWNER prefers to accept it, the OWNER may do so. The CONTRACTOR shall bear all direct, indirect, and consequential costs attributable to the OWNER'S evaluation of and determination to accept such defective WORK (such costs to include but not be limited to, fees and charges of engineers, architects, attorneys and other professionals). If any such acceptance occurs prior to final payment by OWNER, a Change Order will be issued incorporating the necessary revisions in the CONTRACT DOCUMENTS with respect to THE WORK; and the OWNER shall be entitled to an appropriate decrease in the CONTRACT PRICE, and, if the parties are unable to agree as to the amount thereof, the OWNER may make a claim therefore as provided in paragraph 9 herein. If the acceptance occurs after such recommendation, an appropriate amount will be paid by the CONTRACTOR to the OWNER.

12.04 OWNER MAY STOP THE WORK

If the CONTRACTOR fails to correct defective WORK as instructed by the OWNER or persistently fails to carry out THE WORK in accordance with the CONTRACT

DOCUMENTS, the OWNER, upon presentation of a written notice to the CONTRACTOR, may order the CONTRACTOR to stop THE WORK or any portion thereof until the cause for such order has been eliminated. The CONTRACTOR will not be compensated for lost time or any additional expense incurred because of the work stoppage.

12.05 SPECIAL TESTS

If the OWNER determines that any work requires special inspection, testing, or approval, OWNER will require the CONTRACTOR to order such special inspection, testing or approval. If such special inspection or testing reveals a failure of the work to comply with the requirements of the CONTRACT DOCUMENTS, the CONTRACTOR shall bear all costs thereof; otherwise the OWNER shall bear such costs.

12.06 GENERAL WARRANTY FOR ONE YEAR AFTER COMPLETION

For a period of at least one year after final acceptance, or longer if required by law, or by a special warranty provision of the CONTRACT DOCUMENTS, the CONTRACTOR warrants the fitness and soundness of all work done and for materials and equipment put in place. Neither the Final Certificate of Payment nor any other provision in the said CONTRACT shall constitute an acceptance of WORK not done in accordance with the CONTRACT DOCUMENTS, or relieve the CONTRACTOR of liability in respect to any expressed or implied warranties for faulty materials or workmanship. If within one year after the date of final completion or such longer period of time as may be prescribed by Laws or Regulations, or 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, the CONTRACTOR shall promptly, without cost to the OWNER, and in accordance with the OWNER'S written instructions, either correct such defective WORK, or if it has been rejected by the OWNER, remove it from the site and replace it with non-defective WORK. If the CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, the OWNER may have the defective WORK corrected or the rejected WORK removed and replaced, and all direct, indirect, and consequential costs of such removal and replacement (including but not limited to fees and charges of engineers, architects, attorneys and other professionals) will be paid by the CONTRACTOR.

- (A) If in fulfilling the requirements of the CONTRACT or of any guarantee embraced therein or required thereby, the CONTRACTOR disturbs any work guaranteed under another contract, he shall restore such disturbed work to a condition satisfactory to the OWNER, and shall guarantee such restored work to the same extent as it was guaranteed under such other contract.
- (B) If the CONTRACTOR, after notice, fails to proceed promptly to comply with the terms of the guarantee, the OWNER may have the defects corrected and the CONTRACTOR shall be liable for all expenses incurred.

- (C) All special guarantees applicable to definite parts of the work that may be stipulated in the specifications or other papers forming a part of the CONTRACT DOCUMENTS shall be subject to the terms of this paragraph during the first year of the life of such special guarantee.

13.00 WAIVERS EXPLICITLY IN WRITING:

No action or failure to act by the OWNER or the CONTRACTOR shall constitute a waiver of any right or duty afforded any of them under the CONTRACT DOCUMENTS, nor shall any such action or failure to act constitute an approval of or acquiescence in any breach there under, except as may be specifically agreed in writing.

14.00 JURISDICTION OF GOVERNING AUTHORITIES:

Excavation, grading, fill, storm drainage, paving and any other construction or installations in rights-of-way of streets, highways, public carrier lines, utility lines (either aerial, surface or sub-surface), etc., shall be done in accordance with requirements of the authorities having jurisdiction and of applicable requirements of these specifications.

15.00 NONRESIDENT TAXPAYER REGISTRATION AFFIDAVIT INCOME TAX WITHHOLDING and NONRESIDENT WITHHOLDING BOND:

Any CONTRACTOR whose office address and/or office operations are located outside the State of South Carolina and is registered with either the South Carolina Secretary of State or the South Carolina Department of Revenue must submit State of South Carolina Department of Revenue Form I-312, Nonresident Taxpayer Registration Affidavit Income Tax Withholding.

Any CONTRACTOR whose office address and/or office operations are not registered as stated above and/or has not provided FORM I-312 as required above shall furnish a Nonresident Withholding Bond, from an acceptable Surety Company, in the amount of two percent (2%) of the CONTRACT PRICE as security for compliance with all requirements and applicable provisions of the South Carolina Income Tax Act of 1926, as amended, and Chapter 9 of Title 12 of the 1976 Code of Laws of South Carolina.

The Bond shall be dated the same as the Contract and must be accompanied by a current copy of the Power of Attorney for the Attorney-in-Fact representing a Surety Company licensed to do business in the State of South Carolina. The Bond must be executed with the CONTRACT DOCUMENTS and a copy of the Bond must be delivered to the OWNER within fourteen (14) calendar days after the day of the official notice of award and transmittal of Contracts for execution. The CONTRACTOR is responsible for submitting the original copy of the Bond to the South Carolina Tax Commission.

16.00 TAXES:

It is to be noted that all applicable taxes are to be included in the contract price for all work relating to the project.

17.00 HISTORICAL PRESERVATION:

In the event that during the execution of the work, historical or archeological artifacts are uncovered, the CONTRACTOR shall immediately notify the OWNER. Any artifacts recovered during the course of the work shall be saved and turned over to the OWNER.

18.00 LITIGATION OF DISPUTES: JURISDICTION:

OWNER and CONTRACTOR agree that this CONTRACT shall be interpreted according to the Laws of the State of South Carolina, and that the appropriate forum and jurisdiction for resolving any disputes and claims shall be the South Carolina Court of Common Pleas for Charleston County.

19.00 SURVIVAL OF WARRANTIES, REPRESENTATIONS AND GUARANTEES:

The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the warranties, guarantees and obligations imposed upon CONTRACTOR in this CONTRACT, and all of the rights and remedies available to OWNER there under, 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. All representations, warranties and guarantees made in the CONTRACT DOCUMENTS will survive final payment and termination or completion of the Agreement.

20.00 OWNER'S ATTORNEYS' FEES:

In the event that the CONTRACTOR violates any of the terms or provisions of the CONTRACT DOCUMENTS, the CONTRACTOR shall pay all of the OWNER'S attorneys' fees, costs and expenses, to include fees of architects, engineers and other professional consultants in connection with the OWNER'S enforcement of the terms of this CONTRACT.

21.00 ASSIGNMENT OF THE CONTRACT:

The CONTRACTOR shall not assign, transfer, convey or otherwise dispose of the CONTRACT, or of his legal right, title, or interest in or to same or to any part thereof, without the prior written consent of the OWNER. The CONTRACTOR shall not assign by power of attorney or otherwise any monies due him and payable under this CONTRACT without the prior written consent of the OWNER. Such consent, if given, will in no way relieve the CONTRACTOR of any of the obligations under this CONTRACT. The OWNER shall not be bound to abide by or observe the requirements of a

SUPPLEMENTAL CONDITIONS

INDEX

1.1	Project Scope	1.6	Liquidated Damages and Time of Completion
1.2	Furnishing of Contract Documents	1.7	Permits and Licenses
1.3	Furnishing of Materials	1.8	ISO 14001 Requirements
1.4	Jurisdiction of Governing Authorities	1.9	Time of Work
1.5	CPW Request for Early Completion		

1.1 PROJECT SCOPE

The Work covered by this Contract consists of construction of **Thomas Island Regional Pump Station and Interceptor - Division I** as generally described in the "Invitation to Bid".

1.2 FURNISHING OF CONTRACT DOCUMENTS

Contract Documents will be furnished as follows:

- A. Bidders will be supplied Contract Documents for bidding purposes as outlined in "Invitation to Bid".
- B. The successful Bidder will receive six (6) sets of Contract Documents. One set shall be maintained for record documents as outlined in Section 6.14(B) of the General Conditions of the Contract.

1.3 FURNISHING OF MATERIALS

- A. The CPW will purchase and have available for contractor pickup, the various materials as listed. The Contractor shall be responsible for scheduling and coordinating the pickup of all CPW supplied materials as listed below in Section 1.3.B
- B. Materials to be furnished by the CPW
 - 1. None
- C. Materials to be furnished by the Contractor
 - 1. All
- D. Proposed locations of temporary storage areas, if available, are shown on the contract drawings. The Contractor shall notify the CPW as to the location of temporary storage areas he wishes to use for this Project.

1.4 JURISDICTION OF GOVERNING AUTHORITIES

Referring to Section 14 of the General Conditions, the Contractor shall backfill the trenches as required by all applicable permits.

1.5 CPW REQUEST FOR EARLY COMPLETION

The CPW reserves the option to request that construction be completed on a particular portion of the work prior to other parts of the work without affecting the contract amount.

1.6 LIQUIDATED DAMAGES AND TIME OF COMPLETION

- A. The Bidder must agree to commence work within fourteen (14) calendar days of the Notice to Proceed and to fully complete the work within **three hundred sixty (365)** consecutive calendar days from the date of the Notice to Proceed.
- B. The Bidder must also agree to pay as liquidated damages the amount of **five hundred (\$500.00)** for each calendar day that the work is incomplete after the Contract Time, plus the cost of resident engineers and inspectors engaged in the project after the Contract Time.

1.7 PERMITS AND LICENSES

A copy of the permits obtained by the CPW for this project will be provided to the Contractor for his information. Any additional permits or licenses required for the project shall be the sole responsibility of the Contractor. Contractor shall secure such permits and licenses and pay any associated fees and at no additional costs to the CPW. All construction shall adhere to the requirements of these permits and licenses.

The following permits have been obtained by the CPW:

- 1. SCDOT and Berkeley County Encroachment

The following permits have not been obtained by CPW and are pending approval:

- 1. SCDHEC Notice of Intent (NOI)
- 2. SCDHEC Construction Permit
- 3. SCDHEC Coastal Zone Certification (CZC)
- 4. USACE Nationwide Permit
- 5. Berkeley County Stormwater Management Program – Construction Activity
- 6. Dominion Gas and Electrical Service

1.8 ISO 14001 REQUIREMENTS

CPW is an ISO 14001 certified firm by the International Organization for Standardization. ISO is an environmental management system that CPW strictly adheres to and is dedicated to in

order to prevent pollution, minimize waste, and constantly strive to improve. The Contractor must adhere to the Owner's ISO policies which requires strict adherence to the approved Contract Documents and all permits, regulations, and procedures. Deviation may result in disapproved work and may adversely affect the environment.

1.9 TIME OF WORK

- A. The normal time of work for this Contract is limited to 40 hours per week and shall generally be between the hours of 7:00 a.m. and 5:30 p.m., Monday through Friday. No work shall be scheduled on weekends or on holidays. Work outside of the normal time of work shall be allowed only with prior written approval from the Owner and the Engineer. Should the Contractor be allowed to work beyond the normal Monday through Friday hours or on weekends or holidays, he shall bear all costs incurred by the Owner for associated additional engineering and inspection services. The Owner shall deduct the cost of additional engineering costs from monies due the Contractor.
- B. The following CPW holidays shall be observed each year:
- New Year's Day (Actual or Observed)
 - Martin Luther King, Jr. Day (third Monday in January)
 - Good Friday
 - Memorial Day (last Monday in May)
 - Independence Day (Actual or Observed)
 - Labor Day (first Monday in September)
 - Thanksgiving Day (fourth Thursday in November)
 - Day after Thanksgiving Day
 - Christmas Eve (Actual or Observed)
 - Christmas Day (Actual or Observed)
- C. If it shall become imperative to perform work at night, the Owner and Engineer shall be informed within a reasonable time in advance of the beginning of such work. Temporary lighting and all other necessary facilities for performing and inspecting the work shall be provided and maintained by the Contractor.
- D. Unless otherwise specifically permitted, all work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work as will not suffer injury to workmanship or materials will be permitted. Contractor shall carefully protect his work against damage or injury from the weather, and when work is permitted during freezing weather, he shall provide and maintain approved facilities for heating the materials and for protecting the finished work.

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SECTION 01010

SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Work to be done under these Contracts and in accordance with these Specifications consists of furnishing all equipment, superintendence, labor, skill, material and all other items necessary for the construction of the **Thomas Island Regional Pump Station Interceptor – Division I** Project. The Contractor shall perform all work required for such construction in accordance with the Contract Documents and subject to the terms and conditions of the Contract, complete and ready for use.

- B. The work generally consists of, but is not limited to, the following:

Division I - Includes the construction of a new 400 gallon per minute (gpm) submersible pump station to convey wastewater from Thomas Island Regional Pump Station site to the Daniel Island WWTP, Shell Ring Pump Station demolition and Improvements, miscellaneous pump station piping & valves, 10" restrained joint force main, 8" restrained joint force main, 18" gravity sewer, 15" gravity sewer, 12" gravity sewer, 10" gravity sewer, 4 manholes, control panel with pre-engineered canopy & standby generator, electrical switch gear, motor control center & variable frequency drives, instrumentation & control hardware & software and all associated appurtenances.

- C. The Contractor shall refer to Section 01520 – Maintenance of Utility Operations During Construction for construction constraints and sequencing requirements.
- D. The foregoing description(s) shall not be construed as a complete description of all work required.

1.02 CONTRACT DOCUMENTS

- A. The Work to be done is shown on the set of Drawings entitled "Thomas Island Regional Pump Station and Interceptor – Division I" dated December 2019. The numbers and titles of all Drawings appear on the index sheet of the Drawings, Drawing G01. All drawings so enumerated shall be considered an integral part of the Contract Documents as defined herein.
- B. Certain Document Sections refer to Divisions of the Contract Specifications. Sections are each individually numbered portions of the Specifications (numerically) such as 08110, 13182, 15206, etc. The term Division is used as a convenience term meaning all Sections within a numerical grouping. Division 16 would thus include Sections 16000 through 16902.

- C. Where references in the Contract Documents are made to Contractors for specific disciplines of work (i.e. Electrical Contractor, etc.), these references shall be interpreted to be the single prime Contractor when the project is bid or awarded as a single prime contract.

1.03 GENERAL ARRANGEMENT

- A. Drawings indicate the extent and general arrangement of the work. If any departures from the Drawings are deemed necessary by the Contractor to accommodate the materials and equipment he proposes to furnish, details of such departures and reasons therefore shall be submitted as soon as practicable to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer. Approved changes shall be made without additional cost to the Owner for this work or related work under other Contracts of the Project.
- B. The specific equipment proposed for use by the Contractor on the project may require changes, in structures, auxiliary equipment, piping, electrical, mechanical, controls or other work to provide a complete satisfactory operating installation. The Contractor shall submit to the Engineer, for approval, all necessary Drawings and details showing such changes to verify conformance with the overall project structural and architectural requirements and overall project operating performance. The Bid Price shall include all costs in connection with the preparation of new drawings and details and all changes to construction work to accommodate the proposed equipment, including increases in the costs of other Contracts.

1.04 CONSTRUCTION PERMITS, EASEMENTS AND ENCROACHMENTS

- A. The Contractor shall obtain, keep current and pay all fees for any necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract limits and which will be occupied, encountered, used, or temporarily interrupted by the Contractor's operations unless otherwise stated. Record copies of all permits shall be furnished to the Engineer.
- B. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the Contractor's responsibility to familiarize himself and comply with such regulations or requirements as they apply to his operations on this Project.
- C. Permits obtained by the Owner from DHEC, SCDOT and USACE are included in the Supporting Documentation in these Specifications (refer to Supplemental Conditions Part 1.7). The Contractor is responsible for administering and adhering to all the permit requirements. Additionally, the Contractor is responsible for obtaining and paying for Berkeley County and City of Charleston permit fees, if required, for the new facilities associated with this project as stipulated in the Specifications.

1.05 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the Engineer is required to provide additional engineering services as a result of substitution of materials or equipment which are not "or equal" by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Engineer is required to examine and

evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.

- B. Structural design shown on the Contract Drawings is based upon typical weights for major items of equipment as indicated on the Contract Drawings and specified. If the equipment furnished exceeds the weights of said equipment, the Contractor shall assume the responsibility for all costs of redesign and for any construction changes required to accommodate the equipment furnished, including the Engineer's expenses in connection therewith.
- C. In the event that the Engineer is required to provide additional engineering services as a result of Contractor's errors, omissions, or failure to conform to the requirements of the Contract Documents, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.

1.06 ADDITIONAL OWNER'S EXPENSES

- A. In the event the Work of this Contract is not completed within the time set forth in the Contract or within the time to which such completion may have been extended in accordance with the Contract Documents, the additional engineering or inspection charges incurred by the Owner may be charged to the Contractor and deducted from the monies due him. Extra work or supplemental Contract work added to the original Contract, as well as extenuating circumstances beyond the control of the Contractor, will be given due consideration by the Owner before assessing engineering and inspection charges against the Contractor.
- B. Unless otherwise specifically permitted, the normal time of work under this Contract is limited to 8 hours per day, Monday through Friday. Work beyond these hours will result in additional expense to the Owner. Any expenses and/or damages, including the cost of the Engineer's on-site personnel, arising from the Contractor's operations beyond the hours and days specified above shall be borne by the Contractor.
- C. Charges assessed to the Contractor for additional engineering and inspection costs will be determined based on actual hours charged to the job by the Engineer. Daily rates will depend on the number and classifications of employees involved, but in no case shall such charges exceed \$1,000 per day for field personnel and \$1,320 per day for engineering personnel, based on an eight hour workday.
- D. Charges for additional Owner's expenses shall be in addition to any liquidated damages assessed in accordance with the Contract.

1.07 TIME OF WORK

- A. Refer to Supplemental Conditions (SC) Part 1.9.

- B. If it shall become imperative to perform work at night, the Owner and Engineer shall be informed a reasonable time in advance of the beginning of such work. Temporary lighting and all other necessary facilities for performing and inspecting the work shall be provided and maintained by the Contractor at no additional cost to the Owner.
- C. Unless otherwise specifically permitted, all work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work as will not suffer injury to workmanship or materials will be permitted. Contractor shall carefully protect his work against damage or injury from the weather, and when work is permitted during freezing weather, he shall provide and maintain approved facilities for heating the materials and for protecting the finished work.

1.08 SUBSURFACE DATA

- A. Subsurface data are offered in good faith solely for placing the Bidder in receipt of all information available to the Owner and Engineer and in no event is to be considered as part of the Contract Documents.
- B. The Bidder must interpret such subsurface data according to his own judgment and acknowledge that he is not relying upon the same as accurately describing the subsurface conditions, which may be found to exist.
 - 1. The test boring logs present factual information of the subsurface conditions at the specific test boring location only. The Bidder should not consider, or conclude, that the subsurface conditions will be consistent between test boring locations.
- C. The Bidder further acknowledges that he assumes all risks contingent upon the nature of the sub-surface conditions to be actually encountered by him in performing the work covered by the Contract, even though such actual conditions may result in the Bidder performing more or less work than he originally anticipated.
- D. The Bidder is further advised that the Owner has made sub-surface investigations and a report has been prepared, in connection with this project for the Engineer, a copy of which is included in the Supporting Documentation section of these specifications.
- E. In making this data available, the Owner makes no guarantee, either expressed or implied, as to their accuracy or to the accuracy of any interpretation thereof.

1.09 SURVEYS AND LAYOUT

- A. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings or as directed by the Engineer. Elevation of existing ground and appurtenances are believed to be reasonably correct but are not guaranteed to be absolute and therefore are presented only as an approximation. Any error or apparent discrepancy in the data shown or omissions of data required for accurately accomplishing the stake out survey shall be referred immediately to the Engineer for interpretation or correction.

- B. All survey work for construction control purposes shall be made by the Contractor at his expense. The Contractor shall provide a Licensed Surveyor as Chief of Party, competently qualified men, all necessary instruments, stakes, and other material to perform the work.
- C. Contractor shall establish all baselines for the location of the principal component parts of the work together with a suitable number of bench marks and batter boards adjacent to the work. Based upon the information provided by the Contract Drawings, the Contractor shall develop and make all detail surveys necessary for construction, including slope stakes, batter boards, stakes for all working points, lines and elevations.
- D. Contractor shall have the responsibility to carefully preserve the bench marks, reference points and stakes, and in the case of destruction thereof by the Contractor or resulting from his negligence, the Contractor shall be charged with the expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points and stakes.
- E. Existing or new control points, property markers and monuments that will be or are destroyed during the normal causes of construction shall be reestablished by the Contractor and all reference ties recorded therefore shall be furnished to the Engineer. All computations necessary to establish the exact position of the work shall be made and preserved by the Contractor.
- F. The Engineer may check all or any portion of the work and the Contractor shall afford all necessary assistance to the Engineer in carrying out such checks. Any necessary corrections to the work shall be immediately made by the Contractor. Such checking by the Engineer shall not relieve the Contractor of any responsibilities for the accuracy or completeness of his work.
- G. The Contractor shall provide the services of a registered land surveyor, licensed to practice in the state of South Carolina, to survey actual as-built conditions for record drawing purposes. Survey shall verify horizontal and vertical location of all structure corners, features, and underground utility and piping locations. At completion of work, the Contractor shall furnish Record Drawings in accordance with the requirements of Section 01300 indicating the final layout of all structures, roads, existing bench marks, etc. The Record Drawings shall indicate all critical elevations of piping, structures, finish grades, etc.

1.10 OPENINGS, CHASES, SLEEVES, INSERTS, ETC.

- A. The Contractor shall provide all openings, chases, etc., in his work to fit his own work and that of any other Contractors. All such openings or chases shown on the Drawings, or reasonably implied thereby, or as confirmed or modified by shop, setting, or erecting Drawings approved by the Engineer, shall be provided by the Contractor.
- B. Where pipes or conduits are to pass through slabs or walls, or where equipment frames or supports are to be installed as an integral part of an opening, the sleeves, opening forms or frames shall be furnished by the installer of the pipes, conduits, or equipment, but shall be placed by the Contractor. Where hanger inserts and similar items are to be installed as an integral part of a slab or wall, they shall be furnished by the installer of the pipe or other equipment requiring the hanger, but shall be placed by the Contractor.

- C. When requested by the Contractor, the installer of the pipes, conduit, or equipment, including those Contractors who require openings or chases in slabs and walls for passage of ducts, mounting of equipment, etc., shall furnish all necessary information, instructions, and materials to effect accurate installation of the required openings, chases, sleeves, frames, inserts, etc. When such items are secured in position, and just prior to construction of the surrounding slab or wall, the Contractor for whom the items are installed shall ascertain the proper number, locations, and settings thereof; and the General Contractor shall schedule his operations so as to provide a reasonable opportunity and time interval for such inspection.
- D. Any costs resulting from correction of defective, ill-timed, or mislocated work, or for subsequent work which becomes necessary because of omitted openings, chases, sleeves, frames, inserts, etc., shall be borne by the Contractor responsible therefor. To this end, no Contractor shall arbitrarily cut, drill, alter, damage, or otherwise endanger the work of another Contractor. The nature and extent of any corrective or additional work shall be subject to the approval of the Engineer following consultation with the Contractors involved.

1.11 CHEMICALS

- A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of either the EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable rules and regulations.

1.12 ACCIDENTS

A. Accidents

- 1. The Contractor shall promptly report, in writing, to the Engineer and Owner all accidents whatsoever out of, or in connection with, the performance of the work, whether on or adjacent to the site, which cause death, personal injury or property damage, giving full details and statements of witnesses.
- 2. If death, serious injuries, or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Owner and the Engineer.
- 3. If any claim is made by anyone against the Contractor or a Subcontractor on account of any accidents, the Contractor shall promptly report the facts, in writing, to the Engineer and Owner, giving full details of the claim.

1.13 ULTIMATE DISPOSITION OF CLAIMS BY ONE CONTRACTOR ARISING FROM ALLEGED DAMAGE BY ANOTHER CONTRACTOR

- A. During the progress of the work, other Contractors may be engaged in performing other work or may be awarded other Contracts for additional work on this project. In that event, the Contractor shall coordinate the work to be done hereunder with the work of such other Contractors and the Contractor shall fully cooperate with such other Contractors and carefully fit its own work to that provided under other Contracts as may be directed by the Engineer. The Contractor shall not commit or permit any act which will interfere with the performance of work by any other Contractor.
- B. If the Engineer shall determine that the Contractor is failing to coordinate his work with the work of the other Contractors as the Engineer directed, then the Owner shall have the right to withhold any payments otherwise due hereunder until the Contractor completely complies with the Engineer's directions.
- C. If the Contractor notifies the Engineer in writing that another Contractor is failing to coordinate his work with the work of this Contract as directed, the Engineer will promptly investigate the charge. If the Engineer finds it to be true, he will promptly issue such directions to the other Contractor with respect thereto as the situation may require. The Owner, the Engineer, nor any of their agents shall not, however, be liable for any damages suffered by the Contractor by reason of the other Contractor's failure to promptly comply with the directions so issued by the Engineer, or by reason of another Contractor's default in performance, it being understood that the Owner does not guarantee the responsibility or continued efficiency of any Contractor.
- D. The Contractor shall indemnify and hold the Owner and the Engineer harmless from any and all claims of judgments for damages and from costs and expenses to which the Owner may be subjected or which it may suffer or incur by reason of the Contractor's failure to comply with the Engineer's directions promptly.
- E. Should the Contractor sustain any damage through any act or omission of any other Contractor having a Contract with the Owner for the performance of work upon the site or of work which may be necessary to be performed for the proper execution of the work to be performed hereunder, or through any act or omission of a Subcontractor of such Contract, the Contractor shall have no claim against the Owner or the Engineer for such damage, but shall have a right to recover such damage from the other Contractor under the provision similar to the following provisions which have been or will be inserted in the Contracts with such other Contractors.
- F. Should any other Contractor having or who shall hereafter have a Contract with the Owner for the performance of work upon the site sustain any damage through any act or omission of the Contractor hereunder or through any act or omission of any Subcontractor of the Contractor, the Contractor agrees to reimburse such other Contractor for all such damages and to defend at his own expense any suit based upon such claim and if any judgment or claims against the Owner shall be allowed, the Contractor shall pay or satisfy such judgment or claim and pay all costs and expenses in connection therewith and shall indemnify and hold the Owner harmless from all such claims.

- G. The Owner's right to indemnification hereunder shall in no way be diminished, waived or discharged, by its recourse to assessment of liquidated damages as provided in the Contract, or by the exercise of any other remedy provided for by Contract Documents or by law.

1.14 LIMITS OF WORK AREA

- A. The Contractor shall confine his construction operations within the Contract limits shown on the Drawings and/or property lines and/or fence lines and/or limits of disturbance. Storage of equipment and materials, or erection and use of sheds outside of the Contract limits, if such areas are the property of the Owner, shall be used only with the Owner's approval. Such storage or temporary structures, even within the Contract's limits, shall be confined to the Owner's property and shall not be placed on properties designated as easements or rights-of-way unless specifically permitted elsewhere in the Contract Documents.

1.15 WEATHER CONDITIONS

- A. No work shall be done when the weather is unsuitable. The Contractor shall take necessary precautions (in the event of impending storms) to protect all work, materials, or equipment from damage or deterioration due to floods, driving rain, or wind, and snow storms. The Owner reserves the right, through the opinion of the Engineer, to order that additional protection measures over and beyond those proposed by the Contractor, be taken to safeguard all components of the Project. The Contractor shall not claim any compensation for such precautionary measures so ordered, nor claim any compensation from the Owner for damage to the work from weather elements.
- B. The mixing and placing of concrete or pavement courses, the laying of masonry, and installation of sewers and water mains shall be stopped during rainstorms, if ordered by the Engineer; and all freshly placed work shall be protected by canvas or other suitable covering in such manner as to prevent running water from coming in contact with it. Sufficient coverings shall be provided and kept ready at hand for this purpose. The limitations and requirements for mixing and placing concrete, or laying of masonry, in cold weather shall be as described elsewhere in these Specifications.

1.16 PERIODIC CLEANUP: BASIC SITE RESTORATION

- A. During construction, the Contractor shall regularly remove from the site of the work all accumulated debris and surplus materials of any kind which result from his operations. Unused equipment and tools shall be stored at the Contractor's yard or base of operations for the Project.
- B. When the work involves installation of sewers, drains, water mains, manholes, underground structures, or other disturbance of existing features in or across streets, rights-of-way, easements, or private property, the Contractor shall (as the work progresses) promptly backfill, compact, grade, and otherwise restore the disturbed area to the basic condition which will permit resumption of pedestrian or vehicular traffic and any other critical activity or functions consistent with the original use of the land. The requirements for temporary paving of streets, walks, and driveways are specified

elsewhere. Unsightly mounds of earth, large stones, boulders, and debris shall be removed so that the site presents a neat appearance.

- C. The Contractor shall perform the cleanup work on a regular basis and as frequently as ordered by the Engineer. Basic site restoration in a particular area shall be accomplished immediately following the installation or completion of the required facilities in that area. Furthermore, such work shall also be accomplished, when ordered by the Engineer, if partially completed facilities must remain incomplete for some time period due to unforeseen circumstances.
- D. Upon failure of the Contractor to perform periodic cleanup and basic restoration of the site to the Engineer's satisfaction, the Owner may, upon five (5) days prior written notice to the Contractor, without prejudice to any other rights or remedies of the Owner, cause such work for which the Contractor is responsible to be accomplished to the extent deemed necessary by the Engineer, and all costs resulting therefrom shall be charged to the Contractor and deducted from the amounts of money that may be due him.

1.17 USE OF FACILITIES BEFORE COMPLETION

- A. The Owner reserves the right to enter and use any portion of the constructed facilities before final completion of the whole work to be done under this Contract. However, only those portions of the facilities which have been completed to the Engineer's satisfaction, as evidenced by his issuing a Certificate of Substantial Completion covering that part of the work, shall be placed in service.
- B. It shall be the Owner's responsibility to prevent premature connections to or use of any portion of the installed facilities by private or public parties, persons or groups of persons, before the Engineer issues his Certificate of Substantial Completion covering that portion of the work to be placed in service.
- C. Consistent with the approved progress schedule, the Contractor shall cooperate with the Owner, his agents, and the Engineer to accelerate completion of those facilities, or portions thereof, which have been designated for early use by the Owner.

1.18 CONSTRUCTION VIDEO AND PHOTOGRAPHY

- A. The Contractor shall video the entire project site including all concrete and asphalt pavements, curb and gutter, fencing to remain, structures to be demolished, and existing structures that are to be modified. The original videotape shall be turned over to the Engineer prior to beginning construction activities. The video shall be DVD format. The video shall clearly identify existing site and structural conditions prior to construction.
- B. The Contractor shall photograph the entire project site including all existing facilities prior to beginning construction and shall consistently photograph facilities and site areas during execution of the work. Refer to Section 01300 – Submittals for additional construction photography requirements.

1.19 SEISMIC REQUIREMENTS

- A. The Contractor is advised that all proposed structures, non-building structures, and architectural, mechanical and electrical components and systems, including associated equipment and appurtenances furnished and installed on this project shall be subject to the requirements of the most current Building Code for the State of South Carolina for earthquake design requirements. The Contractor is responsible for designing and detailing non-building, architectural, mechanical and electrical components and systems required to be furnished as performance type submissions. Seismic forces and subsequent details shall be developed in accordance with the South Carolina Building Code and all applicable reference codes to the extent that the most stringent provisions are utilized in developing the design earthquake forces. Contractors shall refer to the GENERAL STRUCTURAL NOTES on the Structural Drawings for site, structure and non-building systems specific seismic design criteria. All calculations, seismic certifications and construction details performed and developed as part of the requirements of performance type submissions shall be prepared and sealed by a Professional Engineer (PE) licensed to practice in the State of South Carolina.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.01 SCOPE

- A. The Bid lists each item of the Project for which payment will be made. No payment will be made for any items other than those listed in the Bid.
- B. Required items of work and incidentals necessary for the satisfactory completion of the work which are not specifically listed in the Bid, and which are not specified in this Section to be measured or to be included in one of the items listed in the Bid, shall be considered as incidental to the work. All costs thereof, including Contractor's overhead costs and profit, shall be considered as included in the lump sum or unit prices bid for the various Bid items. The Contractor shall prepare the Bid accordingly.
- C. Work includes furnishing all labor, equipment, tools and materials, which are not furnished by the Owner and performing all operations required to complete the work satisfactorily, in place, as specified and as indicated on the Drawings.

1.02 DESCRIPTIONS

- A. Measurement of an item of work will be by the unit indicated in the Bid.
- B. Final payment quantities shall be determined from the record drawings.
- C. No separate payment will be made for any item of work, materials, parts, equipment, supplies or related items required to perform and complete the work. The costs for all such items required shall be included in the price bid for item of which it is a part.
- D. Should there be a conflict between this Section and other sections of the specifications or Drawings, the requirements of this Section shall govern.
- E. Payment will be made by extending unit prices multiplied by quantities provided and then summing the extended prices to reflect actual work. Such price and payment shall constitute full compensation to the Contractor for furnishing all labor, equipment, tools and materials not furnished by the Owner and for performing all operations required to provide to the Owner the entire Project, complete in place, as specified and as indicated on the Drawings.
- F. "Products" shall mean materials or equipment permanently incorporated into the work.

1.03 LUMP SUM ITEMS

- A. Lump Sum measurement will be for the entire item, unit of work, structure, or combination thereof, as specified and as indicated in the Schedule of Prices in the Bid Form. Measurement and payment for all bid items indicated as Lump Sum shall include the

cost of all labor, materials and equipment necessary to furnish, install, clean, test, and place each bid item into operation; including permitting, general conditions, overhead and profit.

- B. Progress payments will be based on the Schedule of Values prepared by the Contractor and approved by the Owner/Engineer before acceptance of the first Application for Payment.
- C. In order for the Contractor to request progress payments against Lump Sum items, Contractor shall provide a disaggregation or breakdown in sufficient measurable detail that is acceptable to the Owner/Engineer.
- D. Measurement
 - 1. Measurement shall be based on the estimated percent complete of each Lump Sum item of the Schedule of Values, as determined by the Owner/Engineer.
- E. Payment
 - 1. Payment will be made at the lump sum price proportional to the completion percentages approved by the Owner/Engineer.

1.04 UNIT PRICE ITEMS

- A. Quantity and measurement estimates stated in the Schedule of Prices in the Bid Form are estimates for bidding purposes only. Actual payments shall be based on actual quantities installed, in-place, as measured and/or verified by the Owner/Engineer.
- B. Unless otherwise provided in the General Conditions, the bid unit prices shall be in effect throughout the contract duration, regardless of variances between the estimated quantities and the actual installed quantities.
- C. The Contractor shall make no claim, nor receive any compensation, for anticipated profits, loss of profit, damages, or any extra payment due to any difference between the amounts of work actually completed, or materials or equipment furnished, and the estimated quantities.
- D. Unless otherwise approved by the Owner/Engineer, any unit quantities exceeded may not be invoiced until the estimated quantity is increased by contract change order.
- E. Contractor shall assist Owner/Engineer by providing necessary equipment, workers, and survey personnel as required to measure quantities.
- F. Measured quantities shall be rounded to the nearest whole integer, unless the value of the unit price exceeds \$100, in which case measured quantities shall be rounded to the nearest half unit.
- G. Measurement
 - 1. Measurement for progress payment shall be made by, or approved by, the Owner/Engineer based on the estimated effective quantity installed. The effective

quantity installed represents the actual units or quantities installed, adjusted for incomplete elements or components.

2. Unless otherwise provided for in the Schedule of Prices in the Bid Form unit price items are all-inclusive of all related work, direct and indirect, to provide a complete and functional item. For example, sewer pipe installation would include pipe, trenching, shoring, dewatering, bedding, installation, backfill, compaction, testing, flushing, disinfection, and commissioning; including all labor, materials, site access and equipment necessary to furnish, install, clean, test, and place into operation; including permitting, general conditions, overhead and profit.
3. The final measurement shall be based on actual quantities, jointly measured by Contractor and Owner/Engineer, complete, fully, tested and placed into service.

B. Payment

1. Progress payments shall be in accordance with the contract documents based on estimated effective quantities installed, paid at the bid unit price.
2. The final payment shall be based on actual quantities, fully installed, tested and placed into service, paid at the bid unit price.

1.02 OWNER CONTINGENCIES

- A. Owner Contingencies, if any, specified in the Contract Documents and indicated in the Schedule of Prices in the Bid Form are considered provisional amounts to be used only if needed. Owner Contingencies are exclusive of work indicated in the Contract Documents for which payment is included under other items in the Bid Form. No work may be performed under an Owner Contingency without prior written approval of the Owner.
- B. Any unused balance of the Owner Contingencies shall revert to the Owner upon completion of the project. Prior to final payment, the original amount provided for Owner Contingencies shall be adjusted to actual costs by deductive Change Order, adjusting the contract price, accordingly.
- C. The Contractor shall make no claim, nor receive any compensation, for anticipated profits, loss of profit, damages, or any extra payment due to any unexpended portion of the Owner Contingencies.
- D. The Contractor is to include time for allowance work in the construction schedule. No adjustment of Contract Time shall be allowed for any work performed under Owner Contingencies items.
- E. Owner Contingencies items shall be included in the Schedule of Values.
- F. Unless otherwise indicated in the specific measurement and payment provisions under Owner Contingencies items, the measurable and allowable costs for work performed under an Owner Contingencies item shall be limited to the actual, demonstrable, and direct costs associated with that Owner Contingencies item. Shipping and sales taxes are allowable costs.

- G. No mark-up for overhead or profit shall be included for payment under an Owner Contingencies account item. Overhead and profit shall be included in the contract base bid or allocated across other bid items.
- H. Work authorized by the Owner under an Owner Contingencies may be performed as a lump sum (negotiated before the fact), unit prices (when applicable), or time and material. For work performed under time and material, Contractor shall submit detailed verification (break-down) of all costs, subject to the approval of the Owner.

PART 2 – BID ITEMS

2.01 LUMP SUM BID ITEMS

A. A.1 – NEW THOMAS ISLAND REGIONAL PUMP STATION

1. Payment for the New Thomas Island Regional Pump Station shall be made according in the lump sum price as specified in the Bid Form. Work under Bid Item No. A.1 shall also include, but not be limited to, furnishing all products, materials and equipment, dewatering, wetwell, all process mechanical, structural, electrical, instrumentation and control components, plant buffer, etc. and performing all labor necessary and required to complete and put the New Thomas Island Regional Pump Station into operation, including all work shown on the drawings.
2. Payment shall also include the sewer connection to existing receiving manhole at Shell Ring Pump Station, but not limited to, penetrating manhole wall, sealing connection, temporary bypass pumps, temporary trench box and/or sheeting (if needed), plugging existing manhole, forming new invert, Raven 405 epoxy coating repair, testing, etc. and for complete tie-in sewer connection.
3. Payment shall also include all coordination with local utilities (i.e. Dominion Energy) for installation of power and natural gas services as shown on the plans. Power tie-in shall be coordinated with Unit Price Item B.18.
4. Payment for the New Thomas Island Regional Pump Station shall be based upon percentage complete and as authorized by the Engineer. The lump sum payment will be full compensation for furnishing all products, materials, and equipment and performing all labor necessary to complete and put into operation the Thomas Island Regional Pump Station and Interceptor Project – Division I, including all work shown on the drawings and/or specified and not otherwise included in the Lump Sum Items A.2 and A.3, Unit Price Items and Allowance Items.

B. BID ITEM NO. A.2 – MOBILIZATION AND DEMOBILIZATION

1. Payment for Bid Item No. A.2 shall be made in the lump sum price in the Bid Form shall also include, but not be limited to, any permits, licenses, fees, assembling all equipment, materials, tools, etc., and transporting them to and from the work site. The amount bid for Bid Item No. A.2 – Mobilization and Demobilization shall not exceed three (3) percent of the Total Construction Cost. All costs associated with demobilization shall also be included herein under Bid Item No. A.2.

2. No separate payment for access outside of existing easements as shown on the Contract Drawings will be made. All cost of equipment, labor and materials required for additional access outside of existing easements shall be included in the price bid item to which it pertains.
- C. BID ITEM NO. A.3 – SHELL RING PUMP STATION DEMOLITION AND IMPROVEMENTS
1. Payment for the Shell Ring Pump Station Demolition and Improvements shall be made in the lump sum price as specified in the Bid Form. The lump sum bid amount shall include demolition of all material as shown on the plans and as stated in Section 01540 Part 3.05, removal and hauling of materials, proper disposal, and delivery of all retained equipment & materials requested by Owner for storage at PS #77.
 2. Payment for the Shell Ring Pump Station Demolition and Improvements shall be based upon percentage complete and as authorized by the Engineer.

2.02 UNIT PRICE BID ITEMS

A. BID ITEM NO. B.1 THRU B.6 – PVC GRAVITY SEWER

1. Gravity sewer pipe will be measured from center to center of manholes and depth of cut from the invert to original ground at centerline. Payment will be made at the unit prices per linear foot as stated in the Bid Form, and shall include cost of excavation, dewatering, trench box and/or sheeting (if needed), stone bedding, backfilling, approved backfill material, proper compaction, cleanup, testing, video inspection, detection tape, plugs/caps, cleanup, site restoration, traffic control, anti-seep collars, etc. for complete installation.
2. Easement/Permit Stipulations
 - a. No additional payment will be made for Easement/Permit Stipulations. All costs related to the implementation of the easement and permit stipulations shall be included in the unit price bid for the item to which it pertains.
3. Existing Utilities and Obstructions
 - a. Horizontal/Vertical Conflicts and Obstructions
 - 1) No payment will be made for any delay or extra cost encountered by the Contractor due to protection, avoidance or relocation of existing utilities, mains or services or changing the horizontal and vertical alignment of the sewer.
 - 2) No payment will be made for relocation of existing utilities.
4. Location and Grade
 - a. No separate payment shall be made for survey work performed by or for the Contractor in the establishment of reference points, benchmarks, cut sheets, limits of right of way or easement, including their restoration, as well as centerline or baseline points.

B. BID ITEM NO. B.7 – 5' DIAMETER MANHOLE (16'-18')

1. Manholes will be measured from the lowest invert elevation to the top rim of the frame and paid for at the unit price per each as stated in the Bid Form and shall include all costs of materials, excavation, dewatering, trench box and/or sheeting (if needed), stone base, backfilling, approved backfill material, proper compaction, frame and cover, flexible rubber boot, per detail, testing, cleanup, site restoration, grassing, etc. for complete installation.
2. No separate payment will be made for freight and delivery.
3. No additional payment will be made for replacement of defective materials.
4. No separate payment will be made for making connections to manholes and this work shall be included in the unit price for manholes.

C. BID ITEM NO. B.8 – MANHOLE VENT PIPE

1. Payment shall be made according in the unit price per each as specified in the Bid Form, which shall constitute full payment to provide and install Manhole Vents as detailed in the Drawings.
2. The work shall include, but not be limited to, providing necessary site access for equipment, providing all labor, materials (per detail), equipment, and tools required to install manhole vents and joint sealing as needed.
3. Measurement for payment will be at the unit price for each manhole vent installed as directed by the Engineer or Owner.

D. BID ITEM NO. B.9 – RAVEN 405 COATING FOR MANHOLE

1. Measurement for Bid Item No. B.9 will be made in the unit price per vertical foot (VF) of epoxy lining installed. Payment for Epoxy Lining shall include all costs to prepare the manholes for epoxy lining according to the manufacturer's recommendations to include, but not be limited to, providing all labor, materials, equipment, holiday testing, adhesion testing and tools required to install epoxy lining from the invert up to the top of the manhole, etc. for complete installation.

E. BID ITEM NO. B.10 THRU B.11 – RESTRAINED JOINT FORCE MAIN

1. Payment for restrained joint force main piping will be paid for at the unit price per linear foot (LF) as stated in the Bid Form, and shall include cost of all materials, excavation, backfilling, dewatering, detection tape, tracer wire, metallic detection tape, installation records, cleanup, testing, etc. for complete installation. Measurement will be from center to center of fittings; no reduction will be made for the space occupied by valves and fittings.

F. BID ITEM NO. B.12 – FITTINGS

1. Payment for fittings, including couplings/sleeves/plugs, shall be per unit price per ton as stated in the Bid Form and shall include cost for restraint with weight of fittings being based upon the published weight of the compact (C153) fitting body. No payment will be made for the weight of joint accessories for mechanical joint, including joint restraints.

G. BID ITEM NO. B.13 – PLUG VALVE WITH BOX

1. Valves will be paid at the unit price per each as stated in the Bid Form. This payment shall include valve, valve box, concrete collar, per detail, etc. for complete installation.

H. BID ITEM NO. B.14 – CUT-IN TO EXISTING FORCE MAIN

1. Payment will be made at the unit price per lump sum as stated in the Bid Form and shall include cost of labor, excavation, dewatering, equipment, materials, backfill, flow control, cleanup, etc. and will not include cost of fittings used. Payment for fittings and valves used at tie-ins will be paid for as state in “F” and “G” above. No separate measurement or extra payment will be made for temporary valves and fittings used in associate with the tie-ins.

I. BID ITEM NO. B.15 – EROSION AND SEDIMENTATION CONTROL

1. Payment for Erosion and Sedimentation Control shall be made in the lump sum price as specified in the Bid Form. Payment shall include all costs for all materials (i.e., silt fence, sediment filter bag, curb inlet protection, and temporary construction entrance), labor, installation, maintenance, inspection, replacement as necessary, and removal of erosion control measures and cleanup following site stabilization.
2. Payment shall include all costs to adequately prevent erosion and sedimentation from occurring on the project site, and meet all regulatory requirements of SCDOT, City of Charleston, Berkeley County, SCDHEC, U.S. EPA, and U.S. Army Corps of Engineers. No additional payment will be made for erosion and sedimentation control measures required to meet regulatory requirements that are not shown on the Drawings.
3. No payment will be made for any portion of the Project for which temporary erosion and sedimentation controls are not properly maintained.
4. Payment shall be based upon percentage complete and as authorized by the Engineer.

G. BID ITEM NO. B.16 – GRASSING

1. Payment for Grassing shall be made in the lump sum price as specified in the Bid Form and shall meet all regulatory requirements of SCDOT, City of Charleston, Berkeley County, and U.S. EPA. All costs for grassing, including seeding, fertilizing, mulching, as well as temporary measures, shall be included in the price bid for Grassing.

2. No additional payment will be made for those lengths of pipeline where the Contractor must reseed due to inadequate watering and maintenance; loss of seeds caused by site erosion, e.g., wind and rain; inadequate germination of the seeds; inadequate coverage/density; providing permanent species at the appropriate season after temporary grassing has been performed.
3. No additional payment will be made for providing a temporary species of grass where the seasonal limitations do not allow for the proper germination of a permanent species of grass. Any additional cost anticipated for sowing a temporary species shall be included in the price bid for the item to which it pertains.
4. Measurement for payment for Grassing shall be for the entire area impacted by construction. The length of pipe constructed under pavement and via trenchless method shall not be included in quantities for payment for Grassing.
5. No separate payment will be made for temporary grassing.

H. BID ITEM NO. B.17 – CLEARING AND GRUBBING

1. Payment for clearing and grubbing shall be made per acre as specified in the Bid Form. No payment shall be made for areas in which proper erosion control devices are not constructed and maintained. Payment for clearing and grubbing shall be measured at the area cleared.
2. No separate payment will be made for moving and reestablishing landscape features, including labor and materials, shall be included in the unit price bid, or allowance if applicable, for the item to which it pertains.

I. BID ITEM NO. B.18 – GALVANIZED STEEL CONDUIT FOR UTILITY SERVICE

1. Payment for galvanized steel conduit associated with the main utility service will be paid for at the unit price per linear foot (LF) as stated in the Bid Form, and shall include cost of all materials, excavation, backfilling, dewatering, detection tape, tracer wire, metallic detection tape, installation records, cleanup, testing, etc. for complete installation as required by Dominion Energy. Measurement will be from the beginning of the conduit at the newly installed Dominion drop pole to the main transformer pad and in accordance with the requirements listed in Specification 16000.

2.03 ALLOWANCE ITEMS

A. BID ITEM NO. C.1 - ELECTRICAL 3-WAY UNDERGROUND SERVICE BY DOMINION ENERGY

1. The bid includes an allowance which is to be included in the total bid for the project. The items that the Contractor is responsible for versus the utility are outlined in Section 16000 Part 1.03. Any unused portion of the allowance remaining at the completion of the contract shall revert to the Owner as a credit. The Owner reserves the right to delete the allowance prior to Award.

B. BID ITEM NO. C.2 – NATURAL GAS UNDERGROUND SERVICE BY DOMINION ENERGY

1. The bid includes an allowance which is to be included in the total bid for the project. The items that the Contractor is responsible for versus the utility are outlined in Specification 16000. Any unused portion of the allowance remaining at the completion of the contract shall revert to the Owner as a credit. The Owner reserves the right to delete the allowance prior to Award.

C. BID ITEM NO. C.3 - CONTINGENCY CASH ALLOWANCE

1. Work to be performed under a contingency allowance will be authorized by a Work Change Directive. Refer to Supplemental Conditions.
2. The Bid includes a Contingency Allowance which is to be included in the total bid for the project. This allowance is to provide payment for unforeseen conditions which may be encountered in the Work and is to be used only upon a written Work Change Directive from the Engineer. Any unused portion of the allowance remaining at the completion of the contract shall revert to the Owner as a credit. The Owner reserves the right to delete the allowance prior to award.

PART 3 – CLARIFICATIONS

3.01 TRENCH EXCAVATION AND BACKFILL (PIPELINES)

- A. No separate payment will be made for trench excavation, sheeting, bracing, shoring or dewatering. All costs shall be included in the unit price bid for the item to which it pertains at the appropriate depth separate or additional payment will be made for trench excavation or any special or unique method, means, techniques or equipment necessary for the Contractor's compliance with these Specifications, regulatory requirements, permits, laws or regulations which govern this Project.

B. Initial Backfill

1. No separate payment shall be made for initial backfill.
2. No separate payment shall be made for drying out the initial backfill material in order to meet the compaction requirements.
3. No separate payment shall be made for the adding of moisture to the initial backfill materials in order to meet the compaction requirements.
4. No separate payment shall be made for providing approved backfill material if the insitu material cannot meet the compaction requirements.

C. Final Backfilling

1. No additional payment will be made for additional material when excavated materials are used.
2. No separate payment shall be made for drying out the final backfill material in order to meet the compaction requirements.

3. No separate payment shall be made for the adding of moisture to the final backfill materials in order to meet the compaction requirements.
4. No additional payment will be made for providing approved backfill material if the insitu material cannot meet the compaction requirements.

D. Additional Material

NO SEPARATE PAYMENT WILL BE MADE FOR ADDITIONAL EARTH OR FILL MATERIALS IMPORTED TO THE PROJECT SITE

- END OF SECTION -

SECTION 01031

GRADES, LINES AND LEVELS

PART 1 - GENERAL

1.1 CONSTRUCTION LAYOUT

- A. This item shall consist of furnishing, placing, replacing when required, marking and maintaining all Construction Layout stakes necessary for proper guidance and control of construction operations.
- B. It shall also include the preparation of all construction staking field books such as alignment books, slope stake books, blue top book, etc.

PART 2 - MATERIALS

2.1 EQUIPMENT

- A. All surveying equipment, stakes and any other material necessary to perform the work shall be furnished by the Contractor.

PART 3 - EXECUTION

3.1 CONTROL

- A. The Contractor shall provide a Professional Land Surveyor, subject to the Owner's approval, to establish and/or re-establish all benchmarks, reference control points, line, and grade points necessary to complete the work at no expense to the Owner.
- B. Benchmarks and reference control points will be established and/or re-established outside of the construction limits by the Surveyor and are to be maintained by the Contractor's Surveyor.

3.2 RECORDS

- A. The Surveyor shall furnish a copy of all survey records made by his forces to the Engineer who reserves the right to check, correct where necessary, or require any Layout Work to be revised. These records shall be furnished to the Engineer prior to the commencement of construction or as they are completed and shall become a part of the permanent Project records.

3.3 ACCEPTANCE

- A. Acceptance of all or any part of the Contractor's Layout by the Engineer shall not relieve the Contractor of his responsibility to secure proper dimensions in the Work.

- END OF SECTION -

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SECTION 01035

MODIFICATION PROCEDURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Work includes all labor, materials, equipment and appliances required for the complete execution of additions, modifications and alterations to existing buildings and structures as shown on the Drawings and specified under the various Sections of the Contract Specifications and as required by conditions at the site.
- B. The Contractor shall have examined all work to be performed to the existing buildings and familiarize himself with the nature and extent to which the existing buildings will be damaged, items removed or rearranged due to the work under his Contract and that of other Contracts.
 - 1. Cutting and patching shall conform to the requirements of the General Conditions, Supplemental Conditions, and as specified herein.
 - 2. Patching work shall be performed with similar materials and in the same manner as adjoining work. Joining between old and new work shall be perfect and practically invisible. All due caution shall be taken to obtain a bond between old and new work.
- C. Major portions of the work are indicated on the Drawings and the accompanying Specifications thereto. All work must be complete in all respects and executed with high quality workmanship.

1.02 SITE AND BUILDINGS

- A. Site Visit
 - 1. Prior to submission of Bids, the Contractor shall have visited the site and thoroughly acquainted himself with the exact nature of the work indicated on the Drawings and the Specifications requirements. Failure to comply with the aforementioned requirements shall not constitute a basis for claims for additional compensation.
- B. Measurements
 - 1. Prior to ordering any materials or doing any work, the Contractor shall verify all measurements, dimensions and other conditions of each building scheduled for work as may be necessary or required in connection with his work. The Contractor shall be responsible for the correctness of same.

1.03 MATERIALS

- A. All materials to perform and complete the work shall be new. Salvaged materials, such as brick, stone copings, granite sills, may be used under certain conditions subject to the approval of the Owner and Engineer.
- B. All salvaged materials shall be sound and undamaged. Materials to be reused shall be stored and protected as directed by the Engineer. Care shall be taken to prevent damage to materials or equipment to be reused.

1.04 SHORING, UNDERPINNING AND BRACING

- A. When necessary and required, the Contractor shall provide underpinning and temporary shoring and bracings, all in accordance with code requirements, and as approved by the Engineer.
- B. Shoring and bracing shall be of such form and so installed as to safely support the work and interfere as little as possible with the progress of the work. Suitable means shall be provided to adjust any settlement in the shoring supports. Temporary shoring shall consist of sound timbers or rolled shapes of required dimensions which shall be removed after necessity for same ceases to exist. All work removed or damaged through installation of temporary shoring or through improper shoring shall be replaced or repaired after the shoring is removed, at no additional cost to the Owner.

1.05 WORK PREPARATION AND TEMPORARY ACCESS

- A. The Contractor, before commencing work, shall prepare and submit for approval a progress schedule in accordance with the requirements of Section 01300 - Submittals, in order to coordinate the work of all trades and to insure completion on or before the completion date. The Owner and the Engineer reserve the right to revise or modify such schedules as required to expedite each phase of work and to coordinate such work with the partial use of the building for purposes as directed.
- B. No facility such as toilets, corridors, etc., shall be barricaded or access restricted without providing other temporary or interim means of access. It is further required that no work specified hereinafter shall disturb or interfere with the operation of the existing mechanical installation until proposed new work has been completed or satisfactorily installed. Exception may be made to this requirement only by written approval from the Owner and Engineer.
- C. Detailed sequence of availability of areas within the present buildings where work is to be performed under each Contract shall be in accordance with Section 01520, Maintenance of Utility Operations During Construction, but may be modified by the Contractor, upon authorization by the Owner and Engineer as the work progresses.

- D. Existing built-in equipment to remain in the final work, but requiring temporary removal for the installation of new construction, alterations, repairs and/or renovations, shall be disconnected by the Electrical Contractor (Subcontractor) and removed by the Contractor to temporary storage areas designated by the Owner. Resetting of existing equipment under this heading shall be performed by the Contractor and connecting to electric service lines shall be performed by the Electrical Contractor (Subcontractor).
- E. The Contractor shall furnish and install all temporary fire exits, fire extinguishers, hose and safety devices as may be required by authorities having jurisdiction.
- F. Work within existing buildings to be performed, once started, shall be completed as quickly as practicable and each trade shall determine before work is started that all required materials are at hand or readily obtainable to avoid delays.
- G. Shutdowns of existing services within existing buildings which may be occupied during construction will be permitted only upon approval by the Owner subject to at least three weeks notice in writing to the Owner in each case. Shutdowns will be limited to times which will result in the least interference with normal operations. Refer to Section 01520 - Maintenance of Utility Operations During Construction for additional requirements.

1.06 WEATHER PROTECTION

- A. Where exterior walls or roofs are being altered, or disturbed for any adjacent alteration, the Contractor shall provide temporary weather protection in those areas to keep interior of buildings absolutely dry and unaffected by the weather. The Contractor will be held responsible for any damage caused by improper protection against weather.
- B. Where existing exterior walls or roofs are disturbed due to alterations, disturbances shall be kept to a minimum and walls or roofs shall be repaired and patched in such a manner that the buildings will be absolutely watertight and meet the conditions of the existing roofing flashing and waterproofing bonds and guarantees.

1.07 CUTTING, PATCHING, REPAIRING, AND REFINISHING

- A. The Contractor shall be responsible for cutting all openings in walls, floors and ceilings (indicated to remain) to accommodate alteration work under his Contract in accordance with the requirements of the General Specification, Special Provisions, and as hereinafter specified. Rough patching and all finish patching shall be by the Contractor.
 - 1. Where new openings are to occur in existing exterior and interior concrete and masonry bearing walls and structural concrete floor, the Contractor will be required to notify the Owner and Engineer in writing and shall obtain approval prior to cutting operations. The Engineer will determine whether such openings affect the structural stability or load bearing capacities of walls and floors.
 - 2. All holes and openings to be cut in existing walls, floors and ceilings of any nature shall be geometrically correct and no larger than necessary to accommodate the new work.

3. No cutting of finished or structural work may be done without the approval of the Engineer.

B. Major demolition and removal work such as demolition of buildings and structures, complete or nearly complete removal of floors, walls and ceilings indicated on the Drawings, shall be performed by the Contractor. The Contractor shall also be responsible for all finish patching operations of holes and openings in existing floors, walls, ceilings and roofs to accommodate the alteration work under the Plumbing, HVAC and Electrical Sections as well as that required for the Contractor's work hereinafter specified.

C. Each Contractor and/or his Subcontractors shall provide sleeves, forms and inserts for installation by the Contractor as specified in Section 01010, Summary of Work.

1.08 EXISTING EQUIPMENT AND FURNISHINGS

A. Existing built-in equipment to remain in the final work and requiring temporary removal shall be as hereinbefore specified under paragraph 1.05, D.

B. Existing appliances and portable equipment such as desks, chairs, tables, etc., shall remain the property of the Owner and will be removed from rooms and spaces to be altered by the Contractor prior to construction and alteration operations, and stored where directed by the Owner.

C. All unsalvageable equipment shall become the property of the Contractor in accordance with the requirements of Section 01540, Demolition and Removal of Existing Structures and Equipment, and shall be removed from each building and away from the site. Equipment to be retained, or relocated, shall be as shown on the Drawings or as specified.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01040

COORDINATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall allow the Owner or his agents, and other project Contractors or their agents, to enter upon the work for the purpose of constructing, operating, maintaining, removing, repairing, altering, or replacing such pipes, sewers, conduits, manholes, wires, poles, or other structures and appliances which may be required to be installed at or in the work. The Contractor shall cooperate with all aforesaid parties and shall allow reasonable provisions for the prosecution of any other work by the Owner, or others, to be done in connection with his work, or in connection with normal use of the facilities.
- B. Each Contractor shall cooperate fully with the Owner, the Engineer, and all other Contractors employed on the work, to effect proper coordination and progress to complete the project on schedule and in proper sequence. Insofar as possible, decisions of all kinds required from the Engineer shall be anticipated by the Contractor to provide ample time for inspection, or the preparation of instructions.
- C. Each Contractor shall assume full responsibility for the correlation of all parts of his work with that of other Contractors. Each Contractor's superintendent shall correlate all work with other Contractors in the laying out of work. Each Contractor shall lay out his own work in accordance with the Drawings, Specifications, and instructions of latest issue and with due regard to the work of other Contractors.
- D. Periodic coordinating conferences shall be held per Section 01200, Project Meetings, of these Contract Documents.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01070

ABBREVIATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The following is a partial list of typical abbreviations which may be used in the Specifications, and the organizations to which they refer:

AASHTO	-	American Association of State Highway and Transportation Officials
ACI	-	American Concrete Institute
ACIFS	-	American Cast Iron Flange Standards
AFBMA	-	Anti-Friction Bearing Manufacturer's Association
AGA	-	American Gas Association
AGMA	-	American Gear Manufacturers Association
AIA	-	American Institute of Architects
AISC	-	American Institute of Steel Construction
AISI	-	American Iron and Steel Institute
ANSI	-	American National Standard Institute
API	-	American Petroleum Institute
ASCE	-	American Society of Civil Engineers
ASHRAE	-	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society for Testing and Materials
AWS	-	American Welding Society
AWWA	-	American Water Works Association
CEMA	-	Conveyor Equipment Manufacturer's Association
CRSI	-	Concrete Reinforcing Steel Institute
DIPRA	-	Ductile Iron Pipe Research Association
Fed Spec	-	Federal Specifications
IEEE	-	Institute of Electrical and Electronic Engineers
IPCEA	-	Insulated Power Cable Engineers Association
ISO	-	Insurance Services Offices
NBS	-	National Bureau of Standards
NEC	-	National Electric Code
NEMA	-	National Electrical Manufacturers Association
OSHA	-	Occupational Safety and Health Act
PCI	-	Precast Concrete Institute
SCDOT	-	South Carolina Department of Transportation
UL	-	Underwriters Laboratories, Inc.
USGS	-	United States Geological Survey

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01090

REFERENCE STANDARDS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Wherever reference is made to any published standards, codes, or standard specifications, it shall mean the latest standard code, specification, or tentative specification of the technical society, organization, or body referred to, which is in effect at the date of invitation for Bids.

- B. All materials, products, and procedures used or incorporated in the work shall be in strict conformance with applicable codes, regulations, specifications, and standards.

- C. A partial listing of codes, regulations, specifications, and standards includes the following:

Air Conditioning and Refrigeration Institute (ARI)

Air Diffusion Council (ADC)

Air Moving and Conditioning Association (AMCA)

The Aluminum Association (AA)

American Architectural Manufacturers Association (AAMA)

American Concrete Institute (ACI)

American Gear Manufacturers Association (AGMA)

American Hot Dip Galvanizers Association (AHDGA)

American Institute of Steel Construction, Inc. (AISC)

American Iron and Steel Institute (AISI)

American National Standards Institute (ANSI)

American Society of Civil Engineers (ASCE)

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)

American Society of Mechanical Engineers (ASME)

American Society for Testing and Materials (ASTM)

American Standards Association (ASA)

American Water Works Association (AWWA)

American Welding Society (AWS)

American Wood-Preserver's Association (AWPA)

Anti-Friction Bearing Manufacturers Association (AFBMA)

Building Officials and Code Administrators (BOCA)

Conveyor Equipment Manufacturers Association (CEMA)

Consumer Product Safety Commission (CPSC)

Factory Mutual (FM)

Federal Specifications

Instrument Society of America (ISA)

Institute of Electrical and Electronics Engineers (IEEE)

National and Local Fire Codes

Lightning Protection Institute (LPI)

National Electrical Code (NEC)

National Electrical Manufacturer's Association (NEMA)

National Electrical Safety Code (NESC)

National Electrical Testing Association (NETA)

National Fire Protection Association (NFPA)

Regulations and Standards of the Occupational Safety and Health Act (OSHA)

Southern Building Code Congress International, Inc. (SBCCI)

Sheet Metal & Air Conditioning Contractors National Association (SMACNA)

Standard Building Code

Standard Mechanical Code

Standard Plumbing Code

Uniform Building Code (UBC)

Underwriters Laboratories Inc. (UL)

- D. Contractor shall, when required, furnish evidence satisfactory to the Engineer that materials and methods are in accordance with such standards where so specified.
- E. In the event any questions arise as to the application of these standards or codes, copies shall be supplied on-site by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01200
PROJECT MEETINGS

PART 1 -- GENERAL

1.01 PRECONSTRUCTION MEETING

- A. A preconstruction meeting will be held after Award of Contract, but prior to starting work at the site.
- B. Attendance:
 - 1. Owner
 - 2. Engineer
 - 3. Contractor
 - 4. Major subcontractors
 - 5. Safety representative
 - 6. Representatives of governmental or other regulatory agencies.
- C. Minimum Agenda:
 - 1. Tentative construction schedule
 - 2. Critical work sequencing
 - 3. Designation of responsible personnel
 - 4. Processing of Field Decisions and Change Orders
 - 5. Adequacy of distribution of Contract Documents
 - 6. Submittal of Shop Drawings and samples
 - 7. Procedures for maintaining record documents
 - 8. Use of site and Owner's requirements
 - 9. Major equipment deliveries and priorities
 - 10. Safety and first aid procedures
 - 11. Security procedures

12. Housekeeping procedures
13. Processing of Partial Payment Requests
14. General regard for community relations

1.02 PROGRESS MEETING

- A. Progress meetings will be held monthly during the performance of the work of this Contract. Additional meetings may be called as progress of work dictates.
- B. Engineer will preside at meetings and record minutes of proceedings and decisions. Engineer will distribute copies of minutes to participants.
- C. Attendance:
 1. Engineer
 2. Contractor
 3. Subcontractors, only with Engineer's approval or request, as pertinent to the agenda
- D. Minimum Agenda:
 1. Review and approve minutes of previous meetings.
 2. Review progress of Work since last meeting.
 3. Review proposed 30-60 day construction schedule.
 4. Note and identify problems which impede planned progress.
 5. Develop corrective measures and procedures to regain planned schedule.
 6. Revise construction schedule as indicated and plan progress during next work period.
 7. Maintaining of quality and work standards.
 8. Complete other current business.
 9. Schedule next progress meeting.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01300

SUBMITTALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Construction Schedule

1. Refer to Section 01310 – Construction Schedule and Sequence.

B. Equipment and Material Orders Schedule

1. Contractor shall prepare and submit five (5) copies of his schedule of principal items of equipment and materials to be purchased to the Engineer for review and approval.
2. If so required, the schedule shall be revised until it is approved by the Engineer.
3. Schedule shall be updated monthly and five (5) copies submitted to the Engineer not later than the fifth day of every month with the application for progress payment.
4. The updated schedule shall be based on the Progress Schedule developed under the requirements of Paragraph 1.01(A) of this Section.
5. Schedule shall be in tabular form with appropriate spaces to insert the following information for principal items of equipment and materials:
 - a. Dates on which Shop Drawings are requested and received from the manufacturer.
 - b. Dates on which certification is received from the manufacturer and transmitted to the Engineer.
 - c. Dates on which Shop Drawings are submitted to the Engineer and returned by the Engineer for revision.
 - d. Dates on which Shop Drawings are revised by manufacturer and resubmitted to the Engineer.
 - e. Date on which Shop Drawings are returned by Engineer annotated either "Furnish as Submitted" or "Furnish as Corrected".
 - f. Date on which accepted Shop Drawings are transmitted to manufacturer.
 - g. Date of manufacturer's scheduled delivery.
 - h. Date on which delivery is actually made.

C. Working Drawings

1. Within thirty (30) days after the Notice to Proceed, each prime Contractor shall prepare and submit five (5) copies of his preliminary schedule of Working Drawing submittals to the Engineer for review and approval. If so required, the schedule shall be revised until it is approved by the Engineer.
2. Working Drawings include, but are not limited to, Shop Drawings, layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc. Contractor shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Working Drawings required and necessary under this Contract and to fulfill all other requirements of his Contract. Contractor shall secure such information, details, Drawings, etc., from all possible sources including the Drawings, Working Drawings prepared by subcontractors, Engineers, suppliers, etc.
3. Working Drawings shall accurately and clearly present the following:
 - a. All working and installation dimensions.
 - b. Arrangement and sectional views.
 - c. Units of equipment in the proposed positions for installation, details of required attachments and connections, and dimensioned locations between units and in relation to the structures.
 - d. Necessary details and information for making connections between the various trades including, but not limited to, power supplies and interconnecting wiring between units, accessories, appurtenances, etc.
4. In the event that the Engineer is required to provide additional engineering services as a result of a substitution of materials or equipment by the Contractor, the additional services will be provided in accordance with Section 01010 - Summary of Work, and will be covered in supplementary or revised Drawings which will be issued to the Contractor. All changes indicated that are necessary to accommodate the equipment and appurtenances shall be incorporated into the Working Drawings submitted to the Engineer.
5. Working Drawings specifically prepared for this Project shall be on mylar or other approved reproducible material sheets of the same size as the Drawings. Working Drawings shall conform to recognized drafting standards and be neat, legible and drawn to a large enough scale to show in detail the required information.
6. The Drawings are used for engineering and general arrangement purposes only and are not to be used for Working Drawings.

7. Shop Drawings

- a. Shop Drawings shall be submitted for each item of equipment furnished. The drawings shall indicate all equipment and its precise locations, all anchor bolt locations, sizes, materials and dimensions necessary for installation and connection, all mechanical and piping interconnections, piping supports and details, all interconnecting electrical and control wiring terminal strips. The Drawings will clearly indicate which equipment shall be furnished by the equipment supplier and what is furnished by the installation contractor. The Drawings will match the general arrangement furnished by the Engineer and include sufficient detail so the installation contractor can furnish a complete and operating system. The equipment supplier shall be responsible for structural details and walkways, and will be required to review the package for completeness and accuracy of details involving the equipment supplied. Structural design calculations will be required on equipment that performs structural functions.
- b. Shop Drawings on all electrical items shall include elementary diagrams and circuit schematics for all electrical and electronic components. Diagrams shall clearly identify the components parts of the electrical items and assembly details of circuit boards.
- c. Equipment data including, but not limited to, installation instructions, estimated weight of each unit of equipment, certified pump head – capacity and efficiency curves, wiring diagrams for controls and alarm circuits, lists of electrical controls including manufacturer's name and catalog number, motor load data and efficiency, and auxiliary equipment description and specifications. In addition, the equipment manufacturer will submit a guarantee for the equipment submitted for review and approval. The guarantee will be in a form acceptable to the Engineer and Owner.
- d. Contractor shall submit for review by the Engineer Shop Drawings for all fabricated work and for all manufactured items required to be furnished by the Contract Documents.
- e. Structural and all other layout Drawings prepared specifically for the Project shall have a plan scale of not less than 1/4-inch = 1 foot.
- f. Where manufacturer's publications in the form of catalogs, brochures, illustrations or other data sheets are submitted in lieu of prepared Shop Drawings, such submittals shall specifically indicate the item for which approval is requested. Identification of items shall be made in ink, and submittals showing only general information are not acceptable.

8. Layout and Installation Drawings

- a. Contractor shall prepare and submit for review by the Engineer layout and installation drawings for all pipes, valves, fittings, sewers, drains, heating and ventilation ducts, all electrical, heating, ventilating and other conduits, plumbing lines, electrical cable trays, lighting fixture layouts, and circuiting, instrumentation, interconnection wiring diagrams, communications, power supply, alarm circuits, etc., under this Contract. The final dimensions, elevation, location, etc., of pipe, valves, fittings, sewers, ducts, conduits, electrical cable trays, equipment, etc., may depend upon the dimensions of equipment and valves to be furnished by the Contractor.
- b. Layout and installation drawings are required for both interior and exterior piping, valves, fittings, sewers, drains, heating and ventilation ducts, conduits, plumbing lines, electrical cable trays, etc.
- c. Layout and installation Drawings shall show connections to structures, equipment, sleeves, valves, fittings, etc.
- d. Drawings shall show the location and type of all supports, hangers, foundations, etc., and the required clearances to operate valves, equipment, etc.
- e. The Drawings for pipes, ducts, conduits, etc., shall show all 3-inch and larger electrical conduits and pressure piping, electrical cable trays, heating and ventilation ducts or pipes, structure, manholes or any other feature within four (4) feet (measured as the clear dimension) from the pipe duct, conduit, etc., for which the profile is drawn.

9. Contractor Responsibilities

- a. All submittals from subcontractors, manufacturers or suppliers shall be sent directly to the Contractor for checking. Contractor shall thoroughly check all Drawings for accuracy and conformance to the intent of the Contract Documents. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors, manufacturers, or suppliers by the Contractor for correction before submitting them to the Engineer.
- b. All submittals shall be bound, dated, properly labeled and consecutively numbered. Information on the label shall indicate Specification Section, Drawing number, subcontractor's, manufacturer's or supplier's name and the name or type of item the submittal covers. Each part of a submittal shall be marked and tabulated.
- c. Working Drawings shall be submitted as a single complete package including all associated drawings relating to a complete assembly of the various parts necessary for a complete unit or system.
- d. Shop Drawings shall be submitted as a single complete package for any operating system and shall include all items of equipment and any

mechanical units involved or necessary for the functioning of such system. Where applicable, the submittal shall include elementary wiring diagrams showing circuit functioning and necessary interconnection wiring diagrams for construction.

- e. ALL SUBMITTALS SHALL BE THOROUGHLY CHECKED BY THE CONTRACTOR FOR ACCURACY AND CONFORMANCE TO THE INTENT OF THE CONTRACT DOCUMENTS BEFORE BEING SUBMITTED TO THE ENGINEER AND SHALL BEAR THE CONTRACTOR'S STAMP OF APPROVAL CERTIFYING THAT THEY HAVE BEEN SO CHECKED. SUBMITTALS WITHOUT THE CONTRACTOR'S STAMP OF APPROVAL WILL NOT BE REVIEWED BY THE ENGINEER AND WILL BE RETURNED TO THE CONTRACTOR.
- f. If the submittals contain any departures from the Contract Documents, specific mention thereof shall be made in the Contractor's letter of transmittal. Otherwise, the review of such submittals shall not constitute approval of the departure.
- g. No materials or equipment shall be ordered, fabricated, shipped or any work performed until the Engineer returns to the Contractor the submittals, herein required, annotated "Furnish as Submitted", "Furnish as Corrected", or "Furnish as Corrected – Confirm." If a submittal is returned "Furnish as Corrected – Confirm" the portions of work covered by the submittal that require confirmation by the Engineer shall not be ordered, fabricated, shipped, or any work performed until those portions are approved in a subsequent submittal either "Furnish as Submitted" or "Furnish as Corrected".
- h. Where errors, deviations, and/or omissions are discovered at a later date in any of the submittals, the Engineer's prior review of the submittals does not relieve the Contractor of the responsibility for correcting all errors, deviations, and/or omissions.

10. Procedure for Review

- a. Submittals shall be transmitted in sufficient time to allow the Engineer at least thirty (30) working days for review and processing.
- b. Contractor shall transmit seven (7) copies of all technical data or drawing to be reviewed.
- c. Submittal shall be accompanied by a letter of transmittal containing date, project title, Contractor's name, number and titles of submittals, a list of relevant specification sections, notification of departures from any Contract requirement, and any other pertinent data to facilitate review.
- d. A 10 character submittal identification numbering system shall be used:

- The first character shall be a D, M, R, S, or U, which represents Shop/Working Drawing and other Product Data (D); Operation and Maintenance Manual (M); Certification, Test Results, and ISA Forms (R); Sample (S); or Test Procedures (U).
- The next five digits shall be the applicable Specifications Section Number.
- The next three digits shall be the numbers 001-999 to sequentially number each separate item or drawing submitted under each specific Section number.
- The last character shall be a letter, A-Z, indicating the submission, or resubmission of the same Drawing, i.e., A-1st submission, B-2nd submission, C-3rd submission, etc. A typical submittal number would be as follows:

"D-15206-008-B"

D = Shop Drawing
 15206 = Specification Section for Sluice Gates
 008 = The eighth sequential submittal under this specification section
 B = The second submission (first resubmission) of that particular shop drawing.

- e. Submittals will be annotated by the Engineer in one of the following ways:

"Furnish as Submitted" (FAS) - no exceptions are taken

"Furnish as Corrected" (FAC) - minor corrections are noted and shall be made.

"Furnish as Corrected – Confirm" (FACC) - some corrections are noted and a partial resubmittal or additional information are required as specifically requested.

"Revise and Resubmit" (R&R) - major corrections are noted and a full resubmittal is required.

"For Information Only – Not Reviewed" (FIO) – submittal was received and was distributed for record purposes without review.

- f. If a submittal is satisfactory to the Engineer in full or in part, the Engineer will annotate the submittal "Furnish as Submitted", "Furnish as Corrected", or "Furnish as Corrected – Confirm", retain four (4) copies and return remaining copies to the Contractor. In the case of "Furnish as Corrected – Confirm" a partial resubmittal or additional information are required as specifically requested.

- g. If a full resubmittal is required, the Engineer will annotate the submittal "Revise and Resubmit" and transmit three (3) copies to the Contractor for appropriate action.
- h. Contractor shall continue to resubmit submittals in part if they are returned "Furnish as Corrected – Confirm" or in full if they are returned "Revise and Resubmit" as required by the Engineer until submittals are acceptable to the Engineer. It is understood by the Contractor that Owner may charge the Contractor the Engineer's charges for review in the event a submittal is not approved (either "Furnish as Submitted" or "Furnish as Corrected") by the third submittal for a system or piece of equipment. These charges shall be for all costs associated with engineering review, meetings with the Contractor or manufacturer, etc., commencing with the fourth submittal of a system or type of equipment submitted for a particular Specification Section.
- i. Acceptance of a Working Drawing by the Engineer will constitute acceptance of the subject matter for which the Drawing was submitted and not for any other structure, material, equipment or appurtenances indicated or shown.

11. Engineer's Review

- a. Engineer's review of the Contractor's submittals shall in no way relieve the Contractor of any of his responsibilities under the Contract. An acceptance of a submittal shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications.
- b. Engineer's review will be confined to general arrangement and compliance with the Contract Drawings and Specifications only, and will not be for the purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of trades, etc.

12. Record Working Drawings

- a. Contractor shall maintain current record drawings onsite for the Engineer's review. Record drawings shall be updated monthly at a minimum.
- b. Prior to final payment, the Contractor shall furnish the Engineer one complete set of all accepted Working Drawings, including Shop Drawings, for equipment, piping, electrical work, heating system, ventilating system, air conditioning system, instrumentation system, plumbing system, structural, interconnection wiring diagrams, etc.
- c. Working Drawings furnished shall be corrected to include any departures from previously accepted Drawings.

D. Operation and Maintenance Manuals

1. Two (2) preliminary copies of Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals shall be provided to the Engineer not less than 60 days prior to the start-up of the respective equipment.
2. The preliminary manuals shall be reviewed by the Engineer prior to the Contractor submitting final copies for distribution to the Owner. Following review of the preliminary copies of the Operation and Maintenance Manuals, one (1) copy will be returned to the Contractor with required revisions noted, or the acceptance of the Engineer noted.
3. Manuals shall contain complete information in connection with assembly, operation, lubrication, adjustment, wiring diagrams and schematics, maintenance, and repair, including detailed parts lists with drawings or photographs identifying the parts.
4. Manuals furnished shall be assembled and bound in separate volumes, by major equipment items or trades, and properly indexed to facilitate locating any required information. In addition, manuals should be labeled in the front cover with the project, name, equipment description, and manufacturer contract information.
5. Engineer and the Owner shall be the sole judge of the acceptability and completeness of the manuals and may reject any submittal for insufficient information included, incorrect references and/or the manner in which the material is assembled.
6. Following the Engineer's review of the preliminary manuals, the Contractor shall submit three (3) paper copies and one (1) electronic copy (tabulated PDF) of the final Operation and Maintenance Manuals to the Engineer. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents. Failure of the final manuals to reflect the required revisions noted by the Engineer during a review of the Preliminary documents will result in the manuals being returned to the Contractor. Acceptable final Operation and Maintenance Manuals shall be provided not less than two weeks prior to equipment start-up.

E. Certified Shop Test Reports

1. Each piece of equipment for which pressure, head, capacity, rating, efficiency, performance, function or special requirements are specified or implied shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and applicable test codes and standards. Contractor shall keep the Engineer advised of the scheduling of shop tests so that the Engineer may arrange for the witnessing or inspection at the proper time and place.

2. The Contractor shall secure from the manufacturers seven (7) copies of the actual test data, the interpreted results and a complete description of the testing facilities and testing setup, all accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company and notarized. These reports shall be forwarded to the Engineer for review.
3. In the event any equipment fails to meet the test requirements, the manufacturer shall make all necessary changes, adjustments or replacements and the tests shall be repeated, at no additional cost to the Owner or Engineer, until the equipment test requirements are acceptable to the Engineer.
4. No equipment shall be shipped to the Project until the Engineer notifies the Contractor, in writing, that the shop test reports are acceptable.

F. Samples

1. Contractor shall furnish for review all samples as required by the Contract Documents or requested by the Engineer.
2. Samples shall be of sufficient size or quantity to clearly illustrate the quality, type, range of color, finish or texture and shall be properly labeled to show the nature of the material, trade name of manufacturer and location of the work where the material represented by the sample will be used.
3. Samples shall be checked by the Contractor for conformance to the Contract Documents before being submitted to the Engineer and shall bear the Contractor's stamp of approval certifying that they have been so checked. Transportation charges on samples submitted to the Engineer shall be prepaid by the Contractor.
4. Engineer's review will be for compliance with the Contract Documents and his comments will be transmitted to the Contractor with reasonable promptness.
5. Accepted samples will establish the standards by which the completed work will be judged.

G. Construction Photographs

1. Aerial photograph sessions are required prior to the start of construction, once (1) during construction, and upon construction completion. Two (2) separate aerial photograph sessions (at different times) shall be required for this contract with 12 different exposures per session.

H. Record Drawings

1. The Contractor shall maintain an accurate and current set of record drawings during the construction. Record drawings shall indicate any changes from the Contract Drawings due to field orders, change orders, differences in equipment and materials provided from those shown on the drawings, or changes in locations of features from those shown on the drawings.

2. The Contractor shall maintain record drawing information current as the project progresses and be prepared to verify status of the record drawings for the Engineer at the monthly progress meetings prior to submission of partial payment request.
3. In addition to the modifications to the drawings required for record drawings, the Contractor shall provide a set of field yard piping and site plan drawings in a computerized format using an AutoCAD compatible software. These drawings shall communicate detailed, survey-verified information on the horizontal and vertical location of all major structures and all major (4" and larger) yard piping including each fitting and valve.

I. Equipment Warranties

1. The equipment furnished under this Contract shall be guaranteed to be free from defects in workmanship, design and/or materials for a period of one (1) year unless otherwise specified. The period of such warranties shall start on the substantial completion date provided that the equipment demonstrates satisfactory performance during the thirty (30) day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty (30) day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. Warranties and guarantees shall be indicated on a form satisfactory to the Engineer and Owner. The Equipment Supplier shall repair or replace without charge (i.e. parts and labor) to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.
2. Certification of start-up and full testing shall be performed by the manufacturer using the services of an authorized service representative trained in this type service. Written certification shall be filed with the Engineer on the manufacturer's stationary. Written certification shall be filed in triplicate and shall indicate tests he made in accordance with the manufacturer's recommendations, and that the test and start-up operation has been satisfactory, and that the equipment is fully operational under design requirements.
3. The Contractor and manufacturer or supplier shall submit, with the Shop Drawings for review and approval, a guarantee for the equipment submitted. The guarantee shall be in a form acceptable to the Engineer and Owner.
4. The Equipment Supplier shall guarantee that the supplied and installed equipment or system shall meet or exceed the requirements, purpose and suitability as set forth in the equipment specifications for the period specified.

If the supplied and installed equipment does not produce the required performance conditions, the Contractor/Equipment Supplier shall make whatever changes necessary including, but not limited to, modifications or improvements to the existing equipment or supply of new or additional units, to achieve the required performance. Such work shall be carried out in the expeditious manner at no additional cost to the Owner and with the full cooperation of the Owner and Engineer.

Should the foregoing modifications, adjustments or supply of additional units fail to achieve the required performance, the Owner, at his option, may accept the equipment or return the equipment for a refund of the purchase price, cost of removal, and return freight of the equipment.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01350

SEISMIC ANCHORAGE AND BRACING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to design and provide seismic restraint and bracing for all nonstructural architectural, mechanical, electrical, and plumbing components and their supports and attachments permanently attached to the primary structure in which the components are to be installed in accordance with the Contract Documents and the seismic restraint requirements of Chapter 13 in ASCE 7.
- B. Furnish mechanical, electrical, and plumbing equipment manufacturer certifications showing seismic compliance in accordance with Chapter 13 of ASCE 7 for equipment designated as an essential component or to remain operational following a seismic event.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01450 – Special Inspections
- B. Section 05010 – Metal Materials
- C. Section 05050 – Metal Fastening
- D. Section 05061 – Stainless Steel
- E. Section 05120 – Structural Steel
- F. Section 05140 – Structural Aluminum
- G. Section 15000 – Basic Mechanical Requirements
- H. Section 15020 – Pipe Supports
- I. (Not Used)
- J. Section 15800 – Heating, Ventilation, and Air Conditioning
- K. Section 16000 – Basic Electrical Requirements
- L. Division 17 – Control and Information Systems
- M. Further requirements for seismic anchorage and bracing may be included in other Sections of the Specifications. See section for the specific item in question.

1.03 DEFINITIONS

- A. Nonstructural components: All architectural, mechanical, electrical or plumbing elements or systems and their supports or attachments provided under this contract which are permanently attached to the floors, roof, walls, columns and beams of newly constructed buildings, building additions, existing buildings or non-building structures.
 - 1. Architectural nonstructural components include, but are not limited to, interior nonstructural walls and partitions, exterior wall panels and glazing elements, glass curtain walls, skylights, cabinets, suspended ceilings, fascias, and cladding.
 - 2. Mechanical nonstructural components include, but are not limited to, HVAC units, fans, water and wastewater treatment process equipment, instrumentation cabinets, piping and ductwork.
 - 3. Electrical nonstructural components include, but are not limited to, conduit systems, cable tray systems, boxes, transformers, panelboards, switchboards, switchgear, busway, individual motor controllers, motor control centers, variable frequency drives, automatic transfer switches, and lighting systems.
 - 4. Plumbing nonstructural components include, but are not limited to, sprinkler systems and associated piping, and sump pumps.
- B. Seismic Restraint: Attachments and supports, including braces, frames, legs, hangers, saddles, and struts which anchor and brace nonstructural components to minimize their displacement during an earthquake and transmit loads between non-structural components and their attachments to the structure or building.
- C. Attachment: Elements including anchor bolts, welded connections, and mechanical fasteners which secure non-structural components or supports to the structure.
- D. Hazardous: Toxic, flammable, explosive or corrosive materials in excess of building code mandated threshold quantities for non-hazardous condition.
- E. Essential Components: Nonstructural components considered necessary to public safety for which the importance factor I_p applies, including:
 - 1. Life safety systems which must function following an earthquake, including but not limited to, sprinklers for fire protection, emergency lighting, egress corridors and stairways, and smoke purge systems.
 - 2. Components which contain, convey or support hazardous materials.
 - 3. Components which are within or attached to an Occupancy or Risk Category IV structure as defined in ASCE 7 Chapter 1.

4. Process systems and elements designated below:
 - a. Water storage facilities and water pumping systems required to maintain water pressure used for fire suppression.
 - b. Natural gas piping and equipment.
- F. Nonbuilding Structures: All self-supporting structures which are supported by an independent foundation or by other structures which include, but are not limited to, storage tanks, silos, exhaust stacks, storage racks, and towers.
- G. Delegated Design: Design of a structure or structural element(s) which has been deferred by the contract documents to be performed during the project construction stage, by a registered design professional retained by the contractor and with the design submitted as a shop drawing to the Engineer.

1.04 EXEMPTIONS

- A. The following nonstructural components are exempt from requiring seismic anchorage and bracing: (See paragraph 1.07.C herein for Seismic Design Category)
 1. All architectural, mechanical, electrical and plumbing nonstructural components in Seismic Design Category A.
 2. All mechanical, electrical and plumbing nonstructural components in Seismic Design Category B.
 3. All architectural nonstructural components in Seismic Design Category B provided $I_p = 1.0$, except parapets supported by bearing or shear walls.
 4. All mechanical, electrical and plumbing nonstructural components in Seismic Design Category C provided $I_p = 1.0$.
 5. All mechanical, electrical and plumbing nonstructural components in Seismic Design Category D, E or F provided all the following apply:
 - a. $I_p = 1.0$.
 - b. Components are positively attached to the structure without consideration of frictional resistance and have flexible connections between the components and associated ductwork, piping and conduit.
 - c. Either of the following:
 - i. Component center of mass is 4 ft or less above a floor level and weighs 400 lbs or less.
 - ii. Component weighs 20 lbs or less or 5 plf or less for distribution systems.

6. Other exemptions as allowed by the Specifications, Codes and Standards referenced herein.

1.05 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. The building code shall be the version in effect at the time of Bid within the jurisdiction where the Work is located. All other referenced specifications, codes, and standards refer to the version as referenced by the building code. If no version is referenced by the building code, then the most current issue available at the time of Bid shall be used.

1. International Building Code
2. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures
3. NFPA 13 Standard for Installation of Sprinkler Systems
4. FEMA 412 Installing Seismic Restraints for Mechanical Equipment
5. FEMA 413 Installing Seismic Restraints for Electrical Equipment
6. FEMA 414 Installing Seismic Restraints for Duct and Pipe
7. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Seismic Restraint Manual: Guidelines for Mechanical Systems
8. ACI 318 Building Code Requirements for Structural Concrete and Commentary
9. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete
10. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete

1.06 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 1. Seismic anchorage and bracing shop drawings for all architectural, mechanical, electrical, and plumbing nonstructural components, elements and systems not meeting any of the exemptions in paragraph 1.4 above and do not have a design for seismic anchorage and bracing provided within the contract documents. Submittals shall include the following:

- a. Component manufacturer's cut sheets and fabrication details for equipment bases and foundations, including dimensions, structural member sizes, support point locations and equipment operational loads. Equipment anchorage details shall clearly indicate anchor size, pattern, embedment and edge distance requirements to satisfy operational and seismic forces. Details shall also indicate grout, bearing pads, isolators, etc required for complete installation.
 - b. Design calculations, signed and sealed by a Professional Engineer registered in the State of South Carolina confirming the proposed seismic restraints and attachment will provide sufficient strength and stiffness to resist the design earthquake and limit damage to nonstructural components and the entire support is sufficient to resist the combined gravity and seismic loads. Separate calculation submittals for vertical and lateral load support systems shall not be allowed.
 - c. Detailed Shop Drawings, signed and sealed by a Professional Engineer registered in the State of South Carolina, showing specific details of the support design including material, installation, attachments, connection hardware, etc, and the restraint layout and location of all hangers and supports (resisting both gravity and seismic loads), including restraint orientation and direction of force(s) to be resisted. Within each submittal, the Contractor shall include a **cumulative** set of hanger and support location drawings (one cumulative 'living drawing for each building structure) containing all proposed mechanical, electrical and plumbing support locations submitted to date showing the locations of all support attachments to the primary structure. Load magnitudes shall be indicated at attachments to the structure where the sum of the reaction loads on a single member exceeds 1,000 pounds vertically or exceeds 500 pounds horizontally. Unless requested by the Engineer, load magnitudes need not be submitted for load values less than these stated values. Separate shop drawing submittals for vertical and lateral load support systems shall not be allowed.
 - d. For components required to be certified as seismically qualified in accordance with paragraph 1.06.A.2 below, submit installation guidelines provided by the equipment manufacturer for proper seismic mounting of the equipment.
2. For each mechanical, electrical and plumbing nonstructural components and systems furnished, including associated equipment appurtenances and attachments, designated as essential components in Seismic Design Categories C through F, provide Manufacturer's Certification signed and sealed by a registered Professional Engineer in the State of South Carolina to show the component is seismically qualified in accordance with the Specifications, Codes, and Standards requirements referenced herein. The following requirements shall be met:

- a. Seismic qualification shall be substantiated either by approved shake table testing or experience data, with the evidence of such qualification testing or experience data submitted to the Engineer along with the manufacturer's statement certifying the equipment shall remain operable following the design seismic event.
 - b. Components with hazardous contents shall also be certified by the manufacturer to maintain containment following the design seismic event based on analysis, approved shake table testing, or experience data. Evidence demonstrating compliance shall be submitted to the Engineer.
 - c. Seismic qualification testing shall be based on ASCE 7 and on a nationally recognized testing standard procedure such as ICC-ES AC 156.
- 3. Seismic anchorage and bracing shop drawings for all architectural, mechanical, electrical, and plumbing nonstructural components, elements and systems that do not meet any of the exemptions in paragraph 1.4 above and do not have a design for seismic anchorage and bracing provided within the contract documents. Submittals shall include the following:
 - a. Component manufacturer's cut sheets and fabrication details for equipment bases and foundations, including dimensions, structural member sizes, support point locations and equipment operational loads. Equipment anchorage details shall clearly indicate anchor size, pattern, embedment and edge distance requirements to satisfy operational and seismic forces. Details shall also indicate grout, bearing pads, isolators, etc required for complete installation.
 - b. Design calculations, signed and sealed by a Professional Engineer registered in the State of South Carolina confirming the proposed seismic restraints and attachment will provide sufficient strength and stiffness to resist the design earthquake and limit damage to nonstructural components and that the entire support is sufficient to resist the combined gravity and seismic loads. Separate calculation submittals for vertical and lateral load support systems shall not be allowed.
 - c. Detailed Shop Drawings, signed and sealed by a Professional Engineer registered in the State of South Carolina, showing specific details of the support design including material, installation, attachments, connection hardware, etc, and the restraint layout and location of all hangers and supports (resisting both gravity and seismic loads), including restraint orientation and direction of force(s) to be resisted. Within each submittal, each Prime Contractor shall include a **cumulative** set of hanger and support location drawings (one cumulative 'living' drawing for each building structure) containing all proposed support locations which that Contractor has submitted to date showing the locations of all support attachments to the primary structure. Load magnitudes shall be indicated at attachments to the structure where the sum of all reaction loads on a single member (from all attachments of all Prime Contractors) exceeds 1000 pounds vertically or exceeds 500 pounds horizontally. Unless requested by the

Engineer, load magnitudes need not be submitted for load values less than these stated values. Separate shop drawing submittals for vertical and lateral load support systems shall not be allowed.

- d. For components required to be certified as seismically qualified in accordance with paragraph 1.06.A.2 below, submit installation guidelines provided by the equipment manufacturer for proper seismic mounting of the equipment.
4. For each mechanical, electrical and plumbing nonstructural components and systems furnished, including associated equipment appurtenances and attachments, designated as essential components in Seismic Design Categories C through F, provide Manufacturer's Certification signed and sealed by a registered Professional Engineer in the State of South Carolina to show the component is seismically qualified in accordance with the Specifications, Codes, and Standards requirements referenced herein. The following requirements shall be met:
- a. Seismic qualification shall be substantiated either by approved shake table testing or experience data, with the evidence of such qualification testing or experience data submitted to the Engineer along with the manufacturer's statement certifying the equipment shall remain operable following the design seismic event.
 - b. Components with hazardous contents shall also be certified by the manufacturer to maintain containment following the design seismic event based on analysis, approved shake table testing, or experience data. Evidence demonstrating compliance shall be submitted to the Engineer.
 - c. Seismic qualification testing shall be based on ASCE 7 and on a nationally recognized testing standard procedure such as ICC-ES AC 156.

1.07 DESIGN REQUIREMENTS

- A. Seismic restraints systems for nonstructural components shall be subject to the most current local Building Code in conjunction with the seismic provisions of the International Building Code (IBC) Section 1613 and referenced ASCE 7 Chapter 13.
- B. Seismic restraints systems for nonbuilding structures shall be subject to the most current local Building Code in conjunction with the seismic provisions of the International Building Code (IBC) Section 1613 and referenced ASCE 7 Chapter 15,
- C. Nonstructural components shall be assigned to the same Seismic Design Category as the structure they occupy or to which they are attached. Design of seismic support system and anchorage shall follow the site-specific seismic criteria noted on the drawings. Criteria shall include site-specific spectral response coefficients, site class, seismic design category, and risk category.
- D. Component Importance Factor I_p shall be 1.5 for all essential nonstructural components noted in item 1.03.E above. All other nonstructural components shall utilize $I_p = 1.0$ unless noted otherwise.

- E. Components shall be restrained and braced for earthquake forces both in the vertical and each orthogonal direction. Seismic restraint systems shall limit deflections of components per ASCE 7 and the displacements shall not impede component functionally and containment.
- F. Anchorage shall be designed in accordance with ASCE 7. Mechanical fasteners used to secure nonstructural architectural, mechanical, electrical and plumbing components shall meet the requirements of Specification Section 05050. All mechanical fasteners used to anchor essential components and other elements so designated in Specification Section 05050 shall be considered Structural Anchors.
- G. Avoid crossing structural expansion joints with seismic supports or bracing. Nonstructural components shall not be attached to multiple structure elements which may respond differently in an earthquake without provisions to accommodate independent movement. Flexible expansion loops or offsets, flexible joints, bellows type pipe expansion joints, couplings, etc shall be provided at structure expansion joints to allow for independent structure movement and thermal movement of piping, ductwork and conduit. Minimum movement capability in the vertical and each orthogonal direction shall equal the width of the joint.
- H. Provide flexible connections, piping, conduit, etc at foundation levels where below grade utilities enter into the structure.
- I. Design of support system for components with multiple attachments shall take into account the stiffness and ductility of the supporting members. Equipment designed as free-standing shall only be attached at its base. Use of non-free standing equipment requiring both vertical and lateral attachment is contingent upon loads applied to the structure and requires approval by the Engineer.
- J. The seismic restraint design shall be based on actual equipment data (dimensions, weight, center of gravity, etc) obtained from the specifications or the approved equipment manufacturer. The equipment manufacturer shall verify the attachment points on the equipment can safely withstand the combination of seismic, self-weight and other loads imposed.
- K. Attachments of nonstructural component supports and seismic restraints causing the building structure slabs, beams, walls, columns, etc. to be overstressed shall not be permitted.
- L. Where the weight of a nonstructural component is greater than or equal to 25 percent of the effective seismic weight (as defined by ASCE 7) of the structure it is attached to, the component shall be classified as a nonbuilding structure and its support designed in accordance with ASCE 7 Chapter 15.
- M. No reaction loads (either vertical or lateral) from nonstructural component supports and seismic restraints shall be allowed on any element where design has been delegated unless the additional loads on the element have been coordinated with the delegated designer and the submittal is accompanied by a sealed letter from the delegated designer indicating the element has been designed to support the reaction loads.

- N. Reaction loads from nonstructural component supports and seismic restraints shall be transferred directly to the primary structural members, with no components supported from secondary members unless otherwise approved.
- O. No holes shall be drilled into any structural steel for attachment of component supports without prior approval of the Engineer.

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Seismic restraints and braces shall be constructed of appropriate materials and connecting hardware to provide a continuous load path between the component and supporting structure of sufficient strength and stiffness to resist the calculated design seismic forces and displacements.
- B. Component restraint, bracing and connection materials shall be compatible with and in general match the component and component gravity support materials. Contact between dissimilar metals shall be prevented. See Section 15020 – Pipe Supports for additional details.
- C. Post-installed concrete anchors used for seismic restraint and bracing anchorage shall be considered structural anchors per Section 05050 and shall be prequalified for use in seismic applications.
- D. Powder actuated fasteners in steel or concrete shall not be used for sustained tension loads in Seismic Design Categories D, E or F unless approved for seismic loading or specifically exempted by ASCE 7. Powder actuated fasteners in masonry shall not be used unless approved for seismic loading regardless of Seismic Design Category.
- E. Friction clips shall not be used in Seismic Design Categories D, E or F for supporting sustained tension loads in combination with resisting seismic forces. C-type and large flange clamps may be used for hanger attachments provided restraining straps meeting NFPA 13 requirements are utilized and loosening of threaded connections is prevented by lock nuts, burred threads, etc.

PART 3 -- EXECUTION

3.01 INSTALLATION OF SEISMIC RESTRAINTS AND ANCHORAGES

- A. No components, seismic anchorages or restraints shall be installed prior to review and acceptance by the Engineer and permitting agency.
- B. Seismic certified equipment shall be installed per the manufacturer's recommendations. Fasteners shall meet manufacturer's requirements.
- C. Following installation, all seismic restraints, bracing and seismically qualified equipment shall be inspected. See Specification Section 01450 for Special Inspection requirements.

- END OF SECTION -

SECTION 01400
QUALITY CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Testing Laboratory Services

1. Laboratory testing and checking required by the Specifications, including the cost of transporting all samples and test specimens, shall be provided and paid for by the Owner unless otherwise indicated in the Specifications.
2. Materials to be tested include, but are not necessarily limited to the following: cement, concrete aggregate, concrete, bituminous paving materials, structural and reinforcing steel, waterproofing, select backfill, crushed stone or gravel and sand.
3. Tests required by the Owner shall not relieve the Contractor from the responsibility of supplying test results and certificates from manufacturers or suppliers to demonstrate conformance with the Specifications.
4. Procedure
 - a. The Contractor shall plan and conduct his operations to permit taking of field samples and test specimens, as required, and to allow adequate time for laboratory tests.
 - b. The collection, field preparation and storage of field samples and test specimens shall be as directed by the Engineer with the cooperation of the Contractor.
5. Significance of Tests
 - a. Test results shall be binding on both the Contractor and the Owner, and shall be considered irrefutable evidence of compliance or noncompliance with the Specification requirements, unless supplementary testing shall prove, to the satisfaction of the Owner, that the initial samples were not representative of actual conditions.
6. Supplementary and Other Testing
 - a. Nothing shall restrict the Contractor from conducting tests he may require. Should the Contractor at any time request the Owner to consider such test results, the test reports shall be certified by an independent testing laboratory acceptable to the Owner. Testing of this nature shall be conducted at the Contractor's expense.

1.02 WATERTIGHTNESS OF STRUCTURES

- A. It is the intent of these Specifications that all concrete work, sealing work around built-in items and penetrations be performed as required to insure that groundwater, surface water, and water or liquids in tanks, channels and containers will not intrude into any equipment rooms, pipe galleries, habitable areas or other generally dry areas.
- B. The required watertightness shall be achieved by quality concrete construction and proper sealing of all joints and penetrations.
- C. Each unit shall be tested separately and the leakage tests shall be made prior to backfilling and before equipment is installed. Raw water may be used in testing of any item or system not forming a part of the potable water supply.
- D. The General Contractor shall provide at his own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests.

E. Built-In Items and Penetrations

- 1. All pipe sleeves, built-in items and penetrations shall be sealed as detailed and as required to insure a continuous watertight seal.
- 2. Penetration through built-up roofing areas shall be made prior to application of the built-up roofing utilizing suitable sleeves and flashings as required.

If roofing surfaces are penetrated after roofing has been applied, the waterproofing integrity shall be restored.

F. Structures

- 1. All water holding structures shall be tested for leakage by the General Contractor.
- 2. Each structure shall be filled with water to overflowing or such other level as directed by the Engineer for a period of not less than 24 hours. All sleeves and other openings shall be temporarily plugged during the test period.
- 3. Exterior surfaces shall be examined for leakage, especially at joints. Leakage will be considered to be within allowable limits when there is no visible sign of leakage and the water surface does not drop more than 1/2-inch during 24 hours. A slight dampness on exterior walls will not be considered as leakage. If the leakage exceeds the allowable limit, the work shall be corrected by methods approved by the Engineer.
- 4. Upon completion of the necessary remedial work, the leakage test shall be repeated until it is successfully passed.

G. Notification by Engineer

If any leaks, in excess of the specified amount, are not remedied by the General Contractor within four (4) weeks of notification by the Engineer, regardless of whether the cause of

these leaks is or is not determined, the Engineer shall have the authority to have these leaks repaired by others. The cost of repairs, by others, shall be deducted from monies due or to become due to the General Contractor.

1.03 FIELD TESTING OF EQUIPMENT

A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions.

B. Preliminary Field Tests, Yellow Tag

1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall check the equipment for alignment, direction of rotation and that it is free from defects.
2. Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.
3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or his assigned representative and attached to the equipment. The tag shall not be removed.
4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

C. Final Field Tests, Blue Tag

1. Upon completion of the installation, and at a time approved by the Engineer, equipment will be tested by operating it as a unit with all related piping, ducting, electrical controls and mechanical operations.
2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his assigned representative and the Owner or his assigned representative.
3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Equipment shall be tested for the characteristics as specified for the item.
4. Each pump shall be tested at maximum rated speed for at least four points on the pump curve for capacity, head and electric power input. The rated motor nameplate current and power shall not be exceeded at any point within the specified range. Vibrometer readings shall be taken when directed by the Engineer and the results recorded. Additional tests shall be performed as prescribed in other sections of the Specifications.

5. Pumps with drive motors rated at less than five horsepower shall only be tested for excess current or power when overheating or other malfunction becomes evident in general testing.
6. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.
7. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.
8. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.
9. All costs in connection with such tests including all materials, equipment, instruments, labor, etc., shall be borne by the Contractor.

1.04 IMPERFECT WORK, EQUIPMENT, OR MATERIALS

- A. Any defective or imperfect work, equipment, or materials furnished by the Contractor which is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be removed immediately even though it may have been overlooked by the Engineer and estimated for payment. Any equipment or materials condemned or rejected by the Engineer shall be tagged as such and shall be immediately removed from the site. Satisfactory work or materials shall be substituted for that rejected.
- B. The Engineer may order tests of imperfect or damaged work, equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor; and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the work, equipment, or material was not impaired, consistent with the final general appearance of same, the work, equipment, or materials may be deemed acceptable. If the results of such tests reveal that the required functional capability of the questionable work, equipment, or materials has been impaired, then such work, equipment, or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect work, equipment, or material in lieu of performing the tests.

1.05 INSPECTION AND TESTS

- A. The Contractor shall allow the Engineer ample time and opportunity for testing materials and equipment to be used in the work. He shall advise the Engineer promptly upon placing orders for material and equipment so that arrangements may be made, if desired, for inspection before shipment from the place of manufacture. The Contractor shall at all times furnish the Engineer and his representatives, facilities including labor, and allow proper time for inspecting and testing materials, equipment, and workmanship. The Contractor must anticipate possible delays that may be caused in the execution of his work due to the necessity of materials and equipment being inspected and accepted for use. The Contractor shall furnish, at his own expense, all samples of materials required

by the Engineer for testing, and shall make his own arrangements for providing water, electric power, or fuel for the various inspections and tests of structures and equipment.

- B. The Contractor shall furnish the services of representatives of the manufacturers of certain equipment, as prescribed in other Sections of the Specifications. The Contractor shall also place his orders for such equipment on the basis that, after the equipment has been tested prior to final acceptance of the work, the manufacturer will furnish the Owner with certified statements that the equipment has been installed properly and is ready to be placed in functional operation. Tests and analyses required of equipment shall be paid for by the Contractor, unless specified otherwise in the Section which covers a particular piece of equipment.
- C. Where other tests or analyses are specifically required in other Sections of these Specifications, the cost thereof shall be borne by the party (Owner or Contractor) so designated in such Sections. The Owner will bear the cost of all tests, inspections, or investigations undertaken by the order of the Engineer for the purpose of determining conformance with the Contract Documents if such tests, inspection, or investigations are not specifically required by the Contract Documents, and if conformance is ascertained thereby. Whenever nonconformance is determined by the Engineer as a result of such tests, inspections, or investigations, the Contractor shall bear the full cost thereof or shall reimburse the Owner for said cost. In this connection, the cost of any additional tests and investigations, which are ordered by the Engineer to ascertain subsequent conformance with the Contract Documents, shall be borne by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION –

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SECTION 01450

SPECIAL INSPECTIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. This section defines the requirements for Special Inspections as required by Section 1704 of the International Building Code (IBC) and any State or local amendments.
- B. The Engineer will prepare a Statement of Special Inspections, which identifies the type and extent of required Special Inspections. These Agencies shall be independent from the Contractor and approved by the Building Official.
- C. The Contractor shall plan and conduct his operations as to schedule and allow Special Inspections, providing adequate time and safe access for inspections. The Contractor shall coordinate requirements for Special Inspections with the Special Inspections Agency.
- D. Special Inspections shall be in addition to inspections performed by Building Officials that are specified in IBC Section 109.
- E. Special Inspections shall be in addition to any Structural Observations required by IBC Section 1710.
- F. Special Inspections do not supersede other inspections and testing required by the Contract Documents to satisfy the Contractor's quality control responsibility. Contractor shall be responsible for all costs associated with quality control requirements as required by other sections of the Specifications.
- G. Special Inspections shall not relieve Contractor's obligation to perform and complete work in accordance with Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.
- H. This section does not apply to construction equipment, shoring, earth retention systems, and temporary structures used by the Contractor in construction and not detailed in the Contract Documents. The Contractor shall be solely responsible for means, methods, techniques, sequences, or procedures of construction and any associated building code requirements.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Special Inspections requirements apply to work detailed in other sections of the Specifications. Special Inspections requirements shall be in addition to any other inspection or quality control requirements detailed in other sections of the Specifications. See individual specification sections for type of work in question.

1.03 DEFINITIONS

- A. Periodic Special Inspections: The part-time or intermittent observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.
- B. Continuous Special Inspections: The full-time observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work is being performed.
- C. Engineer: The Registered Design Professional in Responsible Charge of each building system. These systems include structural, mechanical, electrical, and architectural components.
- D. Special Inspector: Individual employed by or retained by the Special Inspections Agency who is qualified in inspection of a particular type of construction and conducts inspection activities in that type of construction, as required by this section.
- E. Statement of Special Inspections: Document prepared by the Engineer and submitted to the Building Official which identifies the type and extent of required Special Inspections.
- F. Approved Fabricator: Fabricator who has been registered and approved by the Building Official to perform a particular type of work without Special Inspections.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents and all other documents referenced in the specifications. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code
 - 2. ACI 318 Building Code Requirements for Structural Concrete
 - 3. ACI 530.1/ASCE 6 Specifications for Masonry Structures
 - 4. AISC "Code of Standard Practice."
 - 5. AISC "Specification for Structural Steel Buildings".
 - 6. AISC 348 "The 2009 RCSC Specification for Structural Joints".
 - 7. AWS "Structural Welding Code".
 - 8. Aluminum Association Specifications for Aluminum Structures

1.05 SUBMITTALS

- A. The Contractor shall submit the following in accordance with Section 01300, Submittals.
 - 1. The Contractor shall submit a written statement of responsibility to the Building Official and Engineer using the attached form entitled "Contractor's Statement of Responsibility" prior to beginning work. A statement is required from each Contractor who has responsibility for construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections.
 - 2. The Contractor shall submit qualifications of any fabricators they intend to use that may qualify as Approved Fabricators to the Special Inspections Agency for review.

1.06 SPECIAL INSPECTOR QUALIFICATIONS

Special Inspectors shall meet minimum qualifications established by the Building Official and shall be approved by the Building Official.

1.07 OFF-SITE FABRICATIONS

- A. When structural elements or assemblies are fabricated off site, Special Inspections are required to be performed in the fabricator's shop unless the fabricator is an Approved Fabricator. Special Inspections are not required if work is done on the premises of an Approved Fabricator.
- B. Fabricators shall maintain detailed fabrication and quality control procedures to ensure workmanship and conformance with Contract Documents and reference standards. The Special Inspections Agency shall review the fabricator's quality control procedures and coordinate required Special Inspections with the fabricator and the Contractor.
- C. The Contractor shall submit qualifications of fabricators seeking Approved Fabricator status to the Special Inspections Agency for review. Approval as an Approved Fabricator shall be given by the Building Official upon the recommendation of the Special Inspections Agency or upon review of the fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 PRE-INSPECTION MEETING

At least two weeks prior to beginning work, a Pre-inspection Meeting shall be held to discuss the Special Inspection procedures and submittals. The following parties shall participate: the Engineer, a Special Inspections Agency representative, the Contractor, Subcontractors, Testing Agencies, and the Building Official. The type of meeting (in-person or teleconference) and location of meeting shall be determined by the Building Official.

3.02 STATEMENT AND SCHEDULE OF SPECIAL INSPECTIONS

The Special Inspections Agency and all Special Inspectors are required to comply with all requirements of the Statement of Special Inspections and the Schedule of Special Inspections. Together, these documents identify materials, systems, components, and work that are required to have Special Inspections, the type and extent of Special Inspections, and whether they will be continuous or periodic.

3.03 SPECIAL INSPECTIONS AGENCY REQUIREMENTS AND RESPONSIBILITIES

- A. The Special Inspections Agency shall be an established and recognized agency regularly engaged in conducting tests or furnishing inspection services, which has been approved by the Building Official and is retained by the Owner. The Agency shall demonstrate competence, to the satisfaction of the Building Official, for the inspection of the particular type of construction or operation requiring Special Inspection.
- B. The Special Inspections Agency shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the Engineer or the Building Official. The Agency shall submit all required reports to the Engineer and Building Official. Where Engineer approval is required for corrections, the Special Inspector shall maintain copies of all related correspondence and submit with all required reports. The Agency shall coordinate all required Special Inspection activities with the Special Inspectors, the Contractor, and any fabricators and shall coordinate designation of fabricators as Approved Fabricators when requested.

3.04 SPECIAL INSPECTORS' REQUIREMENTS AND RESPONSIBILITIES

- A. All Special Inspectors shall meet the qualification requirements determined by the Building Official for the particular type of inspection services they will be providing and shall be approved by the Building Official. Special Inspectors shall submit written documentation demonstrating their competence and experience or training to the Building Official for approval of their qualifications.
- B. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the Engineer or the Building Official. Special Inspectors shall submit all required reports to the Engineer and the Building Official. Where Engineer approval is required for corrections, the Special Inspector shall maintain copies of all related correspondence and

submit with all required reports. Special Inspectors shall coordinate inspection requirements and timing with the Contractor.

- C. Any discrepancies in work noted by the Special Inspector shall be brought to the immediate attention of the Contractor for correction. Special Inspectors shall coordinate correction of discrepancies with the Contractor. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the Engineer. If noted discrepancies are not corrected, the Special Inspector shall notify the Contractor, the Engineer, and the Building Official. All noted discrepancies and corrections shall be documented in all inspection records and all required reports.

3.05 CONTRACTOR RESPONSIBILITIES

- A. Each Contractor responsible for the construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections shall submit a Statement of Responsibility to the Building Official and Engineer prior to the commencement of work. The Statement of Responsibility shall contain acknowledgement of the special requirements contained in the Statement of Special Inspections.
- B. The Contractor shall coordinate requirements of Special Inspections with the Special Inspections Agency and the Special Inspectors and shall provide adequate time and access to conduct inspections. The Contractor is solely responsible for providing safe access and any necessary safety equipment required to conduct inspections. The Special Inspector shall not supervise, direct, control, or have authority over or be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of the Contractor to comply with Laws and Regulations applicable to the performance of the Work.
- C. Special Inspections shall not relieve the Contractor's obligation to perform and complete work in accordance with the Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.
- D. The Contractor shall provide advance notice of work to be conducted that will require Special Inspections. If the Special Inspector is delayed in inspecting the work due to inadequate notice or completion of the work, the Contractor shall reimburse the Owner for the cost of additional subsequent Special Inspections.
- E. The Contractor shall promptly correct any discrepancies noted by the Special Inspectors. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the Engineer. Where Engineer approval is required, the Contractor shall report the discrepancy to the Engineer in accordance with provisions of the General Conditions. The Engineer will authorize any changes to the Contract Documents required for the correction in accordance with provisions of the General Conditions. Copies of all correspondence related to the correction shall be submitted concurrently to the Special Inspections Agency.

3.06 BUILDING OFFICIAL OR AUTHORITY RESPONSIBILITIES

The Building Official will approve qualifications of the Special Inspections Agency, all Special Inspectors, and any Approved Fabricators. The Building Official will approve all forms submitted by the Contractor, any Approved Fabricators, the Engineer, the Special Inspections Agency, and the Special Inspectors. The Building Official and the Special Inspections Agency shall agree to the frequency of Interim Reports and the submittal deadline for the Final Report.

3.07 ENGINEER RESPONSIBILITIES

The Engineer shall complete the Statement of Special Inspections and the Schedule of Special Inspections. The Engineer shall respond to discrepancies noted by the Special Inspector, if required.

3.08 MINIMUM INSPECTION REQUIREMENTS

Detailed requirements for Special Inspections are shown in the Statement of Special Inspections and the Schedule of Special Inspections, which references the IBC, applicable code standards, and any State or local amendments. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Additional requirements for specific materials listed in other sections of these specifications shall also be satisfied. The frequency of inspections shall be continuous or periodic as indicated in the Schedule of Special Inspections and in accordance with applicable building codes.

3.10 DISCREPANCIES AND CORRECTIVE MEASURES

- A. The Special Inspector shall bring any discrepancies to the immediate attention of the Contractor for correction. The Contractor shall promptly correct any discrepancies noted by the Special Inspectors. Special Inspectors shall coordinate correction of discrepancies with the Contractor. Discrepancies and their correction shall be noted in inspection records and in all required reports. Any corrections that result in changes to the work as shown on the Contract Documents shall be approved by the Engineer. Where Engineer approval is required, the Contractor shall report the discrepancy to the Engineer in accordance with provisions of the General Conditions. The Engineer will authorize any changes to the Contract Documents required for the correction in accordance with provisions of the General Conditions. Copies of all correspondence related to the correction shall be submitted concurrently to the Special Inspections Agency.
- B. If discrepancies are not corrected promptly, the Special Inspector shall notify the Contractor, the Engineer, and the Building Official using the attached form "Notification of Failure to Correct Discrepancies."

3.11 REPORTS

Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the Engineer or the Building Official. The Special Inspections Agency shall submit all required reports to the Building Official and Engineer as agreed upon with the Building Official. Reports shall indicate the inspections and testing performed and whether work inspected was or was not completed in conformance to Contract Documents and any corrective measures taken. Where Engineer approval is required for corrections, the Agency shall maintain copies of all related correspondence and submit with all required reports.

STATEMENT OF SPECIAL INSPECTIONS

PROJECT: _____
LOCATION: _____
PERMIT APPLICANT: _____
APPLICANT'S ADDRESS: _____
ARCHITECT OF RECORD: _____
STRUCTURAL ENGINEER OF RECORD: _____
MECHANICAL ENGINEER OF RECORD: _____
ELECTRICAL ENGINEER OF RECORD: _____
REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE: _____

This Statement of Special Inspections is submitted in accordance with Section 1705 of the 2009 International Building Code. It shall be considered in conjunction with the Schedule of Special Inspections included in the Contract Documents. If applicable, it includes *Requirements for Seismic Resistance* and/or *Requirements for Wind Resistance*.

Are *Requirements for Seismic Resistance* included in the *Statement of Special Inspections*? ☐ Yes ☐ No

Are *Requirements for Wind Resistance* included in the *Statement of Special Inspections*? ☐ Yes ☐ No

The Special Inspector(s) shall keep detailed records of all inspections, including a copy at the jobsite. All records shall be available upon request by the Engineer or the Building Official. Any discrepancies shall be brought to the immediate attention of the Contractor. The Special Inspections Agency shall furnish Interim Reports to the Building Official and to the Engineer at the frequency indicated in the Statement of Special Inspections. A Final Report shall be submitted to the Building Official and the Engineer at the time agreed upon by the Owner and the Building Official.

Frequency of Interim Report submittals to the Building Official and the Engineer:

__Weekly __Bi-Weekly __Monthly Other; specify: _____

Special Inspections do not relieve the Contractor of the obligation to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

Statement of Special Inspections Prepared by:

Type or print name

Signature Date

Building Official's Acceptance:

Signature Date

Permit Number:

Registered Design Professional's Seal

Statement of Special Inspections Requirements for Seismic Resistance

See the Schedule of Special Inspections for inspection and testing requirements.

Seismic Design Category: _

Statement of Special Inspection for Seismic Resistance Required (Yes/No): _____

Description of seismic force-resisting system subject to special inspection and testing for seismic resistance:

(Required for Seismic Design Categories C, D, E or F)

Description of designated seismic systems subject to special inspection and testing for seismic resistance:

(Required for architectural, electrical and mechanical systems and their components that require design in accordance with Chapter 13 of ASCE 7, have a component importance factor, I_p , greater than one and are in Seismic Design Categories D, E or F.)

Description of additional seismic systems and components requiring special inspections and testing:

(Required for systems noted in IBC Section 1705.3, cases 3, 4 & 5 in Seismic Design Categories C, D, E or F.)

Statement of Responsibility:

Each Contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

Statement of Special Inspections Requirements for Wind Resistance

See the Schedule of Special Inspections for inspection and testing requirements

Basic Wind Speed (3 second gust): _____ m.p.h.

Wind Exposure Category: __

Statement of Special Inspection for Wind Resistance Required (Yes/No): _____

*(Required in wind exposure Category B, where the basic wind speed is 120 miles per hour or greater.
Required in wind exposure Category C or D, where the basic wind speed is 110 miles per hour or greater)*

Description of main wind force-resisting system subject to special inspection for wind resistance:

Description of wind force-resisting components subject to special inspection for wind resistance:

Statement of Responsibility:

Each Contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

INTERIM REPORT OF SPECIAL INSPECTIONS

City/County of:							
Project Name/Address:				Inspection Type(s) Coverage:			
				<input type="checkbox"/> Continuous	<input type="checkbox"/> Periodic		
Describe Inspections Made, Including Locations:							
Tests Made:							
Total Inspection Time Each Day	Date:						
	Hours:						
List items requiring Special Inspection, and any discrepancies and corrections. If Engineer approval is required for any corrections, note this, and indicate that approval was obtained. Attach copies of all related correspondence.							
Comments:							

To the best of my knowledge, work inspected was in accordance with the Contract Documents and applicable standards except as noted above.

Signed: _____

Date: _____

Print Full Name: _____

I.D. _____

Phone Number: _____

This report is to be submitted to the Building Official and the Engineer. A copy shall be maintained at the jobsite.

FINAL REPORT OF SPECIAL INSPECTIONS

PROJECT: _____
LOCATION: _____
PERMIT APPLICANT: _____
APPLICANT'S ADDRESS: _____
ARCHITECT OF RECORD: _____
STRUCTURAL ENGINEER OF RECORD: _____
MECHANICAL ENGINEER OF RECORD: _____
ELECTRICAL ENGINEER OF RECORD: _____
REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE: _____

To the best of my information, knowledge, and belief, Special Inspections required for this Project in accordance with Section 1705 of the 2009 International Building Code and any State or local amendments have been performed, and all work has been completed in accordance with the Contract Documents and all applicable standards, except as indicated.

The Special Inspection program does not relieve the Contractor of the obligation to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

This Final Report includes information submitted in previous Interim Reports numbered ____ to _____, as well as any Special Inspections, discrepancies, and corrections occurring since the last Interim Report, dated _____.

All items requiring Special Inspection are listed below. All inspections, tests, and similar services that were performed are listed and any discrepancies and corrections are indicated. If Engineer approval was required for any corrections, this is noted, and copies of all related correspondence are attached.

(Attach 8 1/2"x11" continuation sheet(s) if required to complete the description of corrections)

Prepared By:

Special Inspection Agency

Type or print name

Signature

Date

Special Inspector's Seal

CONTRACTOR'S STATEMENT OF RESPONSIBILITY

Each Contractor responsible for the construction or fabrication of a main-wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections must submit this Statement of Responsibility prior to commencement of work on the system or component.

Project: _____

Contractor's Name: _____

Address: _____

License No.: _____

Description of building systems and components included in Statement of Responsibility:

Contractor's Acknowledgement of Special Requirements

I hereby acknowledge that I have received, read, and understand the Statement of Special Inspections and its requirements.

Name and Title (type or print)

Signature

Date

FABRICATOR'S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section 1704.2.2 of the 2009 International Building Code must submit this Fabricator's Certificate of Compliance at the completion of fabrication.

Project: _____

Fabricator's Name: _____

Address: _____

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated on my premises in strict accordance with the Contract Documents and applicable standards.

Name and Title (type or print)

Signature

Date

Attach copy of Building Official's approval of fabricator as an Approved Fabricator.

NOTIFICATION OF FAILURE TO CORRECT DISCREPANCY

City/County of:
Project name/Address:
List discrepancies, proposed correction, and Contractor response. If Engineer approval is required for any corrections, note this, and indicate whether approval was obtained. Attach copies of all related correspondence.
Comments:

Signed: _____

Date: _____

Print Full Name: _____

I.D. _____

Phone Number: _____

This report is to be submitted to the Building Official, the Contractor, and the Engineer.

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SECTION 01470

WATERTIGHTNESS TESTING OF CONCRETE STRUCTURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. It is the intent of these Specifications that all concrete work and sealing work around built-in items and penetrations be performed as required to insure that groundwater, surface water, and water or liquids in tanks, channels and containers will not intrude into any equipment rooms, pipe galleries, habitable areas or other generally dry areas.
- B. The required watertightness shall be achieved by quality concrete construction and proper sealing of all joints and penetrations.
- C. Each unit shall be tested separately and the leakage tests shall be made prior to backfilling and before equipment is installed. Testing water shall be from any potable, non-potable, or natural moving source such as a river or stream, but not from any still water source such as a lake or pond, and not from any wastewater source.
- D. All water holding structures shall be tested for leakage by the Contractor. The Contractor shall provide at his own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01400 – Quality Control
- B. Section 03300 – Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ACI 350.1-10 - Specification for Tightness Testing of Environmental Engineering Concrete Structures

1.04 SUBMITTALS

- A. Testing procedures shall be submitted for approval prior to the test.
- B. Testing Report: Prior to placing the structure in service, submit for review and approval a detailed bound report summarizing the watertightness test data, describing the testing procedure and showing the calculations on which the test data is based.

PART 2 – PRODUCTS
(NOT USED)

PART 3 – EXECUTION

3.01 TEST PREPARATION

- A. The design capability of the structure to withstand testing shall be verified for the pressures to be applied. Another type of test shall not be substituted for hydrostatic tightness testing without approval of the Engineer.
- B. The structure shall not be tested before all elements of the structure which resist any portion of the retained liquid pressure are in place and the concrete has attained its specified compressive strength.
- C. Unless otherwise specified, coatings shall not be applied until after the hydrostatic tightness testing is complete. Liners that are mechanically locked to the surface during the placement of the concrete shall be installed before the hydrostatic tightness testing. Interior liners shall be visually examined for deficiencies (pinholes, tears and partially fused splices) and must pass integrity testing. Deficiencies shall be prepared.
- D. Clean the exposed concrete surfaces of the structure, including the floor, of all foreign material and debris. Prior to testing, standing water in or outside of the structure that would interfere with the inspection of the exposed concrete surfaces of the structure shall be removed.
- E. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired before filling the containment structure with water.
- F. All openings, fittings, and pipe penetrations in the structure shell shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired prior to testing. All structural penetrations and inlet/outlets shall be securely sealed to prevent the loss of water from the structure during the test. All structural penetrations shall be monitored before and during the test to determine the watertightness of these appurtenances. If the structure is to be filled using the inlet/outlet pipe, positive means shall be provided to check that water is not entering or leaving through this pipe once the structure is filled to the test level. Leakage at these inlet/outlets shall be repaired prior to testing. No allowance shall be made in test measurements for uncorrected known points of leakage.
- G. The flow from any underdrain system, if a system is provided, shall be monitored during this same period, and any increase in flow shall be recorded and considered for information as a part of the hydrostatic tightness testing.
- H. The ground water level shall be brought to a level below the top of the base slab and kept at that elevation or at a lower elevation during the test.

- I. No backfill shall be placed against the walls or on the wall footings of the structure to be tested unless otherwise specified.

3.02 PROCEDURE

- A. The initial filling of a new structure should not exceed a rate of 4 ft/h. Filling shall be continued until the water surface is at the design maximum liquid level, or either 1 in. below any fixed overflow level in covered containment structure or 4 in. in open structure, whichever is lower.
- B. The exterior surfaces of the structure shall be inspected during the period of filling the structure. If any flow of water is observed from the structure exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired prior to testing.
- C. Watertightness Test - Part 1: Qualitative Criteria
 1. The water shall be kept at the test level for at least 3 days prior to Part 2 of the testing.
 2. The exterior surfaces of the structure shall be observed in both the early mornings and later afternoons during the 3-day period before Part 2 of the test. If any water is observed on the structure exterior surfaces, including joints, repaired honeycombed areas and cracks, where moisture can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the test.
 3. Wet areas on top of wall footing shall not be cause to fail Part 1 of the test unless the water can be observed to be flowing.
 4. Part 2 of the test may begin prior to completion of repairs for Part 1. However, all defects causing the failure of Part 1 shall be repaired before the structure is accepted.
- D. Watertightness Test - Part 2: Quantitative Criteria
 1. The test measurements shall not be scheduled for a period when the forecast is for a difference of more than 35°F between the ambient temperature readings at the times of the initial and final level measurements of the water surface. The test shall also not be scheduled when the weather forecast indicates the water surface would be frozen before the test is completed.
 2. The vertical distance to the water surface shall be measured to within 1/16 in. from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals. Measurements taken at the same time of day will reduce the probability of temperature difference.
 3. Measurements shall be taken at two locations, 180° apart, which will minimize the effect of differential settlement. Measurements shall be taken at the same locations to reduce the probability of measurement differences.

4. The test period shall be at least the theoretical time required to lower the water surface 3/8 in. assuming a loss of water at 0.050% of the water volume per 24-hour period. The test period shall not be longer than five days.
5. The water temperature shall be recorded at a depth of 18 in. below the water surface at the start and end of the test.
6. A floating, restrained, partially filled, calibrated, open container for evaporation and precipitation measurement should be positioned in open structures and the water level in the container recorded at 24-hour intervals. Determination of evaporation by a shallow pan-type measuring device is not acceptable due to possible heating of the bottom of the shallow pan resulting in accelerated evaporation.

3.03 EVALUATION

- A. The containment structure shall continue to be observed in both the early mornings and late afternoons to verify compliance with Part 1 of the test during Part 2.
- B. At the end of the test period, the water surface shall be recorded to within 1/16-in at the location of original measurements. The water temperature and the evaporation and precipitation measurements shall be recorded.
- C. The allowable loss of water for tightness tests shall not exceed 0.050% of the test water volume in 24 hours.
- D. The change in water volume in the structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature based on the change recorded in the water level from the open container. If the loss exceeds the allowable loss, the structure shall be considered to have failed the test.
- E. During Part 2 of the test, observed flow or seepage of water from the exterior surface, including that from cracks and joints, should be considered as a failed test. The structure shall also be considered to have failed the test if moisture can be transferred from the exterior surface to a dry hand. Dampness or wetness on top of a footing shall not be considered as a failure test.

3.04 RETESTING

- A. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.
- B. The Contractor shall be permitted to immediately retest when no visible leakage is exhibited. If the structure fails the second test or if the Contractor does not exercise the option of immediately retesting after the first test failure, the interior of the structure shall be inspected by a diver or by other means to determine probable areas of leakage. The structure shall only be retested after the most probable areas of leakage are repaired.
- C. If the leakage exceeds the allowable limit, the work shall be corrected by methods approved by the Engineer.

- D. Upon completion of the necessary remedial work, the leakage test shall be repeated until it is successfully passed.

3.05 NOTIFICATION BY ENGINEER

- A. If any leaks, in excess of the specified amount, are not remedied by the Contractor within four (4) weeks of notification by the Engineer, regardless of whether the cause of these leaks is or is not determined, the Engineer shall have the authority to have these leaks repaired by others. The cost of repairs, by others, shall be deducted from monies due or to become due to the General Contractor.

- END OF SECTION -

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SECTION 01510
TEMPORARY UTILITIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall provide temporary light and power, heating, water service and sanitary facilities for his operations, for the construction operations of the other Contractors of this Project at the site. The temporary services shall be provided for use throughout the construction period.
- B. The Contractor shall coordinate and install all temporary services in accordance with the requirements of the utility companies (i.e. Dominion Energy) having jurisdiction and as required by applicable codes and regulations.
- C. At the completion of the work, or when the temporary services are no longer required, the facilities shall be restored to their original conditions.
- D. All costs in connection with the temporary services including, but not limited to, installation, utility company service charges, maintenance, relocation and removal shall be borne by the Contractor at no additional cost to the Owner.
- E. Some temporary facilities that may be required may be indicated on the Drawings; however, the Drawings do not necessarily show any or all of the temporary facilities that the Contractor ultimately uses to complete the work.
- F. Temporary Light and Power
 - 1. The temporary general lighting and small power requirements shall be serviced by 120/240 V, 1 phase, 3 wire temporary systems furnished and installed by the Contractor. This service shall be furnished complete with main disconnect, overcurrent protection, meter outlet, branch circuit breakers, and wiring as required; including branch circuit breakers and wiring as required for furnishing temporary power to the various Contractor's field office service connections, all in accordance with the requirements of the servicing power company and applicable standards and codes. The meter for the temporary 120/240 V service for construction purposes shall be registered in the name of the Contractor and all energy charges for furnishing this temporary electric power shall be borne by the Contractor. Any Contractor with a need for power other than the 120/240 V, 1 phase, 3 wire shall provide such power at his own expense.
 - 2. The Contractor shall make all necessary arrangements, and pay for all permits, inspections, and power company charges for all temporary service installations. All temporary systems shall comply with and meet the approval of the local authorities having jurisdiction. All temporary electrical systems shall consist of wiring, switches, necessary insulated supports, poles, fixtures, sockets, receptacles, lamps, guards, cutouts, and fuses as required to complete such

installations. The Contractor shall furnish lamps and fuses for all temporary systems furnished by him and shall replace broken and burned out lamps, blown fuses, damaged wiring and as required to maintain these systems in adequate and safe operating condition. All such temporary light and power system shall be installed without interfering with the work of the other Contractors.

When it is necessary during the progress of construction that a temporary electrical facility installed under this Division interferes with construction operations, the Contractor shall relocate the temporary electrical facilities to maintain temporary power as required at no additional cost to the Owner. The Contractor shall be responsible at all times for any damage or injury to equipment, materials, or personnel caused by improperly protected or installed temporary installations and equipment.

3. The various Contractors doing the work at the site shall be permitted to connect into the temporary general lighting system small hand tools, such as drills, hammers, and grinders, provided that:
 - a. Equipment and tools are suitable for 120 V, single phase, 60 Hz operation and operating input does not exceed 1,500 volt-amperes.
 - b. Tools are connected to outlets of the system with only one (1) unit connected to a single outlet.
 - c. In case of overloading of circuits, the Contractor will restrict use of equipment and tools as required for correct loading.
4. The Contractor shall keep the temporary general lighting and power systems energized fifteen minutes before the time that the earliest trade starts in the morning and de-energized fifteen minutes after the time the latest trade stops. This applies to all weekdays, Monday through Friday, inclusive, which are established as regular working days.

Any Contractor requiring temporary light and power before or after the hours set forth hereinbefore, or on a Saturday, Sunday, or holiday, shall pay for the additional cost of keeping the system energized and repaired. If more than one Contractor is involved, the charges shall be prorated, such amounts to be determined from the meter readings or other acceptable means previously agreed upon by the Contractors involved. If it is necessary for any Contractor or his employees to be in any structure after regular working hours and the temporary general lighting system is not required for illumination, that Contractor shall provide such illumination required by means of flashlights, electric lanterns, or other devices not requiring use of electricity from the temporary general lighting system.

5. Each Contractor requiring additional power and lighting other than that specified herein (including power for temporary heating equipment to be provided by the Contractor) shall furnish his own service complete with all fuses, cutouts, wiring and other material and equipment necessary for a complete system between the service point and the additional power consumers and shall install his own metering equipment in accordance with the requirements of the servicing power company.

6. The temporary general lighting system shall be installed progressively in structures as the various areas are enclosed or as lighting becomes necessary because of partial enclosure. Lighting intensities shall be not less than 10 foot candles.
7. The Contractor shall provide a separate temporary night lighting circuit for construction security. This system shall be energized at the end of each normal working day and de-energized at the start of each normal working day by the Contractor. The system is to be left energized over Saturdays, Sundays, and all holidays. Lighting intensities shall be not less than 2 foot candles.
8. Electrical welders provided by each trade used in the erection and fabrication of the buildings, structures and equipment shall be provided with an independent grounding cable connected directly to the structure on which the weld is being made rather than adjacent conduit piping, etc.

Electricians and other tradesmen necessary for the required connections and operation of welding equipment and generator, standby generators and similar equipment shall be furnished by the individual Contractors. All costs for such labor and equipment shall be borne by the individual Contractors.

9. Upon completion of the work, but prior to acceptance by the Owner, the Contractor shall remove all temporary services, security lighting systems, temporary general lighting systems and all temporary electrical work from the premises.

G. Temporary Heating

1. The Contractor shall provide temporary heating, ventilation coverings and enclosures necessary to properly protect all work and materials against damage by dampness and cold, to dry out the work and to facilitate work in all structures.
2. The equipment, fuel, materials, operating personnel and methods used shall be at all times satisfactory and adequate to maintain critical installation temperatures and ventilation for all work in those areas where the same is required.
3. After any structure is enclosed, the minimum temperature to be maintained is 50°F, unless otherwise specified, where work is actually being performed.
4. Before and during the application of interior finishing, painting, etc., the Contractor shall provide sufficient heat to maintain a temperature of not less than 65°F.
5. Any work damaged by dampness or insufficient or abnormal heating shall be replaced by the Contractor at no additional cost to the Owner.

H. Temporary Sanitary Service

1. Sanitary conveniences, in sufficient numbers, for the use of all persons employed on the work and properly screened from public observation, shall be provided and maintained at suitable locations by the Contractor, all as prescribed by State Labor Regulations and local ordinances. The contents of same shall be removed and disposed of in a manner consistent with local and state regulations, as the occasion requires. Each Contractor shall rigorously prohibit the committing of nuisances within, on, or about the work. Sanitary facilities shall be removed from the site when no longer required.

I. Temporary Water

1. The Contractor shall provide temporary water service for construction purposes, sanitary facilities, fire protection, testing, field offices and for cleaning. The Contractor shall make all arrangements for connections to the potable water at the plant site.

The Contractor shall pay all charges associated with the connection and all charges for potable water used under this Contract.

2. Each Contractor shall supply potable water for his employees either by portable containers or drinking fountains.
3. An adequate number of hose bibbs, hoses, and watertight barrels shall be provided for the distribution of water.
4. Water service shall be protected from freezing and the service shall be extended and relocated as necessary to meet temporary water requirements.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01520

MAINTENANCE OF UTILITY OPERATIONS DURING CONSTRUCTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The existing pump station shall be maintained in continuous operation by the Owner during the entire construction period during the entire construction period as hereinafter specified. The intent of this Section is to outline the minimum requirements necessary to allow the Owner to continuously operate and maintain the existing facility in to remain in compliance with all requirements.
- B. Work under the Contract shall be scheduled and conducted by the Contractor so as not to impede any process, cause odor or other nuisance except as explicitly permitted hereinafter. In performing the work shown and specified, the Contractor shall plan and schedule his work to meet the collection system operating requirements, and the constraints and construction requirements as outlined in this Section. No discharge of raw or inadequately treated wastewater shall be allowed. The Contractor shall pay all civil penalties, costs, assessments, etc., associated with any discharge of raw or inadequately treated wastewater associated with the Contractor's work.
- C. The Contractor shall be responsible for coordinating the general, electrical, HVAC and plumbing construction schedules and for ensuring that permanent or temporary power is available for all existing, proposed, and temporary facilities that are required to be on line at any given time.
- D. The Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without additional cost to the Owner and provided that all requirements of these Specifications are fulfilled. The Contractor shall submit any such plan for providing additional temporary facilities to eliminate a constraint to the Engineer for review. Such plans must be approved by the Engineer and Owner prior to the Contractor proceeding. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter.
- E. All references to days in this Section shall be consecutive calendar days.
- F. All references to "shutdowns" shall mean the partial or full shutdown of any pump operation or portion thereof. A "long term shutdown" is defined as greater than two hours.

1.02 GENERAL CONSTRAINTS

- A. The Contractor shall schedule the Work so that the facility is maintained in continuous operation. All facilities shall be maintained in continuous operation during the construction period except during approved process interruptions. All short-term system or partial systems shutdowns and diversions shall be approved by the Engineer. Long-term process shutdowns and diversions shall conform to the requirements hereinafter specified and

shall be minimized by the Contractor as much as possible. If in the judgement of the Engineer a requested shutdown is not required for the Contractor to perform the Work, the Contractor shall utilize approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the Owner. Shutdowns shall not begin until all required materials are on hand and ready for installation. Each shutdown period shall commence at a time approved by the Owner, and the Contractor shall proceed with the Work continuously, start to finish, until the Work is completed and normal operation is restored. If the Contractor completes all required Work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service.

- B. The Contractor shall schedule short-term and long-term shutdowns in advance and shall present all desired shutdowns in the 30 and 60-day schedules at the progress meetings (see Section 01200). Shutdowns shall be fully coordinated with the Owner at least seven (7) calendar days before the scheduled shutdown. Owner personnel shall operate Owner's facilities involved in the short-term and long-term shutdowns and diversions.
- C. Short-term shutdowns in flow will be allowed for tie-ins to existing facilities, installation of temporary bulkheads, etc. All such shutdowns shall be scheduled for week-end low-flow periods and shall be limited to less than two (2) hours depending on incoming flow rate and storage volume in the collection system. Any shutdown of two (2) hours or longer duration shall be defined as a long-term shutdown. The Contractor shall provide appropriate diversion facilities to be approved by the Owner, and at no additional cost to the Owner, when the pump station cannot be shut down for a sufficient long time to accomplish the required work. Duration of short-term interruptions allowed will depend on incoming wastewater flow rate and prevention of any discharge of raw wastewater from the collection system. The schedule and duration of short-term shutdowns shall be at the discretion of the Owner.
- D. Any temporary work, facilities, roads, walks, protection of existing structures, pumps, piping, blind flanges, valves, equipment, etc. that may be required within the Contractor's work limits to maintain continuous and dependable pump station operation shall be furnished by the Contractor at the direction of the Engineer at no additional cost to the Owner.
- E. The Owner shall have the authority to order Work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the pump station operations.
- F. If the Contractor impairs performance or operation of the facility as a result of not complying with specified provisions for maintaining pump station operations, then the Contractor shall immediately make all repairs or replacements and do all work necessary to restore the facility to operation to the satisfaction of the Engineer. Such work shall progress continuously to completion on a 24-hours per day, seven work days per week basis.
- G. The Contractor shall provide the services of emergency repair crews on call 24-hours per day to affect repairs to portions of the pump station affected by the Contractor's operations.

1.03 GENERAL OPERATING REQUIREMENTS, CONSTRAINTS, AND CONSTRUCTION REQUIREMENTS

A. Access to Pump Station Site, Roadways, and Parking Areas

1. An unobstructed traffic route through the Main Gate shall be maintained at all times for the Owner's operations personnel and maintenance equipment.
2. Construction personnel may park outside the pump station fence in areas approved by the Engineer. The Contractor shall be responsible for providing access to and for preparing and maintaining/approved parking areas.
3. The Contractor shall not undertake the restoration/construction of new roadway (paved, gravel, or asphalt overlay) shown on the Contract Drawings, until all other work on the pump station improvements has been completed.

B. Personnel Access

1. Operating personnel shall have access to all areas which remain in operation throughout the construction period. The Contractor shall locate stored material, dispose of construction debris and trash, provide temporary walkways, provide temporary lighting, and other such work as directed by the Engineer to maintain personnel access to areas in operation. Access and adequate parking areas for pump station personnel must be maintained throughout construction.

C. Power, Light and Communications Systems (General)

1. Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas which remain in operation. Individual units may be disconnected as required for replacement, but service shall be available at all times including periods when pump station elements are out of service. Shutdown of electrical facilities shall be limited to not more than two (2) hours. The Contractor shall coordinate shutdowns required with his Subcontractor to minimize the total number of shutdowns required to complete construction.

D. Draining Process Pipes and Conduits (General)

1. The contents of all pipes and conduits to be removed, replaced or relocated (or dewatered for a specific purpose) shall be transferred to a suitable facility in a manner approved by the Owner through hoses or piping, or by using pumps if hydraulic conditions so require them. The Contractor shall provide the pumps, piping and hoses at no additional cost to the Owner. No uncontrolled spillage of a pipe or conduit shall be permitted. Any spillage, other than potable water, shall be immediately washed down and flushed into the appropriate process flow train.
2. The Drawings do not indicate all abandoned process piping. The Contractor shall coordinate with the Owner and Engineer when encountering unknown piping and conduits. Should the piping/conduits be confirmed to be abandoned and no longer in active service, the piping/conduits shall be removed by the Contractor to facilitate new work.

3. Abandoned piping shall be assumed to be full of wastewater or sludge from previous abandonment. Abandoned piping removal shall be performed with care to collect and retain any spillage when pipe is cut for demolition. Contractor shall transfer collected spillage to a pump station process facility as directed by the Owner and Engineer.
4. Remaining abandoned piping that the Contractor leaves in place shall be plugged at all terminations.

G. Potable Water System

1. Potable water service shall be maintained in continuous service at all times during construction except for short-term interruptions required for tie-ins. Shutdown of the potable water system shall be fully planned and coordinated with the Owner and shall be limited to not more than two (2) hours. Existing fire hydrants within the pump station site shall be operational at all times, unless otherwise approved by the Owner.
2. In areas where potable water serves key pump station processes such as seal water, temporary systems shall be provided in order to maintain pump station operations, including during short-term system interruptions. The Contractor shall furnish any required temporary potable water systems at no additional cost to the Owner.

H. Non-potable Water System

1. No non-potable water system is available.

I. Sump Pumps and Sumps

1. All existing sumps shall be maintained in an operable condition with either existing pumps or temporary pumps. Interim piping, power and controls shall be provided as required by the staged construction sequence.

J. Seal Water and Service Water Piping

1. A supply of service and seal water and the necessary connections to existing equipment shall be maintained during construction. Interim piping shall be provided as required.

K. Temporary Piping, Pumps, and Electrical Service

1. Specifically required temporary piping, pumps, and electrical service are described herein. The Contractor shall provide temporary piping, pumps, and electrical service needed to maintain individual pump station processes in service under the Base Bid at no added cost to the Owner, whether specifically described herein or otherwise identified during construction.

2. The Contractor shall relocate temporary piping, pumps, and electrical service during construction as needed to coordinate crane access during various construction phases. Relocation shall be included in the Base Bid at no added cost to the Owner.

1.04 SPECIFIC OPERATIONAL CONSTRAINTS

- A. The Contractor shall schedule the work based on the constraints given in the following section and in such a manner as to maintain the wastewater treatment pump station in continuous operation.
- B. At startup of new facilities, existing facilities shall remain available for service in the event that new facilities fail or are not fully suitable for continuous operation. New facilities shall be subjected to a testing and demonstration period where they shall be successfully operated and be fully functional for thirty (30) consecutive days prior to approval for continuous operation. This 30 day operational period shall be completed prior to isolation and demolition of existing pump station facilities.

C. General

1. The Contractor's sequence of construction for Division I shall be to construct, test and demonstrate performance of the new influent sewer and Thomas Island Regional Pump Station prior to abandoning/demolishing the existing influent sewer and demolishing the existing Shellring Pump Station (PS 168). Contractor to construct new gravity sewer from Shellring Pump Station (PS 168) to the new Thomas Island Regional Pump Station. Contractor to construct gravity sewer from new lift station to manhole #4 (SSMH-4) including two (2) 20-foot pipe sections (12-inch and 10-inch) to be stubbed-out with cap for future Division II work.
2. Construction activities shall not prevent the flow of wastewater through the existing influent gravity sewer.
3. The Contractor may find it necessary to perform Work during low flow conditions. Work performed outside of specified working hours shall be approved by the Owner as specified in these Specifications and shall be at no additional cost to the Owner.

D. Soil and Erosion Control Measures

1. Prior to start of the Work (e.g., excavation, etc.), the Contractor shall install all soil and erosion control measures as shown on the Drawings and as required by the local regulatory authority. Sequence of Work shall be scheduled to comply with soil and erosion control phasing as shown on the Drawings.

E. Pump Station

1. Both the new Thomas Island Regional Pump Station and new section of force main shall be tested out and operational prior to connection of the new influent gravity sewer to the existing influent gravity sewer system. As a minimum, all of the major equipment and structures shall have successfully passed testing (e.g. submersible pumps; level control system; electrical power and control systems – VFDs, control panels, SCADA; water holding structures – wet wells; and all ancillary systems required to operate the Pump Station successfully) using potable water. Contractor shall make necessary provisions to prevent overheating the water. The new influent gravity sewer shall be fully tested (i.e. mandrel, air testing, CCTV inspection, and any other required testing by CWS) out prior to connection to the existing influent gravity sewer system.
2. Contractor shall be responsible for providing appropriate means to allow continuous flow to the existing Shellring Pump Station (PS 168) during the tie-in to the new diversion structure. Bypass pumping may be required.
3. After connection of the new influent sewer and, up until demolition activities commence on the existing pump station, the Contractor shall maintain the means to direct 100% of the incoming wastewater flow either to the new or to the existing lift station. Directing partial flow to both stations is not acceptable.
5. The Contractor shall make provisions to provide adequate volumes of water/wastewater to the station for all testing activities, at no additional cost to the Owner.

F. Demolition of Existing Facilities

1. Demolition of the existing pump station and abandonment of the short section of existing influent sewer shall not commence until all testing has been completed and full acceptance by the Owner of the new influent sewer and the new Thomas Island Regional Pump Station. The Contractor shall notify the Owner a minimum of two (2) weeks prior to commencing demolition of the existing lift station. Demolition activities shall begin only with Owner's approval.

G. Bypass Pumping Requirements

1. When required, contractor shall provide adequate bypass pumping, in accordance with Specification 02665, to convey the current average and peak flows at the pump station without surcharging the conveyance system upstream. The bypass pumping system shall include at least one standby pump for redundancy.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01530

PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Contractor shall be responsible for the preservation and protection of property adjacent to the work site against damage or injury as a result of his operations under this Contract. Any damage or injury occurring on account of any act, omission or neglect on the part of the Contractor shall be restored in a proper and satisfactory manner or replaced by and at the expense of the Contractor to an equal or superior condition than previously existed.
- B. Contractor shall comply promptly with such safety regulations as may be prescribed by the Owner or the local authorities having jurisdiction and shall, when so directed, properly correct any unsafe conditions created by, or unsafe practices on the part of, his employees. In the event of the Contractor's failure to comply, the Owner may take the necessary measures to correct the conditions or practices complained of, and all costs thereof will be deducted from any monies due the Contractor. Failure of the Engineer to direct the correction of unsafe conditions or practices shall not relieve the Contractor of his responsibility hereunder.
- C. In the event of any claims for damage or alleged damage to property as a result of work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defense against such claims. Prior to commencement of work in the vicinity of property adjacent to the work site, the Contractor, at his own expense, shall take such surveys as may be necessary to establish the existing condition of the property. Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained.

1.02 PROTECTION OF WORK AND MATERIAL

- A. During the progress of the work and up to the date of final payment, the Contractor shall be solely responsible for the care and protection of all work and materials covered by the Contract.
- B. All work and materials shall be protected against damage, injury or loss from any cause whatsoever, and the Contractor shall make good any such damage or loss at his own expense. Protection measures shall be subject to the approval of the Engineer.

1.03 BARRICADES, WARNING SIGNS AND LIGHTS

- A. The General Contractor shall provide, erect and maintain as necessary, strong and suitable barricades, danger signs and warning lights along all roads accessible to the public, as required by the authority having jurisdiction, to insure safety to the public. All barricades and obstructions along public roads shall be illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise.
- B. Each Contractor shall provide and maintain such other warning signs and barricades in areas of and around their respective work as may be required for the safety of all those employed in the work, the Owner's operating personnel, or those visiting the site.

1.04 EXISTING UTILITIES AND STRUCTURES

- A. The term existing utilities shall be deemed to refer to both publicly-owned and privately-owned utilities such as electric power and lighting, telephone, water, gas, storm drains, process lines, sanitary sewers and all appurtenant structures.
- B. Where existing utilities and structures are indicated on the Drawings, it shall be understood that all of the existing utilities and structures affecting the work may not be shown and that the locations of those shown are approximate only. It shall be the responsibility of the Contractor to ascertain the actual extent and exact location of existing utilities and structures. In every instance, the Contractor shall notify the proper authority having jurisdiction and obtain all necessary directions and approvals before performing any work in the vicinity of existing utilities.
- C. Prior to beginning any excavation work, the Contractor shall, through field investigations, determine any conflicts or interferences between existing utilities and new utilities to be constructed under this project. This determination shall be based on the actual locations, elevations, slopes, etc., of existing utilities as determined in the field investigations, and locations, elevation, slope, etc. of new utilities as shown on the Drawings. If an interference exists, the Contractor shall bring it to the attention of the Engineer as soon as possible. If the Engineer agrees that an interference exists, he shall modify the design as required. Additional costs to the Contractor for this change shall be processed through a Change Order as detailed elsewhere in these Contract Documents. In the event the Contractor fails to bring a potential conflict or interference to the attention of the Engineer prior to beginning excavation work, any actual conflict or interference which does arise during the Project shall be corrected by the Contractor, as directed by the Engineer, at no additional expense to the Owner.
- D. The work shall be carried out in a manner to prevent disruption of existing services and to avoid damage to the existing utilities. Temporary connections shall be provided, as required, to insure uninterrupted of existing services. Any damage resulting from the work of this Contract shall be promptly repaired by the Contractor at his own expense in a manner approved by the Engineer and further subject to the requirements of any authority having jurisdiction. Where it is required by the authority having jurisdiction that they perform their own repairs or have them done by others, the Contractor shall be responsible for all costs thereof.

- E. Where excavations by the Contractor require any utility lines or appurtenant structures to be temporarily supported and otherwise protected during the construction work, such support and protection shall be provided by the Contractor. All such work shall be performed in a manner satisfactory to the Engineer and the respective authority having jurisdiction over such work. In the event the Contractor fails to provide proper support or protection to any existing utility, the Engineer may, at his discretion, have the respective authority to provide such support or protection as may be necessary to insure the safety of such utility, and the costs of such measures shall be paid by the Contractor.
- F. Contractor shall protect existing underground and covered facilities. Protection and support for all underground facilities shall be provided to insure that the service for all existing facilities is not interrupted. Any relocation, rerouting, or repair of existing facilities for construction operations shall be done only with the written permission of the Engineer and only in the manner and time approved by the Engineer at no additional cost to the Owner.
- G. The Contractor shall be responsible for damage to existing structures, equipment, and facilities caused by the Contractor's operations and shall repair all such damage when and as ordered by the Engineer at no additional cost to the Owner.
- H. The Contractor shall remove and reset mailboxes, as required, at no additional cost to the Owner.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01540

DEMOLITION AND REMOVAL OF EXISTING STRUCTURES AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. This Section covers the demolition, removal, and disposal of existing buildings, structures, pavement, curbs, and sidewalk, removal and disposal of asbestos materials, and any existing equipment including electrical, plumbing, heating and ventilating equipment and piping not required for the operation of the rehabilitated plant as indicated on the Drawings and as specified hereinafter. The Contractor shall furnish all labor, materials and equipment to demolish buildings and structures and to remove fixtures, anchors, supports, piping and accessories designated to be removed on the Drawings.

1.02 TITLE TO EQUIPMENT AND MATERIALS

- A. Contractor shall have no right or title to any of the equipment, materials or other items to be removed from the existing buildings or structures unless and until said equipment, materials and other items have been removed from the premises. The Contractor shall not sell or assign, or attempt to sell or assign any interest in the said equipment, materials or other items until the said equipment, materials or other items have been removed.
- B. Contractor shall have no claim against the Owner because of the absence of such fixtures and materials.

1.03 CONDITION OF STRUCTURES AND EQUIPMENT

- A. The Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.
- B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner so far as practicable.
- C. The information regarding the existing structures and equipment shown on the Drawings is based on visual inspection and a walk-through survey only. Neither the Engineer nor the Owner will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

3.01 DEMOLITION AND REMOVALS

- A. The removal of all equipment and piping, and all materials from the demolition of buildings and structure shall, when released by the Owner and Engineer, shall be done by the Contractor and shall become the Contractor's property, unless otherwise noted, for disposition in any manner not contrary to the Contract requirements and shall be removed from the site to the Contractor's own place of disposal.
- B. The Electrical Contractor (Subcontractor) specifically, shall de-energize all panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar power equipment prior to removal. Any electric panels or equipment which are to be retained shall be relocated or isolated by the Electrical Contractor (Subcontractor) specifically, prior to the removal of the equipment specified herein.
- C. The Contractor shall proceed with the removal of the equipment, piping and appurtenances in a sequence designed to maintain the plant in continuous operation as described in Section 01520, Maintenance of Utility Operations During Construction, and shall proceed only after approval of the Engineer.
- D. Any equipment piping and appurtenances removed without proper authorization, which are necessary for the operation of the existing facilities shall be replaced to the satisfaction of the Engineer at no cost to the Owner.
- E. Excavation caused by demolitions shall be backfilled with fill free from rubbish and debris.

3.02 PROTECTION

- A. Demolition and removal work shall be performed by competent experienced workmen for the various type of demolition and removal work and shall be carried out through to completion with due regard to the safety of Owner employees, workmen on-site and the public. The work shall be performed with as little nuisance as possible.
- B. The work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, all governing codes, and as hereinafter specified.
- C. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. The Contractor shall give particular attention to shoring and bracing requirements so as to prevent any damage to new or existing construction.
- D. The Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

- E. The Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.
- F. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new work is being done, connections made, materials handled or equipment moved.
- G. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing buildings affected by the operations under this Section shall be protected by dust-proof partitions and other adequate means.
- H. The Contractor shall provide adequate fire protection in accordance with local Fire Department requirements.
- I. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.
- J. The Contractor shall be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.
- K. The Contractor shall be responsible for damages due to failure of Contractor provided temporary facilities, including pipe plugs, at any point in the project, until final acceptance.

3.03 WORKMANSHIP

- A. The demolition and removal work shall be performed as described in the Contract Documents. The work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration and new work in accordance with applicable Technical Sections of the Specifications and in accordance with the details shown on the Drawings. Prior to starting of work, the Contractor shall provide a detailed description of methods and equipment to be used for each operation and the sequence thereof for review by the Engineer.
- B. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. Concrete bases, anchor bolts and other supports shall be removed to approximately 1-inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas. Superstructure wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified under applicable Sections of these Specifications, as shown on the Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate Sections of these Specifications, as shown on the Drawings, and as directed and approved by the Engineer.

- C. Materials or items designated to remain the property of the Owner shall be as hereinafter tabulated. Such items shall be removed with care and stored at a location at the site to be designated by the Owner.
- D. Where equipment is shown or specified to be removed and relocated, the Contractor shall not proceed with removal of this equipment without specific prior approval of the Engineer. Upon approval, and prior to commencing removal operations, the equipment shall be operated in the presence of representatives of the Contractor, Owner and Engineer. Such items shall be removed with care, under the supervision of the trade responsible for reinstallation and protected and stored until required. Material or items damaged during removal shall be replaced with similar new material or item. Any equipment that is removed without proper authorization and is required for plant operation shall be replaced at no cost to the Owner.
- E. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.
- F. Materials or items demolished and not designated to become the property of the Owner or to be reinstalled shall become the property of the Contractor and shall be removed from the property and legally disposed of.
- G. The Contractor shall execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the building.
- H. In general, masonry shall be demolished in small sections, and where necessary to prevent collapse of any construction, the Contractor shall install temporary shores, struts, and bracing.
- I. Where alterations occur, or new and old work join, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, so as to leave the altered work in as good a condition as existed prior to the start of the work. The materials and workmanship employed in the alterations, unless otherwise shown on the Drawing or specified, shall comply with that of the various respective trades which normally perform the particular items or work.
- J. The Contractor shall finish adjacent existing surfaces to new work to match the specified finish for new work. The Contractor shall clean existing surfaces of dirt, grease, loose paint, etc., before refinishing.
- K. The Contractor shall cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.
- L. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the work.

3.04 MAINTENANCE

- A. The Contractor shall maintain the buildings, structures and public properties free from accumulations of waste, debris and rubbish, caused by the demolition and removal operations.
- B. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish, and he shall wet down dry materials to lay down and prevent blowing dust.
- C. At reasonable intervals during the progress of the demolition and removal work or as directed by the Engineer, the Contractor shall clean the site and properties, and dispose of waste materials, debris and rubbish.

3.05 EQUIPMENT AND MATERIALS RETAINED BY OWNER

- A. The following equipment and materials from Shell Ring Pump Station will be retained by the Owner:
 - 1. Control Panel
 - 2. Transfer switch
 - 3. Pumps
 - 4. Pump railing
 - 5. Plug Valves
 - 6. Ball check valves
 - 7. Generator plug
 - 8. SCADA panel
 - 9. Antenna
- B. The equipment and materials shall be moved by the Contractor to storage areas to Pump Station 77 at 501 Stinson Drive, Charleston, SC 29407 for storage. Contractor to notify CWS Operational Staff 48 hours in advance of its delivery.

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SECTION 01550

SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Access Roads

1. The General Contractor shall construct and maintain such temporary access roads as required to perform the work of this Contract.
2. Access roads, where possible, shall be located over the areas of the future road system.
3. Access roads shall be located within the property lines of the Owner unless the Contractor independently secures easements for his use and convenience. Contractor shall submit written documentation to the Engineer for any Contractor secured easements across privately held property. Easement agreement shall specify terms and conditions of use and provisions for site restoration. A written release from the property owner certifying that all terms of the easement agreement have been complied by the Contractor shall be furnished to the Engineer prior to final payment.
4. Existing access roads used by the Contractor shall be suitably maintained by the Contractor at his expense during construction. Contractor shall not be permitted to restrict Owner access to existing facilities. Engineer may direct Contractor to perform maintenance of existing access roads when Engineer determines that such work is required to insure all weather access by the Owner.
5. The Contractor shall obtain and pay all cost associated with any bonds required by the S.C. Department of Transportation for the use of State maintained roads.

B. Parking Areas

1. Contractor shall construct and maintain suitable parking areas for his construction personnel on the project site where approved by the Engineer and the Owner.

C. Restoration

1. At the completion of the work, the surfaces of land used for access roads and parking areas shall be restored by each Contractor to its original condition and to the satisfaction of the Engineer. At a minimum, such restoration shall include establishment of a permanent ground cover adequate to restrain erosion for all disturbed areas.

D. Traffic Regulations

1. Contractor shall obey all traffic laws and comply with all the requirements, rules and regulations of the SCDOT and other local authorities having jurisdiction to maintain adequate warning signs, lights, barriers, etc., for the protection of traffic on public roadways.

E. Storage of Equipment and Materials

1. Contractor shall store his equipment and materials at the job site in accordance with the requirements of the General Conditions, the Supplemental Conditions, and as hereinafter specified. All equipment and materials shall be stored in accordance with manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations and rulings of the public authority having jurisdiction. Where space or strip heaters are provided within the enclosure for motors, valve operators, motor starters, panels, instruments, or other electrical equipment, the Contractor shall make connections to these heaters from an appropriate power source and operate the heaters with temperature control as necessary until the equipment is installed and being operated according to its intended use.
2. Contractor shall enforce the instructions of Owner and Engineer regarding the posting of regulatory signs for loadings on structures, fire safety, and smoking areas.
3. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.
4. Contractor shall not store unnecessary materials or equipment on the job site, and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.
5. Materials shall not be placed within ten (10) feet of fire hydrants. Gutters, drainage channels and inlets shall be kept unobstructed at all times.
6. Contractor shall provide adequate temporary storage buildings/facilities, if required, to protect materials or equipment on the job site.
7. The Contractor shall maintain an equipment storage rotation log for all equipment provided. Rotation log shall include, as a minimum, the equipment identification, date stored, date removed from storage, copy of manufacturers' recommended storage guidelines, date of rotation of equipment, and signature of party performing rotation. Contractor shall submit a copy of the rotation log to the Engineer at each monthly progress meeting. Failure to properly maintain stored materials is sufficient cause for rejection of the equipment by the Owner.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01560

TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Dust Control

1. Contractor shall take all necessary measures to control dust from his operations, and to prevent spillage of excavated materials on public roads.
2. Contractor shall remove all spillage of excavated materials, debris or dust from public roads by methods approved by the Engineer.
3. Contractor shall sprinkle water at locations and in such quantities and at such frequencies as may be required by the Engineer to control dust and prevent it from becoming a nuisance to the surrounding area.
4. Dust control and cleaning measures shall be provided at no additional cost to the Owner.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01600
MATERIALS AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and Install

1. Where the words "furnish", "provide", "supply", "replace", or "install" are used, whether singularly or in combination, they shall mean to furnish and install, unless specifically stated otherwise.
2. In the interest of brevity, the explicit direction "to furnish and install" has sometimes been omitted in specifying materials and/or equipment herein. Unless specifically noted otherwise, it shall be understood that all equipment and/or materials specified or shown on the Drawings shall be furnished and installed under the Contract as designated on the Drawings.

B. Concrete Foundations for Equipment

1. Each Contractor shall provide all concrete foundations shown, specified or required for all equipment furnished under their respective Contract.
2. Anchor bolts and templates for equipment foundations shall be furnished under the respective Contracts for installation by the respective Contractor. The Contractor shall cooperate with the respective Contractors to secure a satisfactory installation and to maintain the schedule of construction.
3. All concrete foundations for equipment shall be treated, by the respective Contractor, with an approved sealer to prevent oil from seeping into the concrete.

1.02 EQUIPMENT AND MATERIALS

- A. All equipment, materials, instruments or devices incorporated in this project shall be new and unused, unless indicated otherwise in the Contract Documents. Equipment and materials to be incorporated into the work shall be delivered sufficiently in advance of their installation and use to prevent delay in the execution of the work, and they shall be delivered as nearly as feasible in the order required for executing the work.
- B. The Contractor shall protect all equipment and materials from deterioration and damage, including provisions for temporary storage buildings as needed and as specified in Section 01550, Site Access and Storage. Storage of equipment and materials shall be in locations completely protected from flooding, standing water, excessive dust, falling rock, brush fire, etc. Storage areas shall be located sufficiently distant from all construction activities and the movement of construction vehicles to minimize the potential for accidental damage. Any equipment or materials of whatever kind which may have

become damaged or deteriorated from any cause shall be removed and replaced by good and satisfactory items at the Contractor's expense for both labor and materials.

1.03 INSTALLATION OF EQUIPMENT

- A. Equipment and materials shall be installed in accordance with the requirements of the General Conditions, Supplementary Conditions, Special Conditions and the respective Specification Sections.
- B. Concrete foundations for equipment shall be of approved design and shall be adequate in size, suitable for the equipment erected thereon, properly reinforced, and tied into floor slabs by means of reinforcing bars or dowels. Foundation bolts of ample size and strength shall be provided and properly positioned by means of suitable templates and secured during placement of concrete. Foundations shall be built and bolts installed in accordance with the manufacturer's certified drawings.
- C. Before mounting equipment on a foundation, the Contractor shall clean the top surface; if necessary, rough it with a star chisel and clean again; and clean out all foundation bolt sleeves. The Contractor shall provide a sufficient number of steel plate shims about 2-inches wide and 4-inches long, and of a varying thickness from 1/8 to 1/2-inch. A combination of these shims shall be placed next to each foundation bolt to bring the bottom of the bedplate or frame about 1/8-inch above the final setting. The equipment shall be lowered by changing the combination of shims. Using brass shim stock of various thicknesses, continue to level the equipment a little at a time and in rotation until it is at the correct elevation in both directions. When the equipment is level, tighten down on the foundation bolts a little at a time in rotation to make certain the equipment remains level and does not shift on the shims. A preliminary alignment check shall be made before grout is placed.
- D. Equipment shall be set, aligned and assembled in conformance with manufacturer's drawings or instructions. Run out tolerances by dial indicator method of alignment shall be plus or minus .002-inches, unless otherwise approved by the Engineer.
- E. All blocking and wedging required for the proper support and leveling of equipment during installation shall be furnished by the Contractor. All temporary supports shall be removed, except steel wedges and shims, which may be left in place with the approval of the Engineer.
- F. Each piece of equipment or supporting base, bearing on concrete foundations, shall be bedded in grout. The Contractor shall provide a minimum of 1-1/2-inch thick grouting under the entire baseplate supporting each pump, motor drive unit and other equipment. Grout shall be non-shrink grout, as specified under Section 03600, Grout.
- G. When motors are shipped separately from driven equipment, the motors shall be received, stored, meggered once a month, and the reports submitted to the Engineer. After driven equipment is set, the motors shall be set, mounted, shimmed, millrighted, coupled and connected complete.

1.04 CONNECTIONS TO EQUIPMENT

- A. Connections to equipment shall follow manufacturer's recommendations as to size and arrangement of connections and/or as shown in detail on the Drawings or approved Shop Drawings. Piping connections shall be made to permit ready disconnection of equipment with minimum disturbance of adjoining piping and equipment.
- B. The Electrical Contractor or General Contractor if no electrical contract exists shall be responsible for bringing proper electrical service to each item of equipment requiring electrical service as shown on the Drawings or approved Shop Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.
- C. The HVAC Contractor or General Contractor if no HVAC Contract exists shall bring and connect HVAC service to all equipment items requiring same as shown on the Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.
- D. The Plumbing Contractor or General Contractor if no plumbing contract exists shall bring and connect plumbing service to all equipment items requiring same as shown on the Drawings.

1.05 SUBSTITUTIONS

- A. Requests for substitutions of equipment or materials after bidding and/or during construction shall conform to the requirements of the General Conditions, Supplementary Conditions, and as hereinafter specified.
 - 1. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature and performance data together with samples of the materials, where feasible, to enable the Owner and Engineer to determine if the proposed substitution is equal.
 - 2. Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.
 - 3. A list of installations where the proposed substitution is equal.
 - 4. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the Owner.
- B. Where the approval of a substitution requires revision or redesign of any part of the work, including that of other Contracts, all such revision and redesign, and all new drawings and details therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to the approval of the Owner and Engineer.

- C. In the event that the Engineer is required to provide additional engineering services, then the Engineer's charges for such additional services shall be charged to the Contractor by the Owner in accordance with the requirements of the General Specifications and the Special Provisions.
- D. In all cases the Owner and Engineer shall be the judge as to whether a proposed substitution is to be approved. The Contractor shall abide by their decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the work without written approval of the Owner and Engineer.
- E. Contractor shall have and make no claim for an extension of time or for damages by reason of the time taken by the Engineer in considering a substitution proposed by the Contractor or by reason of the failure of the Engineer to approve a substitution proposed by the Contractor.
- F. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01650

EQUIPMENT TESTING AND START-UP

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Equipment testing and start-up are requisite to satisfactory completion of the contract and, therefore, shall be completed within the time specified for substantial completion.
- B. The Contractor shall allow sufficient time in his construction schedule to complete equipment testing, trouble shooting, corrections, and start-up.
- C. As construction of the project enters the final stages of completion, the Contractor shall, in accordance with the requirements set forth in the Contract Documents, attend to the following items:
 - 1. Schedule equipment manufacturer's visits to site. Manufacturer shall schedule activities so that plant personnel can attend.
 - 2. Calibrate of instruments and controls.
 - 3. Perform required testing, adjusting, and balancing of project components.
 - 4. Schedule start-up and initial operation.
 - 5. Furnish skilled personnel during initiation operation.
 - 6. Perform Owner operation and maintenance training.
- D. Refer to other Divisions for further requirements regarding this Section.

1.02 EQUIPMENT TESTING

- A. The Contractor shall provide the services of an experienced and authorized representative of the supplier of each item of equipment (excluding minor items of equipment specifically exempted by the Engineer in writing), who shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the Contractor shall arrange to have the supplier's representative revisit the job site as often as necessary until any and all trouble is corrected and the equipment installation and operation are satisfactory to the Engineer.
- B. The Contractor shall require that each supplier's representative test performance of his equipment and furnish to the Engineer a written report addressed to the Owner, and copied to the Engineer, certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, and has been tested, operated satisfactorily under full-load conditions, is ready for operation, and the Owner's operating personnel have observed the operation, maintenance and lubrication of the equipment.

- C. The Contractor shall be responsible for scheduling all operation's testing. The Contractor is advised that the Engineer and the Owner's operating personnel will witness operations testing.
- D. The Contractor shall furnish all personnel, chemicals, lubricants, and all other necessary equipment, facilities, and services required for conducting tests.

1.03 PUMP STATION

- A. The Contractor shall provide the effective coordination of all parties necessary for the successful start-up, including suppliers, subcontractors, the Engineer, and the Owner.
- B. Not less than 1 month prior to start-up, the Contractor shall submit to the Engineer for review, a detailed schedule of operations which will be necessary to affect a successful initial operation and sustained period of operation for the duration of the required start-up period.
- C. The start-up shall not be commenced until all required leakage tests, and equipment tests have been completed to the satisfaction of the Engineer.
- D. All defects in materials or workmanship which appear during this test period shall be immediately corrected by the Contractor. Time lost for equipment repairs, wiring corrections, control point settings, or other reasons which actually interrupt the start-up may, at the discretion of the Engineer, be justifiable cause for extending the start-up test duration.
- E. During the start-up, the Contractor shall provide the services of authorized representatives of the suppliers, in addition to those services required under operations testing, as necessary, to correct faulty equipment operation.

1.04 DEMONSTRATION AND INSTRUCTION

- A. Manufacturer shall schedule start-up activities with the Owner at least two weeks in advance so that the Owner's operating personnel can observe. The Owner's operating personnel shall observe start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment. Start-up services shall be by qualified persons who have been made familiar in advance with the equipment and systems in the plant. The Contractor shall have submitted, and had accepted, the O&M Manuals (specified in Section 01300) prior to commencement of start-up activities.
- B. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01700
PROJECT CLOSEOUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Final Cleaning

1. At the completion of the work, the Contractor shall remove all rubbish from and about the site of the work, and all temporary structures, construction signs, tools, scaffolding, materials, supplies and equipment which he or any of his Subcontractors may have used in the performance of the work. Contractor shall broom clean paved surfaces and rake clean other surfaces of grounds.
2. Contractor shall thoroughly clean all materials, equipment and structures; all marred surfaces shall be touched up to match adjacent surfaces; dirty filters and burned out lights replaced as required; all glass surfaces cleaned and floors cleaned and polished so as to leave work in a clean and new appearing condition.
3. Contractor shall maintain cleaning until project, or portion thereof, is occupied by the Owner.

B. Lubrication Survey

1. A lubrication survey, made by a lubricant supply firm, subject to the approval of the Owner shall be provided and paid for by the Contractor.
2. The lubrication survey shall list all equipment, the equipment manufacturer's lubrication recommendations, and an interchangeable lubricants tabulation standardizing and consolidating lubricants whenever possible.
3. The Contractor shall supply all lubricants, applicators and labor for lubricating the equipment, in accordance with manufacturer's recommendations, for field testing and prior to final acceptance. A supply of required lubricants sufficient for start-up and one year of operation shall also be supplied by the Contractor.
4. Ten (10) copies of the approved lubrication survey shall be furnished to the Engineer prior to final acceptance.

C. Spare Parts and Special Tools

1. As soon as practicable after approval of the list of equipment, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and source or sources of supply.

2. Contractor shall also furnish a list of parts, and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified to be furnished as part of the Contract and a list of additional items recommended by the manufacturer to assure efficient operation for a period of one-hundred and twenty (120) days for the particular installation.
3. All parts shall be securely boxed and tagged, and clearly marked on the box and individually for identification as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least ten (10) years.
4. Contractor shall furnish at no additional cost to the Owner with each piece of equipment as a minimum, one (1) complete set, or the number of sets called for in the Technical Specifications, of suitably marked special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment. Such tools and appliances shall be furnished in approved painted steel cases properly labeled and equipped with good grade cylinder locks and duplicate keys.
5. Contractor shall submit, for approval by the Engineer, a complete list of the special tools and appliances to be furnished. Upon approval, the Contractor shall provide ten (10) copies of the approved list.

D. Equipment Start-Up Services

1. Equipment start-up period, for the training of plant personnel, shall begin after satisfactory completion and acceptance of the field tests and coincidentally with the certified date of substantial completion for the part of the work for which the equipment is included. If the equipment is not covered by a certificate of substantial completion for a part of the work, the period shall begin upon substantial completion of the project.
2. During the equipment start-up period the Contractor shall furnish, at no additional cost to the Owner the services of factory trained representatives of the equipment manufacturers for the equipment designated in the Specifications to:
 - a. Assist in the start-up and operations of the equipment.
 - b. Assist in the training of plant personnel, designated by the Owner in the proper operation and maintenance of the equipment.
- 3 The Owner shall:
 - a. Provide the necessary personnel to be instructed in the operation and maintenance of the equipment. The Owner's personnel shall operate all equipment.
 - b. The Contractor shall pay for fuel, power, and chemicals consumed up to project completion / closeout.

4. Contractor shall be available to promptly repair all work during the start-up period so as to cause minimum disruption to the total plant operation.
5. Upon completion of a minimum of thirty (30) consecutive and continuous days of satisfactory operation, or the number of days called for in the Technical Specifications, the Owner will assume operation and operating cost of the equipment. If the equipment malfunctions during this start-up period, the start-up period will be repeated until satisfactory operation is achieved.
6. In the event a system, equipment or component proves defective or is unable to meet specified performance criteria, the Contractor shall replace the defective item and the minimum one (1) year guarantee period, or the guarantee period called for in the Technical Specifications for the item shall start after satisfactory replacement and testing of the item.

E. Final Cleanup; Site Rehabilitation

1. Before finally leaving the site, the Contractor shall wash and clean all exposed surfaces which have become soiled or marked, and shall remove from the site of work all accumulated debris and surplus materials of any kind which result from his operation, including construction equipment, tools, sheds, sanitary enclosures, etc. The Contractor shall leave all equipment, fixtures, and work, which he has installed, in a clean condition. The completed project shall be turned over to the Owner in a neat and orderly condition.
2. The site of the work shall be rehabilitated or developed in accordance with other sections of the Specifications and the Drawings. In the absence of any portion of these requirements, the Contractor shall completely rehabilitate the site to a condition and appearance equal or superior to that which existed just prior to construction, except for those items whose permanent removal or relocation was required in the Contract Documents or ordered by the Owner.

F. Final Inspection

1. Final cleaning and repairing shall be so arranged as to be finished upon completion of the construction work. The Contractor will make his final cleaning and repairing, and any portion of the work finally inspected and accepted by the Engineer shall be kept clean by the Contractor, until the final acceptance of the entire work.
2. When the Contractor has finally cleaned and repaired the whole or any portion of the work, he shall notify the Engineer that he is ready for final inspection of the whole or a portion of the work, and the Engineer will thereupon inspect the work. If the work is not found satisfactory, the Engineer will order further cleaning, repairs, or replacement.
3. When such further cleaning or repairing is completed, the Engineer, upon further notice, will again inspect the work. The "Final Payment" will not be processed until the Contractor has complied with the requirements set forth, and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is

properly and satisfactorily constructed in accordance with the requirements of the Contract Documents.

G. Project Close Out

1. As construction of the project enters the final stages of completion, the Contractor shall, in concert with accomplishing the requirements set forth in the Contract Documents, attend to or have already completed the following items as they apply to his contract:
 - a. Scheduling equipment manufacturers' visits to site.
 - b. Required testing of project components.
 - c. Scheduling start-up and initial operation.
 - d. Scheduling and furnishing skilled personnel during initial operation.
 - e. Correcting or replacing defective work, including completion of items previously overlooked or work which remains incomplete, all as evidenced by the Engineer's "Punch" Lists.
 - f. Attend to any other items listed herein or brought to the Contractor's attention by the Engineer.
2. Just before the Engineer's Certificate of Substantial Completion is issued, the Contractor shall accomplish the cleaning and final adjustment of the various building components as specified in the Specifications and as follows:
 - a. Clean all glass and adjust all windows and doors for proper operation.
 - b. Clean all finish hardware after adjustment for proper operation.
 - c. Touch up marks or defects in painted surfaces and touch up any similar defects in factory finished surfaces.
 - d. Wax all resilient flooring materials.
 - e. Remove bitumen from gravel stops, fascias, and other exposed surfaces.
 - f. Remove all stains, marks, fingerprints, soil, spots, and blemishes from all finished surfaces, tile, stone, brick, and similar surfaces.
3. In addition, and before the Certificate of Substantial Completion is issued, the Contractor shall submit to the Engineer (or to the Owner if indicated) certain records, certifications, etc., which are specified elsewhere in the Contract Documents. A partial list of such items appears below, but it shall be the Contractor's responsibility to submit any other items which are required in the Contract Documents:

- a. Test results of project components.
 - b. Performance Affidavits for equipment.
 - c. Certification of equipment or materials in compliance with Contract Documents.
 - d. Operation and maintenance instructions or manuals for equipment.
 - e. One set of neatly marked-up record drawings showing as-built changes and additions to the work under his Contract.
 - f. Any special guarantees or bonds (Submit to Owner).
 - g. Licensed surveyor's report showing elevations of weirs specified in the Contract Drawings and the final surveyed elevation.
4. The Contractor's attention is directed to the fact that required certifications and information under Item 3 above, must actually be submitted earlier in accordance with other Sections of the Specifications.
5. Before final payment is issued, the Contractor shall provide the following:
- a. All documentation called for in the Contract Documents, including but not limited to the evidence of insurance for operations coverage in effect for two years after final payment;
 - b. Consent of the surety, if any, to final payment;
 - c. 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.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01701

PROJECT COMMISSIONING

PART 1 - GENERAL

1.1 SCOPE

- A. In order to ensure an orderly and efficient transfer of the project to the Owner, the Contractor shall prepare, assemble and transmit the documents, brochures and drawings herein required.
- B. All commissioning documents shall be transmitted to the Engineer for approval.

PART 2 - MATERIALS

2.1 STATUTORY AFFIDAVIT

Before final acceptance of the work, the Contractor shall be required to furnish a Statutory Affidavit in the exact form included in this section.

2.2 WARRANTY BY CONTRACTOR

- A. Reference is hereby made to the General Conditions in which the one (1) year warranty of the Contractor is required to be submitted, unless a warranty for a longer period of time is specified for certain section of the work, such as roads, etc., in which case the longer period shall govern.
- B. A sample warranty form is included in this section.

2.3 VALVE CARDS

- A. Valve Cards shall be prepared in accordance with Charleston Water System's Valve Card Detail for all wastewater force main valves, water valves, air release valves (ARVs), check valves, and hydrants showing the manufacturer, model name, year, size, opening direction and number of turns as applicable.
- B. Prepare Valve Cards for "Dummy" valve boxes for tracer wire where applicable.
- C. Valves are to be located by distance to two permanent reference points. Diagonal measurements or distances are not acceptable.

2.4 RECORD DRAWINGS

Record Drawings shall reflect all As-Constructed conditions for gravity sewer, force main, pump station mains, water services, and wastewater sewer lateral placements and include the following items at a minimum:

- A. All water and/or wastewater appurtenances and attributes must be tied to State Plane Coordinates.
- B. Plan view for all water and wastewater projects.
- C. Plan and profile for all wastewater gravity sewers and force mains.
- D. Plan and profile for all wastewater force mains.
- E. Plan View and Elevation View for wastewater pump stations.
- F. Show all corresponding Street Addresses, Unit Numbers, Tax Map Numbers, Block Designations and Lot Numbers for each parcel shown on the drawings, including Wastewater Pump Stations.
- G. Show station numbers at all valves, manholes, fire hydrants, blow-offs, water services, wastewater sewer services, air release valves, bends, tees, reducers and all other fittings and appurtenances.
- H. Provide a Coordinate Table for all installed water and/or wastewater appurtenances in a tabular format on the Record Drawings. The table shall include Point Number, Northing, Easting, Elevation, Station Number and Description. Elevations must be provided for water valves (captured from top of nut, not the lid) and wastewater manholes (capture rim elevation). If abbreviations are used as descriptors, a key to those abbreviations must be provided.
- I. Line lengths and termination points.
- J. Indicate top elevation and invert elevation of manholes. Include invert elevation of any other manhole connections to include inside drops and force main connections.
- K. Where applicable, show installed location of electrical conduit, pull boxes, etc.
- L. Reference benchmarks on drawings and tie to National Geodetic Vertical Datum of 1929 (NGVD29) and NAD 1983 FIPS 3900 South Carolina State Plane Coordinates. Note on plans for construction as well as Record Drawings.
- M. Surveyed locations of water and wastewater facilities, including gravity line elevations, shall be prepared by a Land Surveyor registered in the state of South Carolina in accordance with South Carolina Code of Regulations Chapter 49, Article 4.
- N. Certification statement sealed, signed, and dated by the Engineer of Record for the project.
- O. Show all recorded plan and easement information on the Record Drawings.
- P. Record Drawings must be clearly legible and of good quality.

2.5 OTHER REQUIRED RECORDS

- A. Provide the following records if completed and applicable:
- B. Pressure tests for all water mains and wastewater force mains signed by the engineer.
- C. Low-pressure tests for wastewater gravity sewers signed by the Engineer.
- D. Bacteriological Samples from an SC DHEC certified laboratory. Samples must be less than 30 days old.
- E. Complete Closed Circuit Television (CCTV) inspection submittal in accordance with the Contract Documents.
- F. Mandrel test for wastewater gravity sewers, if directed by the Owner.
- G. Complete list of all supplied spare parts.
- H. For wastewater pump stations: laminate and mount to the inside of the control panel door all electrical schematics, drawdown test, and level settings.
- I. Test results for any other project components.

2.6 ASSET DATABASE

- A. The Contractor shall submit at least every 6 months, equipment and process specification data that will be used to establish an asset by asset database. The asset data shall be submitted in a format that can be used to electronically populate a computerized database.
- B. The Contractor shall require all vendors and suppliers to provide specific information in an electronic spreadsheet format (i.e., Excel) delivered on CD-ROM that includes the following:
 - 1. Installed Asset Data:
 - a. Name plate data on all asset components (e.g., motor, valve, gate, geardrive, pump, pre-engineered building, brickwork, etc.) equal to or greater than \$1,000 in value including:
 - 1) Asset identification of "parent" asset (e.g., Butterfly Valve)
 - 2) Manufacturer
 - 3) Manufacturer Drawing Numbers
 - 4) Serial number
 - 5) Model number

- 6) Original cost of installed component
- 7) Estimated useful life
- 8) Other pertinent specification data for that particular component type (e.g., size, capacity, rpm, volts, gear ratio, etc.)

b. Spare Equipment list should include:

- 1) Type (e.g., motor, pump, geardrive, etc.)
- 2) Name of manufacturer
- 3) Serial number
- 4) Model number
- 5) Original cost
- 6) Bill of Materials (if applicable)
- 7) Other pertinent specification data for that particular component type (e.g., size, capacity, rpm, volts, gear ratio, etc.)

PART 3 - EXECUTION

3.1 STATUTORY AFFIDAVIT

Prior to project commissioning, the Contractor shall furnish to the Owner a Statutory Affidavit in the exact form included in this section.

3.2 WARRANTY BY CONTRACTOR

Prior to project commissioning, the Contractor shall furnish to the Owner a Contractor Warranty in accordance with 2.2 above

3.3 VALVE CARDS AND RECORD DRAWINGS

- A. Prior to project commissioning, the Contractor shall furnish to the Engineer as one package the following Hard Copy and Digital submittals. Digital files shall be delivered on a CD or DVD in both AutoCAD format (.dwg) and PDF format. PDF shall be produced from AutoCAD so that drawings are clear and scalable. State Plane Coordinates must be tied to the drawing in AutoCAD for correct positioning in GIS.

1. Hard Copy Submittals

- a. One (1) copy of Contractor's marked-up As-Constructed field drawings.
- b. Two (2) copies of 8.5" x 11" Valve Cards in accordance with the requirements of 2.3 above.
- c. Four (4) copies of surveyed Record Drawings in accordance with the requirements of 2.4 above.

2. Digital Submittals

- a. One (1) copy of Valve Cards in accordance with the requirements of 2.3 above.
- b. One (1) copy of Contractor's Record Drawings in accordance with the requirements of 2.4 above.

B. Valve Cards and Record Drawings found to be in error will be returned to the Contractor for correction.

C. Final Record Drawings, as prepared by the Engineer, shall be sealed, signed and dated by the Contractor's surveyor who shall be a registered Land Surveyor in the state of South Carolina.

D. Project commissioning will not occur until Record Drawings are submitted.

3.4 OTHER REQUIRED RECORDS

A. Prior to project commissioning, the Contractor shall furnish to the Owner as one package one (1) copy each of the required records specified in 2.5 above.

3.5 ASSET DATABASE

A. Prior to project commissioning, the Contractor shall furnish to the Owner as one package the following Hard Copy and Digital submittals. Digital files shall be delivered on a CD or DVD in Excel format (.xlsx).

1. Hard Copy Submittal

- a. Two (2) copies of all data for final installed assets and list of all spare equipment provided to the Owner in accordance with the requirements of 2.5 above.

2. Digital Submittal

- a. Two (2) copies of all data for final installed assets and list of all spare equipment provided to the Owner in accordance with the requirements of 2.5 above.

CONTRACTOR'S AFFIDAVIT

The State of: _____ Date: _____

The County of: _____

The City/Town of: _____

_____ of _____
(Officer's Name) (Officer's Title) (Contractor's Name)

Being duly sworn, deposes and says that _____
(Contractor's Name)

has furnished all labor and material entering into the _____
at _____

(kind of work) (Name and Location of Plant or Work)
called for in the Contract Documents dated _____ with

(Owner's Name)

_____ states that this officer has full knowledge
(Contractor's Name)

of all obligations for such labor and materials which have entered into and become part of that certain project known and designated above, and that this officer further deposes and says that all debts and other obligations for such labor and materials have been fully and completely paid for in good and lawful money of the United States of America and that there are no suits for damages against them proceeding, prospective and/or that there are no suits for damages against them proceeding, prospective, or otherwise, in consequence of their operations on the above said project.

The said _____ will hold the Owners
(Contractor's Name)

_____ blameless of any and all mechanic's liens that
(Owner's Name)

may be hereafter entered or filed for record, so as to constitute charge against said premises for work or labor done or materials furnished by them.

IN WITNESS HEREOF, this officer has heretofore put his hand and seal:

_____ (Seal)
(Officer's Name)

I, _____, Notary Public in and for the above named County and State

do hereby certify that _____ personally known to me to be the affiant
(Officer's Name)

in the foregoing Affidavit, personally appeared before me this day and, having been duly sworn, deposes and says that the facts set forth in the above Affidavit are true and correct.

WITNESS my hand and seal this _____ day of _____, 20 _____.
(Seal)

Notary Public for the State of: _____

My Commission Expires: _____

**WARRANTY
BY CONTRACTOR**

OWNER: Commissioners of Public Works of the City of Charleston, South Carolina
Thomas Island Pump Station and Interceptor –
PROJECT: **Division I** _____ JOB NO. _____
ADDRESS: _____
COUNTY OF: _____
STATE OF: _____

Date: _____, as General Contractor on the above job do hereby guarantee that all work executed under the plans and specifications will be free from defects of materials and/or workmanship for a period of **ONE YEAR**, unless a longer period is required by law or by a special warranty provision of the Contract Documents, beginning _____ and, ending _____, and that all defects occurring within the warranty period shall be replaced or repaired at no cost to the CPW. All pavement work and pavement repair work shall be warranted for **TWO (2) YEARS**, beginning _____ and, ending _____.

This guarantee covers all work as shown on the plans and specified in the specifications and Contract Documents.

Nothing in the above shall be deemed to imply that this guarantee shall apply to any work, which has been abused or neglected by the CPW.

Legal Name of Contractor

By: _____

Title: _____

(Notary Public)

This _____ day of _____, 20 _____

My commission expires: _____

(County) (State)

- END OF SECTION -

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SECTION 01710

CLEANING

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. Inspection: Conduct weekly inspection to verify that requirements of cleanliness are met.
- B. Codes and Standards: In addition to the standards described in this Section, comply with all pertinent requirements of governmental agencies having jurisdiction.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS AND EQUIPMENT

- A. Provide all required personnel, equipment, and materials needed to maintain a litter free site.

2.2 COMPATIBILITY

- A. Use only equipment, which is compatible with the material being cleaned, as recommended by the manufacturer of the material or as approved by the Owner.

PART 3 - EXECUTION

3.1 GENERAL

- A. Retain all stored items in an orderly arrangement, allowing maximum access, not impeding drainage or traffic, and providing the required protection of materials.
- B. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this work.
- C. At least twice each month, and more often if necessary, completely remove and dispose all scrap, debris, and waste material from the job site.
- D. Provide adequate storage for all items awaiting removal from the job site, observing all requirements for fire protection and protection of the ecology.

3.2 SITE

- A. Weekly, and more often if necessary, police the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.
- B. Weekly, and more often if necessary, inspect all arrangements of materials stored on the site; restack, tidy, or otherwise service all arrangements to meet the requirements above.
- C. Maintain the site in a neat and orderly condition at all times.
- D. All holes, ruts, settlement, and depressions resulting from the Work shall be filled and graded to match elevations of adjacent surfaces, and all areas disturbed by construction shall be restored to their original condition to the maximum extent practicable and as acceptable to the Owner and Engineer.

3.3 FINAL CLEANING

- A. Definition: Except as otherwise specifically provided, "clean" (for the purpose of this article) shall be interpreted as meaning free from foreign material left after installation.
- B. General: Prior to completion of the work, remove from the job site all tools, surplus materials, equipment, construction signs, supplies, scrap, debris, and waste. Conduct final progress cleaning as described above.
- C. Site: Unless otherwise specifically directed by the Owner or the Engineer, broom clean all paved area on the site and all public paved areas directly adjacent to the site. Completely remove all resultant debris.
- D. Timing: Schedule final cleaning to enable the Owner or the Engineer to accept clean projects.
- E. Final acceptance will be withheld until final cleaning is complete.

PART 4 - PAYMENT

- 4.1 No additional compensation will be made for labor or materials included in this section.

- END OF SECTION -

SECTION 02050

DEMOLITION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials and equipment in accordance with the requirements of Section 01520 - Maintenance of Utility Operations During Construction and Section 01540 - Demolition and Removal of Existing Structures and Equipment.
- B. In addition, the Contractor shall demolish and remove all concrete and asphaltic paving, curbs, sidewalk, and miscellaneous yard structures as required and shown on the Contract Drawings during the construction work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01090 - Reference Standards
- B. Section 01520 - Maintenance of Utility Operations During Construction
- C. Section 01540 - Demolition and Removal of Existing Structures and Equipment

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. References shall be in accordance with reference standards, codes, and specifications as set forth herein and in Section 02100 - Clearing, Grubbing, and Site Preparation.

PART 2 -- EXECUTION

2.01 DEMOLITION

- A. Existing concrete and asphaltic paving, curbs, sidewalk and miscellaneous yard structures within the areas designated for new construction work shall be completely demolished and all debris removed from the site.
- B. Excavation caused by demolition shall be backfilled with fill free from rubbish and debris.
- C. Work shall be performed in such manner as not to endanger the safety of the workmen or the public or cause damage to nearby structures.
- D. Provide all barriers and precautionary measures in accordance with Owner's requirements and other authorities having jurisdiction.

- E. Where parts of existing structures are to remain in service, demolish the portions to be removed, repair damage, and leave the structure in proper condition for the intended use. Remove concrete and masonry to the lines designated by drilling, chipping, or other suitable methods. Leave the resulting surfaces reasonably true and even, with sharp straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended. Where existing reinforcing rods are to extend into new construction, remove the concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing 1/2-inch below the surface and fill with epoxy resin binder flush with the surface.
- F. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of the adjoining and/or nearby structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

2.02 DISPOSAL OF MATERIAL

- A. All debris resulting from the demolition and removal work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed. All other material shall be disposed of off site by the Contractor at his expense.
- B. Burning of any debris resulting from the demolition will not be permitted at the site.

- END OF SECTION -

SECTION 02100

CLEARING, GRUBBING, AND SITE PREPARATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Includes all labor, material, equipment and appliances required for the complete execution of any additions, modifications, or alterations to existing building(s) and new construction work as shown on the Drawings and specified herein.
- B. Principal items of work include:
 - 1. Notifying all authorities owning utility lines running to or on the property. Protecting and maintaining all utility lines to remain and capping those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.
 - 2. Clearing the site within the Limits of Construction, including removal of grass, brush, shrubs, trees, loose debris and other encumbrances except for trees marked to remain.
 - 3. Boxing and protecting all trees, shrubs, lawns and the like within areas to be preserved. Relocating trees and shrubs, so indicated on the Drawings, to designated areas.
 - 4. Repairing all injury to trees, shrubs, and other plants caused by site preparation operations shall be repaired immediately. Work shall be done by qualified personnel in accordance with standard horticultural practice and as approved by the Engineer.
 - 5. Removing topsoil to its full depth from designated areas and stockpiling on site where directed by the Engineer for future use.
 - 6. Disposing from the site all debris resulting from work under this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 - Earthwork

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. South Carolina DHEC Standards, Regulation 72-300 through 72-316.

1.04 STREET AND ROAD BLOCKAGE

- A. Closing of streets and roads during progress of the work shall be in compliance with the requirements of the Owner and other authorities having jurisdiction. Access shall be provided to all facilities remaining in operation.

1.05 PROTECTION OF PERSONS AND PROPERTY

- A. All work shall be performed in such a manner to protect all personnel, workmen, pedestrians and adjacent property and structures from possible injury and damage.
- B. All conduits, wires, cables and appurtenances above or below ground shall be protected from damage.
- C. Provide warning and barrier fence where shown on the Drawings and as specified herein.

PART 2 -- EXECUTION

2.01 CLEARING OF SITE

- A. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shall be cleared and grubbed.
- B. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, sanitary landfill material, fencing, and other perishable and objectionable material within the areas to be excavated or other designated areas. Prior to the start of construction, the Contractor shall survey the entire Contract site and shall prepare a plan which defines the areas to be cleared and grubbed, trees to be pruned, extent of tree pruning, and/or areas which are to be cleared but not grubbed. This plan shall be submitted to the Engineer for approval. Should it become necessary to remove a tree, bush, brush or other plants adjacent to the area to be excavated, the Contractor shall do so only after permission has been granted by the Engineer.
- C. Excavation resulting from the removal of trees, roots and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02200, Earthwork.
- D. Unless otherwise shown or specified, the Contractor shall clear and grub a strip at least 15 ft. wide along all permanent easement under this Contract.
- E. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, are too close to the work to be maintained or have become damaged due to the Contractor's operations.

2.02 STRIPPING AND STOCKPILING EXISTING TOPSOIL

- A. Existing topsoil and sod on the site within areas designated on the Drawings shall be stripped to whatever depth it may occur, and stored in locations directed by the Engineer.
- B. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling the topsoil.
- C. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

2.03 GRUBBING

- A. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks and other perishable materials to a depth of at least 6-inches below ground surfaces.
- B. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

2.04 DISPOSAL OF MATERIAL

- A. All debris resulting from the clearing and grubbing work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed by the Engineer for reuse in this Project or removal by others.
- B. Burning of any debris resulting from the clearing and grubbing work will not be permitted at the site.
- C. All timbered woods can be mulched along the easement except wetland areas at no additional cost to the Owner.

2.05 WARNING AND BARRIER FENCE

- A. The fence shall be made of a visible, lightweight, flexible, high strength polyethylene material. The fence shall be MIRASAFE as manufactured by Mirafi, Inc., or equal.
- B. Physical Properties

Fence:

Color:	International Orange
Roll Size:	4' x 164'
Roll weight:	34 lbs.
Mesh opening:	1-1/2" x 3"

Posts:

ASTM Designation:	ASTM 702
Length:	5 feet long (T-Type)
Weight:	1.25 #/Foot (min)
Area of Anchor Plate:	14 Sq. In.

- C. Drive posts 12 to 18 inches into ground every 10' to 12'. Wrap fence material around first terminal post allowing overlap of one material opening. Use metal tie wire or plastic tie wrap to fasten material to itself at top, middle and bottom. At final post, cut with utility knife or scissors at a point halfway across an opening. Wrap around and tie at final post in the same way as the first post.
- D. Use tie wire or tie wrap at intermediate posts and splices as well. Thread ties around a vertical member of the fence material and the post, and bind tightly against the post. For the most secure fastening, tie at top, middle and bottom. Overlap splices a minimum of four fence openings, tie as above, fastening both edges of the fence material splice overlap.

- END OF SECTION -

SECTION 02140

DEWATERING

PART 1 -- GENERAL

1.01 WORK INCLUDED

- A. Furnish all labor, materials, and equipment, perform all work necessary to lower and control the groundwater levels and hydrostatic pressures to permit all excavations and construction to be performed in dry conditions. The work shall include the following:
 - 1. Testing, operation, maintenance, supervision, dewatering, and final dismantling and removal from the site of the dewatering system.
 - 2. The cost of any replacement or rehabilitation of the subgrade or structures damaged due to dewatering system failures or Contractor negligence.
 - 3. Compliance with all regulations relating to this work.
 - 4. The diversion, collection, and removal of all ice, snow and surface runoff from the work areas, and removal of groundwater from new excavations to permit construction in the dry.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS CODES AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents to the extent that the provisions therein are not in conflict with the requirements of this Section.
 - 1. ASTM D1556 Density of soil in place by the Sand Cone Method.
 - 2. ASTM D2167 Density of soil in place by the Rubber Balloon Method.
 - 3. Bureau of Reclamation Groundwater Manual Sediment Test by Imhoff Cone

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals:

1. Name of dewatering subcontractor, if applicable
2. Shop Drawings indicating the following:
 - a. Plans showing the methods and location of dewatering and discharge including a sufficient number of detailed sections to clearly illustrate the scope of work.
 - b. Relationship of the dewatering system, observation wells, and discharge line to existing buildings, other structures, utilities, streets and new construction.
 - c. Utility locations.
 - d. Drawings shall bear the seal and signature of the qualified Registered Professional Engineer in charge of preparing the drawings.
 - e. List of materials and equipment to be used.
 - f. A sample of all well record forms to be maintained during construction.
3. Detailed description of the sequence of dewatering operations
4. Dewatering well installation records indicating an identification number, location, dimensions, and installation procedures and materials.
5. Observation well installation records indicating an identification number, location, dimensions, and installation procedures and materials.
6. Emergency observation plan to be put into operation during failure of the dewatering system
7. Monthly Dewatering System Monitoring Reports containing the following data on approved forms:
 - a. For observation wells, daily piezometric levels shall be identified by date, time, well number and system (subsystem if multiple pumps are used) pumping rate. Piezometric levels shall be noted in feet of drawdown and groundwater elevation.
 - b. For dewatering wells, suspended material test results shall be identified by date, time, well number, well pumping rate (if monitored) and system (subsystem if multiple pumps are used) pumping rate.
 - c. Installation records for new wells.

8. Schedule and records of all maintenance tests for primary and standby dewatering systems including the following:
 - a. Maintenance tests and water quality tests for suspended matter at the discharge point including date, time of day, elapsed times of tests procedures, components tested, suspended particles, resultant observations and well readings.
 - b. Daily discharge rates.
 - c. Installation and removal of wells.
 - d. General observations of the system such as equipment running times, and failures.
9. Dewatering well removal records
10. Observation well removal records

1.05 QUALITY ASSURANCE

- A. The Contractor shall be solely responsible for the arrangement, location, and depths of the dewatering system necessary to accomplish the work described herein.
- B. Dewatering shall prevent the loss of fines, seepage, boils, quick conditions or softening of the foundation strata while maintaining stability of the sides and bottom of the excavation, and providing dry conditions for construction operations.

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Materials, especially the well screen, shall be carefully chosen to be compatible with the environment to prevent erosion, deterioration, and clogging.
- B. Surging of the natural formation to form a "gravel pack" is strictly prohibited.

PART 3 -- EXECUTION

3.01 EXAMINATION OF THE SITE

- A. Become familiar with the surface and subsurface site conditions.
- B. Obtain the data required to analyze the water and soil environment at the site in order to assure that the materials used for the dewatering systems will not erode, deteriorate, clog or otherwise hinder the system's performance during the period of the dewatering.

- C. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of adjoining structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

3.02 DESIGN

- A. The dewatering system shall be capable of relieving all hydrostatic pressure against the height of the excavation walls and of lowering the hydrostatic level below the bottom of the base slab a minimum of four (4) feet in the work areas both prior to excavation, and during excavation and construction.
- B. The dewatering system shall be segmented so that if the operation of any one segment is disrupted, the remaining segment plus activated redundant components are capable of maintaining the groundwater at the stated levels.
- C. Provide, operate and maintain all ditches, berms, site grading, sumps and pumping facilities to divert, collect and remove all surface water from work areas. All collected water shall be discharged into the outfall pipe.
- D. Provide pipe and pumps of sufficient size and quantity to be able to flood the excavation within 12 hours in an emergency situation. Restoration of the working area shall be carried out by the Contractor at no additional cost to the Owner.
- E. Carry the dewatering system discharge through pipes out of the area of the excavation into the outfall junction manhole shown on the Drawings. Provide meters to measure the discharge flow.
- F. Place a portion of the header and discharge system underground to provide vehicle crossings or access to existing structure as required.
- G. Provide a standby dewatering system that meets the following requirements:
 - 1. Provide 100 percent standby power.
 - 2. Provide a 15 percent minimum increase in the number of wells and related equipment required to operate the dewatering system installed and ready to operate.
 - 3. Provide a minimum of three separate power units for the standby power system and one installed auxiliary unit for each individually powered pump.
 - 4. Provide separate discharge lines from each well or common lines with valves such that any well or wells that malfunction or are damaged can be isolated from the others.
 - 5. The systems shall be laid out and designed in such a way that portions of the system may be isolated for routine maintenance or repair in case of accidental damage without affecting the normal operation of the system.

- H. Provide sufficient fuel to maintain a five day supply on site for fuel power systems.
- I. Provide observation wells to determine compliance with dewatering requirements as indicated on the Drawings, Shop Drawings, and the Engineer.
- J. Designate certain observation wells as emergency observation wells.

3.03 INSPECTION

- A. All tests and inspections require the witnessing and written approval of the Owner and Engineer.
- B. Provide safe access for the owner and Engineer to perform testing and inspection.
- C. The Owner and Engineer will provide oral and written notice to the Contractor for all tests and inspections that do not meet approval.

3.04 INSTALLATION AND TESTING

- A. Install the dewatering system from the existing ground surface or from the bottom of an excavation which is located above the natural groundwater level.
- B. Pump each well individually at its maximum or design flow and take a water sample using the following procedures:
 - 1. Obtain samples from stopcocks located along the discharge lines at points of high turbulence or between 4 and 8 o'clock on the perimeter of straight sections of pipe.
 - 2. Flush the stopcock for a few seconds before taking a sample.
 - 3. Take a 1 liter sample with the stopcock fully open.
- C. Test the sample following the Sediment Test by Imhoff Cone for two to three minutes and measure the volume of settled materials to the nearest 0.01 milliliters (0.01 milliliters = 10 ppm).
- D. All wells shall be evaluated as follows:
 - 1. Wells producing 10 ppm or less shall be accepted.
 - 2. Wells producing between 10 and 20 ppm may be accepted by the Engineer based on the evaluation of average ppm for all wells, ppm of adjacent wells, and total quantity of water which is actually pumped to dewater the excavation.
 - 3. Well producing more than 20 ppm shall be abandoned and backfilled.
- E. Observation wells shall consist of a standpipe or riser of minimum 1.0-inch inside diameter and a minimum three (3) foot long well-point screen or slotted PVC section at the bottom. Observation wells shall be installed as follows:

1. Employ the jetting method for all observation wells except those within ten feet of existing structures, piping or utilities.
 2. Employ Case Boring Techniques for all observation wells within ten feet of existing structures, piping, or utilities and backfill the annulus between the well point or riser and the natural soil with a free flowing granular material similar to Ottawa Sand.
- F. Test observation wells by adding or removing water from the riser to demonstrate their proper functioning.

3.05 DEWATERING PROCEDURE

- A. Following soldier pile installation and dewatering system installation and testing and prior to excavation, place the dewatering system into operation and lower the water level.
- B. Schedule the dewatering work to coordinate with all the other related work such as excavation, sheeting and tiebacks, pouring of concrete walls and slabs, and any other operations by other Contractors that might be affected by this work.
- C. Test the standby dewatering system with the following procedures:
1. Shut off the primary power source and demonstrate that the standby power can be activated prior to the groundwater level rising to within one (1) foot of the bottom of base slab elevation and that the standby power source is adequate to draw the groundwater level back down to the Contractor's design depth or to the minimum required depths.
 2. Shut off one segment of the system and show that redundant components can be activated prior to the groundwater level rising to within one (1) foot of the bottom of base slab elevation and that the system is adequate to draw the groundwater level back down to the Contractor's design depth or to the minimum required depths.
 3. If the dewatering system fails to meet either performance requirement, the Contractor shall draw the groundwater level to a greater depth, add wells, or modify the system such that it will be in conformance with these requirements when retested.
- D. Operate the dewatering system continuously twenty-four (24) hours per day, seven (7) days per week until all structures have been satisfactorily constructed, including placement of fill materials, and no longer require dewatering.

3.06 MONITORING

- A. Measure the piezometric water levels to the nearest one-tenth foot in all observation wells and submit the readings daily.
- B. Measure the concentration of suspended material in the discharge water of each well once every two days. Wells which exceed the acceptable level of solids concentration shall be replaced.

- C. Test the performance of the standby system and all components by demonstrating that the system is operational at least every two weeks.
- D. Test the observation wells every two weeks by adding and removing water from the risers to demonstrate their proper functioning.
- E. Observation wells that become inoperable shall be immediately replaced while construction is halted if the Engineer determines that the observation well is critical.
- F. Remove and add riser pipe of each observation well located within the excavation as construction progresses until the well conflicts with the structure. When the conflict occurs, abandon the observation well, fill it with grout, and cut the riser off at grade.
- G. In the event of a dewatering system failure, take the following steps:
 - 1. Conduct in situ density tests conforming to ASTM D1556 or ASTM D2167 immediately above and at the structure founding grades.
 - 2. Remove all soils that show unacceptable density and replace them with compacted fill as indicated in Section 02200, Earthwork.
 - 3. Test the repaired soils as required by the Owner and Engineer to verify that they have been returned to their original in situ state or better.
 - 4. Repair or replace damaged structures.

3.07 REWATERING AND REMOVAL OF DEWATERING SYSTEM

- A. Obtain written approval from the Owner and Engineer to begin dewatering operations.
- B. Provide an adequate weight of fill to prevent buoyancy.
- C. Pump water into the excavation such that the water level inside the excavation is always at a higher level than the rising groundwater on the outside until the groundwater level has reached its static level.
- D. Remove all dewatering wells, buried and surface piping, cables, pump foundations, structural supports and all other support facilities.
- E. Backfill as specified in Section 02200, Earthwork, all trenches and excavations below final grades or in fill areas.
- F. Provide documentation of dewatering and observation well removal including the date of removal, well number, location, procedures, and materials used.

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SECTION 02200

EARTHWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, equipment and materials required to complete all work associated with excavation, including off-site borrow excavation, dewatering, backfill, drainage layers beneath and around structures, foundation and backfill stone, filter fabric, embankments, stockpiling topsoil and any excess suitable material in designated areas, in place compaction of embankments, backfill and subgrades beneath foundations and roadways, excavation support, disposing from the site all unsuitable materials, providing erosion and sedimentation control grading, site grading and preparation of pavement and structure subgrade, and other related and incidental work as required to complete the work shown on the Drawings and specified herein.
- B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.
- C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.
- D. All work under this Contract shall be done in conformance with and subject to the limitations of the latest editions of the South Carolina Department of Transportation Standard Specifications for Highway Construction and the South Carolina DHEC Stormwater BMP Handbook.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. South Carolina Department of Transportation Standard Specifications for Highway Construction, latest edition.

2. American Society for Testing and Materials (ASTM):

ASTM C 127	Test for Specific Gravity and Absorption of Coarse Aggregate.
ASTM C 136	Test for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 422	Particle Size Analysis of Soils.
ASTM D 423	Test for Liquid Limit of Soils.
ASTM D 424	Test for Plastic Limit and Plasticity Index of Soils.
ASTM C 535	Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM D 698	Standard Method of Test for the Moisture - Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12-inch (305 mm) Drop.
ASTM D1556	Test for Density of Soil in Place by the Sand-Cone Method.
ASTM D1557	Test for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lbs. (4.5 kg) Rammer and 18-inch (457 mm) Drop.
ASTM D2049	Test Method for Relative Density of Cohesionless Soils.
ASTM D2167	Test for Density of Soil in Place by the Rubber-Balloon Method.
ASTM D2216	Test for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.
ASTM D2487	Test for Classification of Soils for Engineering Purposes.
ASTM D2922	Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.04 SUBSURFACE CONDITIONS

- A. Information on subsurface conditions is referenced under Division 1, General Requirements.
- B. Attention is directed to the fact that there may be water pipes, storm drains and other utilities located in the area of proposed excavation. Perform all repairs to same in the event that excavation activities disrupt service.

1.05 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, the Contractor shall submit the following:

1. Name and location of all material suppliers.
2. Certificate of compliance with the standards specified above for each source of each material.
3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.
4. Plans and cross sections of open cut excavations showing side slopes and limits of the excavation at grade.
5. Samples of synthetic filter fabric and reinforced plastic membrane with manufacturer's certificates or catalog cuts stating the mechanical and physical properties. Samples shall be at least one (1) foot wide and four (4) feet long taken across the roll with the warp direction appropriately marked.
6. Construction drawings and structural calculations for any types of excavation support required. Drawings and calculations shall be sealed by a currently registered Professional Engineer in the State of South Carolina.
7. Monitoring plan and pre-construction condition inspection and documentation of all adjacent structures, utilities, and roadways near proposed installation of excavation support systems and near areas where dewatering is required to facilitate construction.
8. Dewatering procedures.

1.06 PRODUCT HANDLING

- A. Soil and rock material shall be excavated, transported, placed, and stored in a manner so as to prevent contamination, segregation and excessive wetting. Materials which have become contaminated or segregated will not be permitted in the performance of the work and shall be removed from the site.

PART 2 -- PRODUCTS

2.01 SELECT FILL

- A. Soils from the excavations meeting requirements stipulated herein with the exceptions of topsoil and organic material may be used as select fill for backfilling, constructing embankments, reconstructing existing embankments, and as structural subgrade support.
- B. Select fill used for embankment construction shall be a silty or clayey soil material with a Maximum Liquid Limit (LL) of 50 and a Plasticity Index (PI) between 7 and 20.
- C. Select fill used for backfilling shall either be material as described in Paragraph B above or a granular soil material with a Maximum Plasticity Index (PI) of 6.

- D. Regardless of material used as select fill, materials shall be compacted at a moisture content satisfactory to the Engineer, which shall be approximately that required to produce the maximum density except that the moisture content shall not be more than 1% below nor more than 4% above the optimum moisture content for the particular material tested in accordance with the ASTM D698.
- E. Select fill used as subgrade support shall be a coarse aggregate material meeting the gradation requirements of #57 or #78 aggregates in accordance with ASTM C-33, or Aggregate Base Course (ABC) as defined in Section 02207 – Aggregate Materials.
- F. Where excavated material does not meet requirements for select fill, Contractor shall furnish off-site borrow material meeting the specified requirements herein. Determination of whether the borrow material will be paid for as an extra cost will be made based on Article 4 of the General Conditions, as amended by the Supplementary Conditions. When the excavated material from required excavations is suitable for use as backfill, bedding, or embankments, but is replaced with off-site borrow material for the Contractor's convenience, the costs associated with such work and material shall be borne by the Contractor.

2.02 TOPSOIL

- A. Topsoil shall be considered the surface layer of soil and sod, suitable for use in seeding and planting. It shall contain no mixture of refuse or any material toxic to plant growth.

2.03 FOUNDATION DRAINAGE SYSTEMS

- A. The Contractor shall provide foundation drainage systems as indicated on the Drawings and specified herein. The materials and placement shall be as indicated under Section 02712 - Foundation Drainage Systems.

2.04 GEOTEXTILES

- A. The Contractor shall provide geotextiles as indicated on the Drawings and specified herein. The materials and placement shall be as indicated under Section 02274 - Geotextiles.

PART 3 -- EXECUTION

3.01 STRIPPING OF TOPSOIL

- A. In all areas to be excavated, filled, paved, or graveled the topsoil shall be stripped to its full depth and shall be deposited in storage piles on the site, at locations designated by the Engineer, for subsequent reuse. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials.

3.02 EXCAVATION

- A. All material excavated, regardless of its nature or composition, shall be classified as UNCLASSIFIED EXCAVATION. Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, and all other obstacles encountered and shown to be removed within the limits of excavation shown on the Drawings or specified herein. The cost of excavation shall be included in the Lump Sum Bid Price and no additional payment will be made for the removal of obstacles encountered within the excavation limits shown on the Drawings and specified herein.
- B. All suitable material removed in the excavation shall be used as far as practicable in the formation of embankments, subgrades, and shoulders, and at such other places as may be indicated on the Drawings or indicated by the Engineer. No excavation shall be wasted except as may be permitted by the Engineer. Refer to the drawings for specific location and placement of suitable excavated materials in the formation of embankments, backfill, and structural and roadway foundations. THE ENGINEER AND/OR MATERIALS TESTING CONSULTANT WILL DESIGNATE MATERIALS THAT ARE UNSUITABLE. The Contractor shall furnish off-site disposal areas for the unsuitable material. Where suitable materials containing excessive moisture are encountered above grade in cuts, the Contractor shall construct above grade ditch drains prior to the excavation of the cut material when in the opinion of the Engineer and/or materials testing consultant such measures are necessary to provide proper construction.
- C. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such excavation support, pumping and drainage as may be required. Excavation shall be made in accordance with the grades and details shown on the Drawings and as specified herein.
- D. Excavation slopes shall be flat enough to avoid slides that will cause disturbance of the subgrade or damage of adjacent areas. Excavation requirements and slopes shall be as indicated in the Drawings. The Contractor shall intercept and collect surface runoff both at the top and bottom of cut slopes. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded as shown on the Drawings or as may be indicated by the Engineer. Concurrent with the excavation of cuts the Contractor shall construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the Drawings or designated by the Engineer. All slopes shall be finished to reasonably uniform surfaces acceptable for seeding and mulching operations. No rock or boulders shall be left in place which protrude more than 1 foot within the typical section cut slope lines, and all rock cuts shall be cleaned of loose and overhanging material. All protruding roots and other objectionable vegetation shall be removed from slopes. The Contractor shall be required to submit plans of open-cut excavation for review by the Engineer before approval is given to proceed.
- E. It is the intent of these Specifications that all structures shall bear on an aggregate base, crushed stone or screened gravel bedding placed to the thickness shown on the Drawings, specified in these Specifications, or not less than 6-inches. Bedding for process piping shall be as specified in Section 15000 - Basic Mechanical Requirements, or as shown on the Drawings.

- F. The bottom of all excavations for structures and pipes shall be examined by the Engineer and/or materials testing consultant for bearing value and the presence of unsuitable material. If, in the opinion of the Engineer and/or materials testing consultant, additional excavation is required due to the low bearing value of the subgrade material, or if the in-place soils are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, and/or crushed stone or screened gravel as indicated by the Engineer. Payment for such additional work ordered by the Engineer shall be made as an extra by a Change Order in accordance with the General Conditions and Division 1. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.
- G. All cuts shall be brought to the grade and cross section shown on the Drawings, or established by the Engineer, prior to final inspection and acceptance by the Engineer.
- H. Slides and overbreaks which occur due to negligence, carelessness or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as indicated by the Engineer at no additional cost to the Owner. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed.
- I. Where the excavation exposes sludge, sludge contaminated soil or other odorous materials, the Contractor shall cover such material at the end of each workday with a minimum of 6-inches and a maximum of 24-inches of clean fill. The work shall be an odor abatement measure and the material shall be placed to the depth deemed satisfactory by the Engineer for this purpose.

3.03 EXCAVATION SUPPORT

- A. The Contractor shall furnish, place, and maintain such excavation support which may be required to support sides of excavation or to protect pipes and structures from possible damage and to provide safe working conditions. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor. The Contractor shall be responsible for the adequacy of all supports used and for all damage resulting from failure of support system or from placing, maintaining and removing it.
- B. Selection of and design of any proposed excavation support systems is exclusively the responsibility of the Contractor. Contractor shall submit drawings and calculations on proposed systems sealed by a Professional Engineer currently registered in the State of South Carolina.
- C. The Contractor shall exercise caution in the installation and removal of supports to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to installation or removal of excavation support system.

- D. Contractor shall monitor movement in the excavation support systems as well as movement at adjacent structures, utilities and roadways near excavation supports. Contractor shall submit a monitoring plan developed by the excavation support design engineer. All pre-construction condition assessment and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. If any sign of distress such as cracking or movement occurs in any adjacent structure, utility or roadway during installation of supports, subsequent excavation, service period of supports, subsequent backfill and construction, or removal of supports, Engineer shall be notified immediately. Contractor shall be exclusively responsible for repair of any damage to any roadway, structure, utility, pipes, etc. both on-site and off-site, as a result of his operations.
- E. All excavation supports shall be removed upon completion of the work except as indicated herein. The Engineer may permit supports to be left in place at the request and expense of the Contractor. The Engineer may order certain supports left permanently in place in addition to that required by the Contract. The cost of the materials so ordered left in place, less a reasonable amount for the eliminated expense of the removal work omitted, will be paid as an extra by a Change Order in accordance with the General Conditions and Division 1. Any excavation supports left in place shall be cut off at least two (2) feet below the finished ground surface or as directed by the Engineer.

3.04 PROTECTION OF SUBGRADE

- A. To minimize the disturbance of bearing materials and provide a firm foundation, the Contractor shall comply with the following requirements:
 - 1. Use of heavy rubber-tired construction equipment shall not be permitted on the final subgrade unless it can be demonstrated that drawdown of groundwater throughout the entire area of the structure is at least 3 feet below the bottom of the excavation (subgrade). Even then, the use of such equipment shall be prohibited should subgrade disturbance result from concentrated wheel loads.
 - 2. Subgrade soils disturbed through the operations of the Contractor shall be excavated and replaced with compacted select fill or crushed stone at the Contractor's expense as indicated by the Engineer.
 - 3. The Contractor shall provide positive protection against penetration of frost into materials below the bearing level during work in winter months. This protection can consist of a temporary blanket of straw or salt hay covered with a plastic membrane or other acceptable means.

3.05 PROOFROLLING

- A. The subgrade of all structures and all areas that will support pavements or select fill shall be proofrolled. After stripping of topsoil, excavation to subgrade and prior to placement of fills, the exposed subgrade shall be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft, or loose soil, and other undesirable materials shall be removed. The exposed subgrade shall be proofrolled with a heavily loaded tandem-wheeled dump truck to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed shall be removed and replaced with an approved compacted material.

3.06 DEWATERING

- A. The Contractor shall perform all dewatering as required for the completion of the work, as specified in Section 02140 - Dewatering.

3.07 EMBANKMENTS

- A. The Contractor shall perform the construction of embankments in such a manner that cut and fill slopes will be completed to final slopes and grade in a continuous operation. The operation of removing excavation material from any cut and the placement of embankment in any fill shall be a continuous operation to completion unless otherwise permitted by the Engineer.
- B. Surfaces upon which embankments are to be constructed shall be stripped of topsoil, organic material, rubbish and other extraneous materials. After stripping and prior to placing embankment material, the Contractor shall compact the top 12-inches of in place soil as specified under Paragraph 3.09, COMPACTION.
- C. Any soft or unsuitable materials revealed before or during the in place compaction shall be removed as indicated by the Engineer and/or materials testing consultant and replaced with select fill.
- D. Ground surfaces on which embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the embankment with the existing surface. The embankment soils shall be as specified under Part 2 - Products, and shall be deposited and spread in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width of the cross section, and shall be kept approximately level by the use of effective spreading equipment. Hauling shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form during the construction of the embankment. The embankment shall be properly drained at all times. Each layer of the embankment shall be thoroughly compacted to the density specified under Paragraph 3.09, COMPACTION.
- E. The embankment or fill material in the layers shall be of the proper moisture content before rolling to obtain the prescribed compaction. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken at frequent intervals. From these tests, corrections, adjustments, and modifications of methods, materials, and moisture content will be made to construct the embankment.
- F. Where embankments are to be placed and compacted on hillsides, or when new embankment is to be compacted against embankments, or when embankment is built in part widths, the slopes that are steeper than 4:1 shall be loosened or plowed to a minimum depth of 6 inches or, if in the opinion of the Engineer, the nature of the ground is such that greater precautions should be taken to bind the fill to the original ground then benches shall be cut in the existing ground as indicated by Engineer.

- G. When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portions of the embankments and the other material which meets the requirements for select fill shall be incorporated into the formation of the embankments. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the final grade. Stones, fragmentary rock, or boulders larger than 12-inches in their greatest dimension will not be allowed in any portions of embankments and shall be disposed of by the Contractor as indicated by the Engineer. When rock fragments or stone are used in embankments, the material shall be brought up in layers as specified or directed and every effort shall be exerted to fill the voids with finer material to form a dense, compact mass which meets the densities specified for embankment compaction.

3.08 BACKFILLING

- A. All structures and pipes shall be backfilled with the type of materials shown on the Drawings and specified herein. Select fill shall be deposited in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the ground nor within 6 inches of pipes. No stone or fragmentary rock larger than 12-inches in their greatest dimension will be allowed for any portion of backfill. Compaction shall be in accordance with the requirements of Paragraph 3.09, COMPACTION.
- B. Where excavation support is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when supports are removed. If significant volumes of soil cannot be prevented from clinging to the extracted supports, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that supports will be installed in similar soil conditions or employ other appropriate means to prevent loss of support.

3.09 COMPACTION

- A. The Contractor shall compact embankments, backfill, crushed stone, aggregate base, and in place subgrade in accordance with the requirements of this Section. The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

	Density % Std. Proctor (D698)	Density % Mod. Proctor (D1557)	Max. Lift Thickness as Compacted Inches
Embankments Beneath Structures*	98	95	8
Other Embankments	95	92	8
Backfill Around Structures	95	92	8
Backfill in Pipe Trenches	95	92	8
Crushed Stone Beneath Structures	**	**	12
Select Sand	--	98	8
Aggregate Base Course (ABC) Beneath Pavements and Structures	--	98	8
Crushed Stone Backfill	**	**	12
Crushed Stone Pipe Bedding	**	**	12
In place Subgrade Beneath Structures	98	95	Top 12-inches

* Embankments beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope.

** The aggregate shall be compacted to a degree acceptable to the Engineer by use of a vibratory compactor and/or crawler tractor.

- B. Field density tests will be made by the materials testing consultant to determine if the specified densities have been achieved, and these tests shall be the basis for accepting or rejecting the compaction. In-place density tests will be performed in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. The Engineer in conjunction with the materials testing consultant will be the judge as to which test method will be the most appropriate. Failure to achieve the specified densities shall require the Contractor to re-compact the material or remove it as required. The Contractor shall, if necessary, increase his compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the thickness of the layers. The Contractor shall adjust the moisture contents of the soils to bring them within the optimum range by drying them or adding water as required.
- C. Testing will be performed as frequently as deemed necessary by the Engineer and/or materials testing consultant. As a minimum, one in-place density test shall be performed for each 1000 cubic yards of embankment placed and 500 cubic yards of backfill placed or one test performed each day for either.

3.10 REMOVAL OF EXCESS AND UNSUITABLE MATERIALS

- A. The Contractor shall remove and dispose of off-site all unsuitable materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Engineer for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property, the submittal shall also include written permission from the owner of record.
- B. All unsuitable materials shall be disposed of in locations and under conditions that comply with federal, state and local laws and regulations.
- C. The Contractor shall obtain an off-site disposal area prior to beginning demolition or excavation operations.
- D. All excess and unsuitable materials shall be hauled in trucks of sufficient capacity and tight construction to prevent spillage. Trucks shall be covered to prevent the propagation of dust.
- E. When all excess and unsuitable material disposal operations are completed, the Contractor shall leave the disposal sites in a condition acceptable to the Owner and Owner(s) of the disposal site(s).

3.11 BORROW EXCAVATION

A. Description

The work covered by this section consists of the excavation of approved material from borrow sources and the hauling and utilization of such material as required on the Drawings or directed by the Engineer. It shall also include the removing, stockpiling, and replacement of topsoil on the borrow source; the satisfactory disposition of material from the borrow source which is not suitable for use; and the satisfactory restoration of the borrow source and haul roads to an acceptable condition upon completion of the work.

Borrow excavation shall not be used before all available suitable unclassified excavation has been used for backfill and incorporated into the embankments.

B. Coordination with Seeding Operations

The Contractor shall coordinate the work covered by this section with the construction of embankments so that the requirements of Section 02200 are met.

C. Materials

All material shall meet the requirements of Division 2 shown below:

Borrow Material Section 02200, Subsection 2.01 - Select Fill

D. Construction Methods

1. General

The surface of the borrow area shall be thoroughly cleared and grubbed and cleaned of all unsuitable material including all organics, topsoil, etc., before beginning the excavation. Disposal of material resulting from clearing and grubbing shall be in accordance with Section 02100.

Each borrow operation shall not be allowed to accumulate exposed, erodible slope area in excess of 1 acre at any one given time without the Contractor's beginning permanent seeding and mulching of the borrow source or other erosion control measures as may be approved by the Engineer.

The topsoil shall be removed and stockpiled at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Temporary erosion control measures shall be installed as may be necessary to prevent the erosion of the stockpile material. Once all borrow has been removed from the source or portion thereof, the stockpiled topsoil shall be spread uniformly over the source.

Where it is necessary to haul borrow material over existing roads, the Contractor shall use all necessary precautions to prevent damage to the existing roads. The Contractor shall also conduct his hauling operations in such a manner as to not interfere with the normal flow of traffic and shall keep the traffic lanes free from spillage at all times.

2. Owner Furnished Sources

Where borrow sources are furnished by the Owner the location of such sources will be as designated on the Drawings or as directed by the Engineer.

The Owner will furnish the necessary haul road right-of-way at locations designated by the Engineer. All haul roads required shall be built, maintained, and when directed by the Engineer, obliterated, at no cost to the Owner. Where the haul road is to be reclaimed for cultivation the Contractor shall plow or scarify the area to a minimum depth of 8 inches.

The borrow sources shall be left in a neat and presentable condition after use. All slopes shall be smoothed, rounded, and constructed not steeper than 3:1. Where the source is to be reclaimed for cultivation the source shall be plowed or scarified to a minimum depth of 8 inches, disc harrowed, and terraces constructed. The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided.

All sources shall be seeded and mulched in accordance with Section 02910.

3. Contractor Furnished Sources

Prior to the approval of any off-site borrow source(s) developed for use on this project, the Contractor shall obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the removal of the borrow material from the borrow source(s) will have no effect on any known district, site building, structure, or object that is included or eligible for inclusion in the National Register of Historic Places. A copy of this certification shall be furnished to the Engineer prior to performing any work on the proposed borrow source.

The approval of borrow sources furnished by the Contractor shall be subject to the following conditions:

- a. The Contractor shall be responsible for acquiring the right to take the material and any rights of access that may be necessary; for locating and developing the source; and any clearing and grubbing and drainage ditches necessary.

Such right shall be in writing and shall include an agreement with the Owner that the borrow source may be dressed, shaped, seeded, mulched, and drained as required by these Specifications after all borrow has been removed.

- b. Except where borrow is to be obtained from a commercial source, the Contractor and the property owner shall jointly submit a borrow source development, use, and reclamation plan to the Engineer for his approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary. The Contractor's plan shall address the following:

- (1) Drainage

The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided. If drainage is not practical, and the source is to serve as a pond, the minimum average depth below the water table shall be 4 feet or the source graded so as to create wetlands as appropriate.

- (2) Slopes

The source shall be dressed and shaped in a continuous manner to contours which are comparable to and blend in with the adjacent topography, but in no case will slopes steeper than 3:1 be permitted.

(3) Erosion Control

The plan shall address the temporary and permanent measures that the Contractor intends to employ during use of the source and as a part of the reclamation. The Contractor's plan shall provide for the use of staged permanent seeding and mulching on a continual basis while the source is in use and the immediate total reclamation of the source when no longer needed.

4. Maintenance

During construction and until final acceptance the Contractor shall use any methods approved by the Engineer which are necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion.

- END OF SECTION -

SECTION 02207
AGGREGATE MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment and materials required to complete all work associated with the installation of aggregate material beneath foundations, as backfill and as roadway subgrades and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01090 - Reference Standards
- B. Section 02200 - Earthwork
- C. Section 02276 - Erosion and Sedimentation Control
- D. Section 02510 - Paving and Surfacing
- E. Section 02910 - Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. South Carolina Department of Transportation (SCDOT) Standard Specifications for Highway Construction.
 - 2. ASTM C 127 Test for Specific Gravity and Absorption of Coarse Aggregate.
 - 3. ASTM C 136 Test for Sieve Analysis of Fine and Coarse Aggregates.
 - 4. ASTM C 535 Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Materials gradation and certification.
 - 2. ASTM C127, ASTM C136, and ASTM C535 test results

PART 2 -- PRODUCTS

2.01 CRUSHED STONE, SCREENED GRAVEL and AGGREGATE BASE COURSE (ABC)

- A. Crushed stone or screened gravel shall meet the requirements of as defined by SCDOT Standard Specifications, Section 302.
- B. ABC shall meet the requirements of ABC as defined by SCDOT Standard Specifications, Section 305.

2.02 SELECT SAND

- A. Select sand shall meet the requirements of Section 303 of the SCDOT Standard Specifications.

PART 3 -- EXECUTION

3.01 CRUSHED STONE, SCREENED GRAVEL AND AGGREGATE BASE COURSE (ABC)

- A. Contractor shall install crushed stone, screened gravel and ABC in accordance with the SCDOT Standard Specifications and as shown on the Drawings and indicated in the Contract Documents.
 - 1. Unless otherwise stated herein or shown on the Drawings, all mat foundations (bottom slabs) for the proposed structures shall have a blanket of crushed stone or ABC 12-inches thick minimum placed directly beneath the proposed mat. The blanket shall extend a minimum of 12 inches beyond the extremities of the mat.
 - 2. For subgrade preparation at structures and structural fill, the foundation material shall be ABC where specifically specified on Drawings, otherwise, crushed stone or screened gravel shall be used.
 - 3. For ground under drains, pipe bedding, and drainage layers beneath structures the coarse aggregate shall meet the requirements of aggregate crushed stone, as defined by SCDOT Standard Specifications.

3.02 SELECT SAND

- A. Contractor shall install select sand in accordance with the SCDOT Standard Specifications and as shown on the Drawings and indicated in the Contract Documents.

- END OF SECTION -

SECTION 02220

CASING INSTALLATION

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. The work under this section consists of providing all labor, materials, tools, equipment, and services required to perform all casing installation and related work as indicated on the Drawings and as specified within this section and related sections of the Specifications. Contractor shall furnish and install casing pipes under surface structures, where indicated, and as needed for a complete and proper installation.
- B. The use of Permalok steel casing pipe is also an approved material and can be used as an option.

1.02 GENERAL REQUIREMENTS

- A. The installation of casing pipe shall conform to these Specifications and any Federal, State or local Highway requirements or applicable Railroad requirements whichever may be more restrictive.
- B. Contractor shall perform any general excavation and boring required prior to placing casing pipe. Material resulting from boring shall be disposed of off-site by the Contractor in a suitable manner. Contractor shall provide all necessary access including access ladders, ramps, etc. to bore and receiving pits in compliance with all applicable safety requirements prior to the commencement of the boring and jacking operations.
- C. Boring/Tunneling operations will be on a continuous basis, 24 hours per day, 5 days a week (Monday thru Friday). Only pre-approved sub-contractors shall perform the jack & bore work.
- D. Conform with all SC Department of Transportation and all other roadway requirements per permit for work within restricted access highway rights-of-way and any additional requirements of the contiguous property and utility owners.
- E. The materials covered by these Specifications are intended to be standard materials of proven reliability and as manufactured by reputable manufacturers having experience in the production of such materials. The materials furnished shall be designed, constructed, and installed in accordance with the best practices and methods.
- F. The work shall also include: furnishing, installing, monitoring by survey, reducing, plotting, reporting that same survey data to the engineer and maintaining and protecting all the instrumentation on buildings, utilities, rails and in the ground adjacent to the site or on the site and as necessary to monitor construction performance and impacts on adjacent property.

- G. Boring activities shall not cause any damage to nearby structures, utilities and pavement. All existing utilities shall be potholed and field-verified prior to jack & bore at no additional cost to the Owner.
- H. The Contractor shall set the boring rig so that after the casing is complete, and the carrier pipe is installed, the invert of the pipe shall conform to grade and alignment as shown on the Contract Drawings.
- I. The Contractor shall be familiar with the conditions under which the work will be performed and with all necessary details as to the orderly execution of the work. Review and interpret available geotechnical reports and investigate work site soil conditions before bidding.
- J. For all excavations defined herein Contractor shall install casing/jacking pipe using techniques and methods selected by the Contractor that are appropriate for prevailing ground conditions. Contractor selected boring & jacking installation techniques and methods of construction shall include all equipment, all associated support systems and their operation, ground modification where needed, lubrication to reduce jacking forces as needed, cutting face tooling and sizing, face access capabilities, and the use of engineered fluids, slurries, and soil conditioners as required to maintain face stability, reduce wear, advance heading within line and grade tolerances, transport spoils, and accomplish productivity assumed in Contractor's bid proposal.
- K. If any movement or settlement occurs which causes or might cause damage to an existing structure or railroad track over, along or adjacent to the work, immediately stop any or all work except that which assists in making the work secure and in preventing further movement, settlement or damage. Resume boring only after all necessary precautions have been taken to prevent further movement, settlement or damage, and repair the damage at the Contractor's own cost and to the satisfaction of the Engineer.
- L. Follow OSHA regulations regarding confined space for casing installation.
- M. Direct jacking of carrier pipe is prohibited.

1.03 SUBMITTALS

Contractor shall submit Shop Drawings, manufacturer's literature and product data, installation instructions, certifications, and other required submittals for all products furnished under this section in accordance with Section 01300, including the following:

- A. Casing pipe Shop Drawings and material data from casing pipe manufacturer.
- B. Bore pit excavation details including footprint drawing of bore pit, design and calculations for any sheeting or shoring utilized signed and sealed by a professional engineer registered in the State of South Carolina.
- C. Construction sequence plan including drilling, casing, and grouting placement procedures.

- D. Casing spacer manufacturer's data and Shop Drawings.
- E. Casing end seal manufacturer's data and Shop Drawings.
- F. Casing field weld procedure details to be used, which shall be in accordance with AWWA C206 Sec. 4.6.
- G. Results of welder qualification testing conducted by an independent testing agency in accordance with American Welding Society D1.1 requirements. Results of previous qualification tests performed within six months from the date of pipe installation will be acceptable. Results from qualification tests performed prior to six months from the date of pipe installation will not be acceptable.

1.04 RELATED WORK

- A. Section 02140 Dewatering
- B. Section 02200 Earthwork
- C. Section 15008 PVC Pipe

1.05 REFERENCE

Unless otherwise indicated, all references herein to other standards (e.g. AWWA, ASTM, ASME, ANSI etc.) shall mean the most current available revision. The following referenced documents are a part of this section. Comply with all applicable provisions and recommendations of the following documents, except as otherwise specified herein. Where a referenced document contains references to other standards, those other standards are included as references under this section as if referenced directly. In the event of a conflict between the requirements of this section and those of the referenced documents, the requirements of this section shall prevail.

- A. ASTM A53 – Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- B. ASTM A139 – Electro-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
- C. AWWA C200 – Steel Water Pipe, 6 In. and Larger
- D. AWWA C206 – Field Welding of Steel Water Pipe
- E. AWWA C600 – AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances
- F. "Standard Specifications for Pipelines Conveying Flammable and Non-Flammable Substances" from the American Railway Engineering Association, and the "Standard Specifications for Highway Bridges" from AASHTO (Latest Revision).

- G. "Standard Specifications for Highway Construction" from the S.C. Department of Transportation (Latest Revision).
- H. "Utility Accommodations Policy" from the S.C. Department of Transportation (Latest Revision).

1.06 QUALITY ASSURANCE

- A. Use adequate members of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.

PART 2: PRODUCTS

2.01 CASING PIPE

- A. The casing pipe shall be smooth wall, longitudinally-rolled or spiral welded steel pipe. Casing pipe shall be leak-proof construction and be capable of withstanding highway loadings. Casing pipe shall be steel pipe in sizes 24-inches diameter nominal and larger manufactured from steel having a minimum yield stress strength of 35,000 psi and shall have a minimum thickness as indicated on the Contract Drawings.
- B. Steel casing sections may be installed utilizing the following methods:
 - 1. Option 1: Welding in accordance with the requirements listed in Section 3.03 of this specification.
 - 2. Option 2: Permalok Steel Casing Pipe: The Permalok Steel Casing Pipe shall be manufactured from steel conforming to ASTM A 139 for Grade B, with minimum yield strength of 35,000 psi before cold forming. Permalok Steel Casing Pipe with T-5 joint profile shall be provided.
- C. The steel casing pipe diameter and wall thickness shall be as indicated in the table below or as indicated on the Drawings. All casing thicknesses are for uncoated casings. The inside diameter of the casing pipe shall be at least four (4) inches greater than the outside diameter of the carrier pipe joints or couplings for carrier pipe less than six (6) inches in diameter and at least six (6) inches greater than the outside diameter of the carrier pipe joints or couplings for carrier pipe six (6) inches and greater in diameter. Contractor shall ensure that casing pipe size is large enough to comply with these requirements and to afford easy removal of the carrier pipe without disturbing the casing pipe or roadbed. Consideration shall be given to the specific pipe product, joint types, joint restraints, and casing spacers to be used. If larger casing pipe size than indicated in the following table is necessary, Contractor shall provide the larger casing pipe at no additional cost to the Owner.

Casing Outside Diameter (inches)	Carrier Pipe Nominal Sizes Allowed (inches)	Casing Wall Thickness (inches)
		Highway Crossings
24	<=12	0.375
30	<=16	0.500

Any buckling of the casing due to jacking forces shall be repaired at no additional cost to the Owner.

- D. The casing pipe shall conform to AWWA C200 and ASTM A139, Grade B (without hydro-test) or ASTM A53, Grade B (without hydro-test).

2.02 GROUT

- A. Grout shall be composed of Portland Cement and sand, consisting of one part Portland Cement to three parts sand. Sand shall conform to the requirements of ASTM C144. Water amount shall be the minimum amount necessary to achieve desired consistency without compromising strength requirements. The minimum compressive strength at 28 days shall be 4000 psi.
- B. For annular spaces wider than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added.
- C. Contractor or boring Subcontractor may use admixture approved by the Engineer to allow workability of grout at his option and at no additional cost to the Owner.

2.03 CASING SPACERS

- A. Casing spacers shall be flanged, bolt-on style with a two-section stainless steel shell lined with a PVC liner, minimum 0.09" thick, also having a hardness of 85-90 durometer. Runners shall be attached to stainless steel risers which shall be properly welded to the shell. The height of the runners and risers shall be manufactured such that the pipe does not float in the casing. Casing spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, PowerSeal Pipeline Products Corporation Model 4810, or approved equal.

2.04 CASING END SEALS

- A. Grout each end of the casing with concrete brick and Type II concrete in such a manner to prevent the infiltration of foreign materials into the casing pipe, but allowing leakage to pass in the event of a carrier pipe break.

PART 3: EXECUTION

3.01 EXCAVATION

- A. Excavation, backfilling and compaction for jacking and receiving pits and for open cut installation shall conform to the requirements set forth in Section 02200.

3.02 ALIGNMENT AND GRADE

- A. Locate pipelines to cross roadways at approximately right angles where practicable or as specified in the Contract Drawings. Do not place pipelines in culverts or under bridges where there is a likelihood of their restricting the area required for the purposes for which the bridges or culverts were built, or of endangering the foundations. Install the casing pipe on an even grade for its entire length and sloped to one end or as noted in a profile plan if provided. Satisfy a maximum tolerance of 1.5% (18" in one hundred feet) with the desired location of the casing or as otherwise required by regulation or specified on the Drawings, whichever is more restrictive. As the casing is installed, Contractor shall check the horizontal and vertical alignment frequently.

3.03 WELDING

- A. Connect steel casing sections by full-circumference metal arc-welding. All joints shall be butt welded with a full depth, single "V" groove weld. Welding shall conform to AWWA Standard C206.
- B. Welding shall be performed by certified welders. The Contractor shall be responsible for the qualification of welders with qualification testing conducted by an independent testing agency in accordance with American Welding Society D1.1 requirements. All costs associated with qualification testing shall be included in the unit prices bid.

3.04 DEPTH OF INSTALLATION

- A. Unless the depth of casing pipe is specifically specified on the Drawings, the casing pipe depth shall be in accordance with highway requirements.

3.05 INSTALLATION OF STEEL PIPE CASING

A. General:

- 3. Installation of steel pipe casing shall be by the dry bore method at locations as shown on the Contract Drawings and approved by the applicable permits.
- 4. Installation of steel pipe casing shall be in accordance with applicable regulations, the Contract Drawings, these specifications, and any permits required with respect to the particular boring.

B. Bore Pit and Receiving Pit

1. The boring pit shall be solid sheeted, braced, and shored as necessary to provide a safe operation.
2. The Contractor shall take all precautions, and comply with all local, state and federal requirements as may be necessary to protect private property, public property and/or existing utilities.
3. Maintain in dry condition by use of pumps, drains or other approved method.
4. The receiving pit shall be constructed in accordance with the Contract Drawings and applicable permit.

C. Boring:

This method consists of pushing the pipe into the fill with a boring auger rotating within the pipe to remove the soil. When augers or similar devices are used for pipe placement, the front of the pipe shall be provided with mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe. The auger and cutting head arrangement shall be removable from within the pipe in the event an obstruction is encountered. The over-cut by the cutting head shall not exceed the outside diameter of the pipe by more than one-half inch. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow of soft or poor material.

If an obstruction is encountered during installation that stops the forward action of the pipe, and if it becomes evident that it is impossible to advance the pipe, operations will cease and the pipe shall be abandoned in place and filled completely with grout.

If voids are encountered or occur outside the casing pipe, grout holes shall be installed in the top section of the casing pipe at 4 foot (maximum) centers and the voids filled with grout with sufficient water added to produce a flowable mixture and at sufficient pressure to prevent settlement. The Contractor shall be prepared to bore through weathered or partially weathered rock, if encountered, with a specialized bit or hand-mine. Costs associated with this provision shall be deemed as included in the Unit Price Bid for each location and no additional payment will be made. Grout holes shall only be used in casings where it is feasible. Grout around outside of casing pipe when bore hole diameter is great than outside diameter of casing pipe by more than 1 inch.

In the event an obstruction is encountered during the boring and jacking operation, and the casing pipe is at least 30-inches in diameter, the auger shall be withdrawn and the obstruction removed. If a boulder is encountered and is removed, the void shall be filled with grout, as previously specified. No blasting shall be permitted.

The recommended methods and details shown on the Drawings and specified herein, are intended to indicate the minimum acceptable standard of quality required for the casing installation. Other methods of installation, based on acceptable industry standards and techniques, may be acceptable for the

installation. Under no conditions shall jetting or wet boring of the casing be allowed.

Prior to the beginning of any casing excavation, a surface settlement monitoring grid system shall be installed on the highway/roadway. This grid shall consist of PK nails installed along the tunnel centerline at ten-foot intervals. Additional lines of PK nails shall be installed ten feet each side of the centerline. These points shall be initially read and the elevations recorded prior to the start of the casing construction. If no visible settlement is occurring during casing excavations, these points shall be read only at such times as the Contractor's surveyor is present to transfer the line and grade into the casing. These points shall be checked and elevations recorded on a daily basis, until the casing installation is completed. Elevations of casing and pavement shall be referenced to the nearest benchmark elevation and recorded on the record drawings.

3.06 CARRIER PIPE INSTALLATION

The carrier pipe and casing shall be separated by casing spacers. The spacing of casing spacers shall be in accordance with the manufacturer's recommendation to support the weight of the pipe and contents. As a minimum, a casing spacer shall be placed within a maximum of 3 feet on each side of a joint and evenly spaced along the carrier pipe with 3 casing spacers per each length of carrier pipe—or more frequently if recommended by the casing spacer manufacturer. Maximum distance between casing spacer and internal wall of casing pipe shall be 2-inches. The required procedure to install the carrier pipe is to attach the casing spacers and assemble the pipe joints outside the casing and push the assembled carrier pipe through the casing on the casing spacers. Timber skids are not allowed.

- a. Inspect carefully, ensuring that all foreign material is removed from the casing and the casing meeting alignment criteria for the type of carrier pipe being used.
- b. The casing shall be installed as closely to grade as possible with no more deviation than can be adjusted with spacers to achieve the carrier pipe design grade.
- c. Install casing spacers on the carrier pipe per manufacturer's instructions.
- d. Provide a minimum on one spacer per ten linear feet of pipe.
- e. Install the carrier pipe in the casing ensuring each joint is pushed "home" before the joint is installed into the casing.
- f. Provide centered and restrained configuration.

3.07 PROTECTION AT ENDS OF CASING

- A. After installation of the carrier pipe within the casing and successful pressure testing of the carrier pipe, provide casing end seals in accordance with the Owner's standard details at each end of casing pipe as a barrier against backfill debris and seepage. End seals shall be as specified above and shall be installed in accordance with manufacturer's recommendations.
- B. Prior to installation of end seals, the carrier pipe shall be properly and sufficiently secured to prevent movement.
- C. Grout shall not be used to fill the annular space within the casing.

- END OF SECTION -

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SECTION 02221

TRENCH EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section covers the work necessary for the trench excavation and backfill, complete, except for pipe base and pipe zone backfill, which are included under the specification for the pipe.

1.2 TYPE OF BACKFILL

- A. Trench backfill above the pipe zone is classified as follows:
 - 1. Class I (Concrete) Backfill:
 - a. Use Class I (concrete) backfill where, in the opinion of the Engineer, there is insufficient cover over the pipe for proper cover and protection.
 - b. It is also required when a water main and sewer cross with less than 18 inches clearance. In this case, encase the sewer line according to the instructions of the Engineer.
 - 2. Class II Backfill:
 - a. Class II backfill will, generally, be limited to paved streets, driveways and parking lots where final surface replacement will be made shortly after backfilling and subsequent settlement must be held to a minimum.
 - b. Class II backfill shall also be used under all culverts, water, gas, irrigation, and sewer lines, buried telephone, power and television cable, and any other miscellaneous buried pipelines or cables that cross the excavated trench. This work shall be done at no cost to the Owner.
 - 3. Class III Backfill:
 - a. In general, Class III backfill will be used throughout the project except where other backfill is specified.

- b. It is intended that all surfaces for which Class III backfill is specified shall be returned to equal or better condition than that existing prior to construction.
- c. Surfaces shall not settle or rut due to normal weathering or vehicular traffic that can be expected for each area.

1.3 ENGINEER'S DISCRETION

- A. For bidding purposes, the class of backfill to be used above the pipe zone is as shown on the plans.
- B. The Engineer reserves the right to modify the use, location, and quantities of the various types of backfill bid items during construction.

1.4 TRENCH EXCAVATION

- A. Excavation is unclassified.
- B. Complete all excavation regardless of the type of materials encountered.
- C. The Contractor shall make his own estimate of the kind and extent of the various materials, which will be encountered in the excavation.

1.5 JOB CONDITIONS

- A. Existing utilities:
 - 1. Approximate location of certain underground lines and structures are shown on the plans for information only.
 - 2. Locate, excavate, and expose all existing underground lines in advance of trenching operations.
 - 3. The Contractor will be held responsible for the workmanlike repair of any damage done to any of the existing utilities in the execution of his work at no additional cost to the Owner.
 - 4. The Contractor shall familiar himself with the existing conditions and be prepared to adequately care for and safeguard himself and the Owner from damage.
- B. Notification of intent to excavate:

1. South Carolina Underground Facility Damage Prevention Act requires persons to ascertain the location of underground public utility property prior to excavation or demolition in certain situations. The Act also requires such persons to give timely notice of intent to excavate or demolish prior to commencing such operations. Failure to comply could subject the violator to a civil penalty of up to one thousand dollars (\$1,000) for each violation of the Act.
 2. Notification of intent to excavate may be given by calling "811".
- C. Protection of trees, shrubbery, and lawns:
1. Protect all trees and shrubbery in developed areas and along the trench line from disturbance unless absolutely necessary subject to the approval for the Engineer.
 - a. Any such trees and/or shrubbery necessary to be removed shall be heeled in and replanted.
 2. Where trenches cross private property through established lawns, sod shall be cut, removed, stacked and maintained in suitable condition until replacement is approved by the Engineer.
 - a. Topsoil underlying lawn areas shall be removed and kept separate from general excavated materials.
- D. Removing and resetting fences:
1. Where existing fences must be removed to permit construction of utilities, remove fences and reset in their original location and condition as the Work progresses.
- E. Restoration of disturbed areas:
1. Restore all areas disturbed by, during, or as a result of construction activities to their existing or better condition.
 - a. For existing areas with sod type grasses, replace with new sod. Existing sod may be reused where properly removed and stored.
 - b. Do not interpret this as requiring replacement of trees and undergrowth in undeveloped sections of rights-of-way.

PART 2 - PRODUCTS

2.1 SUITABLE BACKFILL MATERIALS

- A. Material suitable for backfill in a properly dewatered trench shall consist of any of the following:
 - 1. Well graded coarse granular materials with maximum particle size not exceeding 2 inches; sands; silty-sands or clayey sands.
 - 2. Soils having more than 35 percent of its weight passing a No. 200 sieve shall not be used for backfill.

2.2 IMPORTED BACKFILL

- A. If in the opinion of the Engineer, the soils encountered in the trench are not suitable for backfill, the Contractor shall import suitable backfill material for use in the trench.
- B. Unsuitable material shall be disposed of in accordance with the specifications.

2.3 CONCRETE FOR TRENCH BACKFILL

- A. Conform to ASTM C 94, Alternate 3. Proportion to obtain a 28-day compressive strength of 2,500 pounds per square inch.
- B. Use a minimum of five sacks of cement per cubic yard of concrete.

2.4 FLOWABLE FILL FOR TRENCH BACKFILL

- A. Conform to South Carolina Department of Transportation (SCDOT) permits or other agency permits.
- B. Material shall reach a 28-day strength of 100 psi if pipe parallels roadway and 200 psi if pipe crosses roadway.

2.5 COMPACTION EQUIPMENT

- A. Utilize compaction equipment of suitable type and adequate to obtain the amount of compaction specified.
 - 1. Operate in strict accordance with the manufacturer's instructions and recommendations and maintain in such condition that it will deliver the manufacturer's rated compactive effort.

- B. Impact type compactors are suitable.
- C. Rubber tired rollers and tract type equipment is not suitable and is not allowed for Class II backfill.
- D. No mechanical equipment is allowed in pipe zone.

PART 3 - EXECUTION

3.1 PREPARATION OF RIGHT-OF-WAY

A. Clearing

1. Where clearing or partial clearing of the right-of-way is necessary, complete prior to the start of trenching.
2. Cut trees and brush as near to the surface of the ground as practicable, remove all stumps, and pile for disposal.
3. Do not permit excavated materials to cover brush or trees prior to disposal or burning.
4. Perform no clearing outside right-of-way or on private property without the written permission of the Engineer.

B. Disposal of Cleared Material

1. Dispose of trees, stumps, brush, roots, limbs and other waste material from the clearing operation in such a manner as to meet all City, County and State regulations regarding health, safety, and public welfare.
2. Make arrangements for the disposal and bear all costs or retain any profit incidental to such disposal.
3. If any material is to be burned, obtain fire permits before burning and burn waste material at a location suitable to the permitting agency and the Engineer.
4. In no case shall any material be left on the project, shoved onto abutting private properties, or be buried in embankments or trenches on the project.

C. Obstructions

1. This item refers to obstructions which may be removed and do not require replacement.

2. Remove obstructions within the trench area or adjacent thereto such as tree roots, stumps, abandoned piling, buildings, and concrete structures, logs, and debris of all types without additional compensation.
3. The Engineer may choose, if requested, to make changes in the trench alignment to avoid major obstructions, if such alignment changes can be made within the easement or right-of-way without adversely affecting the intended function of the facility.
 - a. If the change in alignment involves a change in the quantity of work, the provisions of Article 8 of the General Conditions shall apply.
4. Dispose of obstructions removed from the excavation in accordance with paragraph B, Disposal of Cleared Material.

D. Pavement, Curb, and Sidewalk Removal

1. Cut all bituminous and concrete pavements, regardless of thickness, and all curbs and sidewalks, prior to excavation of the trenches as specified in Section 02616, Repair and Resurfacing, Paragraph 3.3.
2. Width of the pavement cut shall be at least equal to the required width of the trench at ground surface.
3. Pavement cut lines shall be even and parallel.
4. Pavement and concrete materials removed shall be hauled from the site and not used for trench backfill without additional compensation.

3.2 EXCAVATION

A. General

1. Trench excavation shall be made in open cut and true to the lines and grades shown on the plans, unless boring is necessary or required.
2. Banks of the trenches shall be cut in vertical, parallel planes equidistant from the pipe centerline.
3. The horizontal distance between such planes, or the overall width of trench, shall vary with the size of the pipe to be installed.
4. Bell holes for bell-and-spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of joints in the pipe.

5. When muck, quicksand, soft clay, swampy or other material unsuitable for foundations or sub-grade is encountered such material shall be removed and replaced with No. 57 stone.
6. After excavation, the area between the final pipe grade and the trench soil bottom shall be filled with crushed stone materials as required, compacted to proper grade, and made ready for pipe laying.
7. Debris encountered in trench excavation for water mains and other pipelines shall be removed for the overall width of trench which shall be as shown on the plans.
 - a. It shall be removed to a depth of 6" below the bottom of the pipe for pipes smaller than 24" in size.
 - b. It shall be removed to a depth of 8" below the bottom of the pipe for pipes 24" to 36" in size.
 - c. It shall be removed to a depth of 12" below the bottom of the pipe for pipes larger than 36" in size, if debris extends to such depth.
8. In all cases, materials deposited shall be placed so that in the event of rain, no damage will result to the work.

B. Trench Width

1. Minimum width of un-sheeted trenches in which pipe is to be laid shall be 18 inches greater than the inside diameter of the pipe, but not less than that required for proper compaction around the pipe. Sheet piling requirements shall be independent of trench widths.
2. The minimum trench width at the top of the pipe zone is limited to 1.33 times the pipe outside diameter plus 18 inches.
3. In general, the maximum width at the top of the trench will not be limited, except where excess width of excavation would cause damage to adjacent structures or property. However, confine trench widths to dedicated rights-of-way or construction easements, unless special written agreements have been made with the affected property owner.

C. Grade

1. Excavate the trench to the lines and grades shown on the plans with proper allowance for pipe thickness and for pipe base or special bedding when required.

- a. If the trench is over excavated below the required grade, correct any part of the trench excavated below the grade at no additional cost to the Owner, with crushed stone material of the type specified for pipe base.
2. Place the base material over the full width of trench in compacted layers not exceeding 6 inches deep to the established grade.

D. Shoring, Sheet piling, and Bracing of Trenches

1. Sheet and brace the trench when necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workmen, and the public.
2. Maintain the walls of the excavation properly in place and protect all persons and property from injury or damage.
3. Increase trench widths accordingly by the thickness of the sheet piling. Maintain sheet piling in place until the pipe has been placed and backfilled at the pipe zone.
4. Shoring and sheet piling shall be removed, as the backfilling is done, in a manner that will not damage the pipe, permit voids in the backfill, or damage adjacent property.
5. When, in the opinion of the Engineer, sheet piling cannot be safely removed, it shall be left in place and cut off at least two feet below the finished surface at no additional cost to the Owner.
 - a. Written approval from the Owner is required.
6. All sheet piling and bracing shall be left in place until the trench has been backfilled one (1) foot above the top of the pipe.
7. All sheet piling, shoring, and bracing of trenches shall conform to the safety requirements of the Federal, State, or local public agency having jurisdiction. The most stringent of these requirements shall apply.

E. Location of Excavated Materials

1. During trench excavation, place the excavated material only within the construction easement, right-of-way, or approved working area. Do not obstruct any private or public traveled roadways or streets. Locate and retain soil materials away from edge of excavation.

F. Dewatering

1. Dewatering shall conform to Section 02140.

G. Foundation Stabilization

1. When the existing material in the bottom of the trench is unsuitable for supporting the pipe, provide foundation stabilization as described here.
2. Excavate below the pipe zone as directed by the Engineer.
3. Backfill to specified grade with foundation stabilization material.
4. Use suitable backfill material for foundation stabilization only if the trench is properly dewatered.
5. Use a suitable coarse, granular material when a dry trench cannot be obtained.
6. Place the foundation stabilization material over the full width of the trench and compact in layers, not exceeding 6 inches deep, to the required grade.

3.3 BACKFILL

A. General

1. The backfilling of pipeline trenches shall be started immediately after the pipe work has been inspected.
2. Where pipe trenches are cut across or along pavement, the trenches shall be backfilled in accordance with applicable permits.
3. Backfilling around structures shall be done in the manner specified above for pipe trenches by power tamping for the full depth of cut from the bottom of the finished grade.
4. All backfilling shall be done in such a manner as will not disturb or injure the pipe or structure over or against which it is being placed. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be uncovered, repaired, and then re-backfilled as herein specified.

B. Pipe Base and Pipe Zone Backfill

1. Pipe base and pipe zone backfill are included in specification for pipe.

C. Trench Backfill Above Pipe Zone - General

1. When backfill is placed mechanically, push the backfill material onto the slope of the backfill previously placed and allow to slide down into the trench.
2. Do not push backfill into the trench in such a way as to permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe.
3. Under no circumstances allow sharp, heavy pieces of material to drop directly onto the pipe or the tamped material around the pipe.
4. Do not use backfill material of consolidated masses larger than 1/2 cubic feet.

D. Class I (Concrete) Backfill

1. Place concrete backfill in such a manner that no dirt or foreign material becomes mixed with the concrete.
2. Minimum thickness of concrete protection shall be 6 inches on the top and sides of the pipe.
3. Concrete shall have sufficient time to reach initial set before any additional backfill material is placed in the trench.

E. Place pipe base in all trenches requiring concrete backfill Class II Backfill

1. Backfill the trench above the pipe zone with approved backfill material in lifts not exceeding 6-inch loose depth and compact each lift to a minimum of 95 percent of maximum density as determined by ASTM D 1557, with mechanical vibrating or impact tampers.
2. Provide stabilized subgrade, granular base and asphaltic concrete surface.
3. Maintain the surface of the backfilled trench level with the existing grade with 1-1/2 inch minus crushed rock backfill material until pavement replacement is completed or the Engineer accepts the entire project.
4. Any subsequent settlement of the finished surfacing during the warranty period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired by the Contractor at no cost to the Owner.

F. Class III Backfill

1. Backfill the trench above the pipe zone with excavated trench materials.
2. Place the backfill in suitable lifts.
3. Determine the type of compaction equipment, and method to use to provide all of the following:
 - a. Compaction to a density equal to existing trench side materials but not less than 90 percent of maximum density as determined by ASTM D 1557.
 - b. Compaction so that subsequent settlement shall be prevented.
 - c. Compaction of graded surface along roads, road shoulders and other areas subject to vehicular traffic so that the upper 6 inches of backfill reaches a minimum of 95 percent of maximum density as determined by ASTM D 1557.
4. Remove all boulders and stones 2 inches in diameter and larger from material used for backfill in the upper 12 inches of Class A backfilled trenches.
5. Maintain the surface of the backfilled trench level with the existing grade until the Engineer accepts the entire project.
6. Any subsequent settlement of the finished surface during the warranty period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired by the Contractor at no cost to the Owner.

G. Moisture Control - Class II Backfill

1. During all compacting operations, maintain optimum practicable moisture content required for compaction in each lift of the earth fill.
 - a. Maintain moisture content uniform throughout the lift.
 - b. Insofar as practicable, add water to the material at the site of excavation.
 - c. Supplement, if required, by sprinkling the earth fill.
2. At the time of compaction, the water content of the material shall be at optimum moisture content, plus or minus 2 percentage points.

3. Do not attempt to compact fill material that contains excessive moisture. Aerate material by blading, disking, harrowing, or other methods, to hasten the drying process.

H. Disposal of Excess Excavated Material

1. Properly dispose of all excess excavated materials outside the area of work.
2. Make arrangements for the disposal and bear all costs or retain any profit incidental to such disposal.

I. Maintenance of Trench Backfill

1. Maintain the backfilled trench surface until the following operations have been completed and approved by the Engineer:
 - a. Valves and valve boxes installed.
 - b. Hydrostatic testing.
 - c. Cleanup and restoration of all physical features.
 - d. Utilities restored to their original condition or better.
 - e. And, in general, all work required with the exception of repaving.
2. This maintenance shall include, but not be limited to, the addition of crushed rock backfill material to keep the surface of backfilled trenches reasonably smooth, free from potholes, and suitable for normal traffic flow.
3. No additional payment will be made for the maintenance of the trench backfill prior to completion of the work outlined above.
4. No pavement replacement shall be undertaken until all items outlined above have been completed and approved by the Engineer.
5. Maintenance of backfilled trenches is considered as incidental to this item of work and payment for such maintenance will be considered as included in payment for backfill.

J. Compaction Tests

1. The Engineer reserves the right to perform testing to determine the in-place density and moisture content of the subgrade and compacted fill according to: ASTM D 1556.

2. The Contractor will cooperate with this testing work by leveling small test areas as designated by the soil testing company.
3. These test results, and a certified statement by the soil testing company that the actual soil compaction found meets these specifications, shall be submitted to the Engineer as soon as available and are made available to the Contractor.

3.4 PROTECTION OF UTILITIES

A. Culverts and Ditches

1. Protect drainage culverts from damage. If damaged, restore to satisfactory condition at no cost to the Owner.
2. If it is necessary to remove a culvert, do not replace until the proposed pipeline is installed and trench backfilled and compacted to the subgrade of the culvert.
 - a. Replace culverts to previous line and grade.
3. Backfill minor drainage ditches so that the upper one foot of material between ditch banks is topsoil, loam, or clay.
4. Compact this material for the full ditch width to a minimum of 95% of maximum density as determined by ASTM D 1557.
5. Ditches steeper than 2:1 slope shall be protected and reinforced with a synthetic fiber or grid material.
 - a. Contractor has the option not to use reinforcement for slopes 2:1 or flatter.
6. Correct any ditch erosion occurring as a result of pipeline construction at no cost to the Owner.

B. Gas, Telephone, Power, Cable

1. Protect all other utilities from damage.
2. Notify utility owner prior to start of excavation as directed in sub- paragraph 6.20.C of the General Conditions.
3. If, during the work the utility is damaged, notify the utility company and the Engineer immediately.
 - a. Do not attempt to repair or replace damaged utilities unless so directed by the utility company and approved by the Engineer.

- b. Payment for restoration of damaged utilities shall be the Contractor's responsibility.

3.5 SETTLEMENT

- A. Any settlement noted in backfill, or in structures built over the backfill or fill within the warranty period in accordance with the GENERAL CONDITIONS will be considered to be caused by improper construction methods and shall be corrected at no cost to the Owner.
- B. Structures or paved surfaces damaged by settlement shall be restored to their original condition by the Contractor at no cost to the Owner.

PART 4 – PAYMENT (NOT USED)

- END OF SECTION -

SECTION 02276

EROSION AND SEDIMENTATION CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

- A. The Contractor is responsible for implementing Best Management Practices (BMP's) to prevent and minimize erosion and resultant sedimentation in all cleared and grubbed areas during and after construction in accordance with South Carolina Department of Health and Environmental Control (SCDHEC) Stormwater Management requirements. This item covers the work necessary for the installation of structure and measures for the prevention and control of soil erosion. The Contractor shall furnish all material, labor and equipment necessary for the proper installation, maintenance, inspection, monitoring, reporting, and removal (where applicable) of erosion prevention and control measures as required to complete the work on the Drawings and specified herein.
- B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.
- C. It is the intent of this Specification that the Contractor conducts the construction activities in such a manner that erosion of disturbed areas and off site sedimentation be absolutely minimized.
- D. All work under this Contract shall be done in conformance with and subject to the limitations of the SCDHEC Standards for Stormwater Management and Sediment Reduction (Regulation 72-300 thru 72-316) and local erosion control and stormwater management ordinances.
- E. The following excerpts from the regulations are particularly important:
 - 1. Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than fourteen (14) days after work has ceased, except as stated below.
 - a. Where stabilization by the 14th day is precluded by snow cover or frozen ground conditions stabilization measures must be initiated as soon as practicable.
 - b. Where construction activity on a portion of the site is temporarily ceased, and earth-disturbing activities will be resumed within 14 days, temporary stabilization measures do not have to be initiated on that portion of the site.
 - 2. All sediment and erosion control devices shall be inspected once every calendar week. If periodic inspection or other information indicates that a bmp has been inappropriately or incorrectly installed, the permittee must address the necessary replacement or modification required to correct the BMPs within 48 hours of identification.

3. Minimize the discharge of pollutants from dewatering of trenches and excavated areas. These discharges are to be routed through appropriate BMPs (sediment basin, filter bag, etc.).

- F. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion and sedimentation control devices will be adjusted on several occasions to reflect the current phase of construction. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation. The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from constructed areas. All deviations from the erosion and sedimentation control provisions shown on the Drawings shall have the prior acceptance of the Engineer.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02100 - Clearing, Grubbing, and Site Preparation
- B. Section 02200 – Earthwork
- C. Section 02910 - Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.
 1. SCDHEC Regulation 72-300 thru 72-316, Standards for Stormwater Management and Sediment Reduction.
 2. SCDHEC Stormwater Management BMP Field Manual, latest edition.
- B. See Specification Section 01090 - Reference Standards.

1.04 REGULATORY COMPLIANCE

- A. Contractor shall comply with requirements specified in the Contract Documents or by the Engineer. Contractor shall also comply with all other laws, rules, regulations, ordinances and requirements concerning soil erosion and sediment control established in the United States and the State of South Carolina.

1.05 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions Division 1 and Section 01300 - Submittals, the Contractor shall submit the following:
 1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.
3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

1.06 GUARANTEE

- A. All restoration and revegetation work shall be subject to the one-year guarantee period of the Contract as specified in the General Conditions.

PART 2 -- MATERIALS

2.01 MATERIALS

- A. Materials for use in erosion and sedimentation control devices shall be in accordance with these specifications and the SCDHEC Stormwater Management BMP Field Manual, latest edition.

2.02 SILT FENCE

- A. Silt Fence shall be a woven geotextile filter fabric made specifically for sediment control. Filter fabric shall not rot when buried and shall resist attack from soil chemicals, alkalies and acids in the pH range from 2 to 13, and shall resist damage due to prolonged ultraviolet exposure. Filter fabric shall be supplied from manufacturer listed on SCDOT Qualified Product List No. 34.
- B. Posts for silt fence shall be steel and shall have the following properties:

ASTM Designation:	ASTM A702
Length:	48-inch (T-Type)
Weight:	1.25 lb/foot (+/- 8%)
Minimum Yield Strength:	50,000 psi
Area of Soil Stabilization Plate:	17 in ² (15 gauge steel, min)

Note: Five (T) Fasteners shall be furnished with each post.

Silt Fence shall be installed and maintained in accordance with Part 3 of this Section and the notes on the Drawings and to the satisfaction of the Engineer until the site has been stabilized. The cost of Silt Fence shall include the fabric, posts, wire fabric, excavation and all maintenance and restoration activities required.

2.03 STONE FOR EROSION CONTROL

- A. The Contractor shall place Stone for Erosion Control as shown on the Drawings, as specified herein. The Stone for Erosion Control shall be as indicated on the Drawings.

2.04 RIP RAP

- A. The Contractor shall place rip rap as shown on the Drawings and as specified in Section 804, Rip Rap and Slope Protection, of the SCDOT Standard Specifications for Highway Design.

2.05 TEMPORARY EROSION CONTROL LINING (RECM)

- A. The Contractor shall place straw with net, curled wood, coconut fiber rolled erosion control matting (RECM) in areas indicated on the Drawings. Straw with net matting shall consist of clean wheat straw from agricultural crops made into a knitted straw mat that is machine assembled. The straw shall be evenly distributed throughout the mat. The straw with net mat shall be covered with a photodegradable synthetic mesh attached to the straw with degradable thread. The curled wood or coconut fiber mat shall consist of machine-produced mat of curled wood excelsior or coconut fiber with a majority of the fibers 6 inches or longer with consistent thickness and the fibers evenly distributed over the entire area of the mat. The top of the mat shall be covered with a biodegradable synthetic mesh. The mesh shall be attached to the curled wood excelsior or coconut fiber with photodegradable synthetic yarn.
- B. The Contractor shall place the straw with net temporary channel and slope RECM where directed immediately after the channel or slope has been properly graded and prepared, fertilized, and seeded. If the mat is of single net construction, the netting shall be on top with the straw in contact with the soil.
- C. The Contractor will immediately repair or replaced any section of temporary channel and slope RECM which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.
- D. Straw with net RECM shall be as manufactured by North American Green, American Excelsior, Contech, or equal with a minimum bare soil shear stress value as indicated on drawings.

2.06 PERMANENT EROSION CONTROL TURF REINFORCEMENT MAT (TRM)

- A. The Contractor shall place synthetic channel and slope TRM in channel or on slopes as shown on the Drawings. The mat shall consist of entangled nylon, polypropylene or polyester monofilaments mechanically joined at their intersections forming a three dimensional structure. The mat shall be crush-resistant, pliable, water-permeable, and highly resistant to chemical and environmental degradation.
- B. The Contractor shall place the synthetic TRM where directed immediately after the channel or slope has been properly graded and prepared.
- C. After the TRM has been placed, the area shall be properly fertilized and seeded as specified allowing the fertilizer and seeds to drop through the net.
- D. The Contractor will immediately repair or replace any section of TRM which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.

- E. Synthetic TRM shall be as manufactured by Colbond Geosynthetics, Synthetic Industries, TC Mirafi, or equal matting with a minimum long-term unvegetated shear stress value as indicated on drawings.

2.07 TEMPORARY SLOPE DRAINS

- A. Temporary slope drains shall be constructed as shown on the Drawings and as specified herein. The temporary slope drains shall be constructed and maintained in accordance with Part 3 of this Section and the notes on the Drawings to the satisfaction of the Engineer until the site has been stabilized. The cost of the temporary slope drains shall include the piping, earthwork, stone for erosion control, and all maintenance activities required.

2.08 GRAVEL CONSTRUCTION ENTRANCES

- A. Gravel Construction Entrances shall be constructed as shown on the Drawings and as specified herein. Temporary gravel construction entrances shall be maintained in accordance with Part 3 of this Section and the notes on the Drawings to the satisfaction of the Engineer until the site has been stabilized. The cost of temporary gravel construction entrances shall include the gravel and all maintenance activities required.

2.09 TEMPORARY SOIL STABILIZER

- A. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as "Enviroseal 2001" by Enviroseal Corporation, "Terra Control" by Quattro Environmental, Inc., or "CHEM-CRETE ECO-110" by International CHEM-CRETE Corporation, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.

PART 3 -- EXECUTION

3.01 INSTALLATION AND MAINTENANCE

- A. Erosion and sedimentation control devices shall be established prior to or concurrent with the clearing operations in a given area. Where such practice is not feasible, the erosion and sedimentation control device(s) shall be established immediately following completion of the clearing operation.
- B. The Contractor shall furnish the labor, materials and equipment required for routine maintenance of all erosion and sedimentation control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device. Maintenance shall include but not be limited to 1) the removal and satisfactory disposal of accumulated sediment from traps or silt barriers and 2) replacement of filter fabrics used for silt fences and stone used in temporary sediment traps, stone filters, gravel construction entrances, etc.. Sediment removed from erosion and sedimentation control devices shall be disposed of in locations that will not result in off site sedimentation as acceptable to the Engineer, at no additional cost to the Owner.

- C. The Contractor shall provide temporary sedimentation traps at all locations shown on the Contract Drawings and for the settling of water pumped from the excavations or intercepted by drainage ditches for keeping water out of the excavations or to protect existing structures. The Contractor shall remove accumulated sediment from the traps as necessary to maintain their effectiveness or as indicated by the Engineer. Sediment material removed from the traps shall be disposed by the Contractor in locations that will not result in off-site sedimentation as acceptable to the Engineer, at no additional cost to the Owner.
1. Inspect temporary sediment traps after each period of significant rainfall. Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in a designated disposal area and replace the contaminated part of the gravel facing.
 2. Check the structure for damage from erosion or piping. Periodically check the depth of the spillway to ensure it is a minimum of 1.5 ft. below the low point of the embankment. Immediately fill any settlement of the embankment to slightly above design grade. **Any riprap displaced from the spillway must be replaced immediately.**
 3. After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.
- D. The Contractor shall provide temporary diversions at all locations noted on the Contract Drawings. All temporary diversions shall outlet at a temporary sediment trap or other appropriate structure.
1. Inspect temporary diversions once a week and after every rainfall. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it.
- E. Silt fence shall be erected as shown on the Drawings and specified herein. Silt fence shall be erected and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Replacement of the filter fabric, if required by the Engineer, will be at the Contractor's expense.
1. Silt fence shall be erected around all catch basins which are located downstream from any construction work. Should any catch basins be indicated to be relocated or modified, silt fence shall be utilized until work is completed on the catch basins. Upon completion of the modification, the area shall be rough graded, as shown on the Drawings, until the end of the project, at which time final grading shall occur.
 2. Inspect silt fence at least once a week and after each rainfall. Make any required repairs immediately.
 3. Should the fabric of a silt fence collapse, tear, decompose or become in-effective, replace it promptly.

4. Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.
 5. Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized. Removal of any silt fence shall be permitted only with the prior approval of the Engineer, or the local governing agency.
- F. Riprap shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone. The placed riprap shall have a minimum depth of 24 inches. Type II Separator Geotextile shall be used under all riprap unless otherwise noted.
- G. Riprap and stone for erosion control shall be dumped and placed in such manner that the larger rock fragments are uniformly distributed throughout the rock mass and the smaller fragments fill the voids between the larger fragments. Rearranging of individual stones by equipment or by hand shall only be required to the extent necessary to secure the results specified above, to protect structures from damage when rock material is placed against the structures, or to protect the underlying Separator Geotextile from damage during installation.
- H. The Contractor shall provide gravel and riprap filter berm basins at all locations noted on the Contract Drawings.
1. Inspect gravel and riprap filter berm basins after each period of significant rainfall. Remove sediment and restore the basin to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in a designated disposal area and replace the contaminated part of the gravel facing.
 2. Check the structure for damage from erosion or piping. **Any stone or riprap displaced from the berm must be replaced immediately.**
 3. After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.
- I. Engineer may direct the Contractor to place Straw with Net, Curled Wood or Coconut Fiber RECM's and Synthetic TRM's in permanent channels or on slopes at other locations not shown on Drawings.
1. All temporary and permanent channel and slope lining RECM's and TRM's shall be unrolled in the ditch in the direction of the flow of water. Temporary linings shall overlap the buried end of the downstream blanket by a minimum of 6 inches. Permanent linings shall overlap a minimum of 3 feet. All anchor and transverse trenches shall be a minimum of 12 inches deep. All mat shall be stapled as per manufacturer's specifications.

2. During the establishment period, check grass, RECM and TRM-lined channels after every rainfall event. For grass-lined channel once grass is established, check periodically and after every heavy rainfall event. Immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping and scour holes. Give special attention to the outlet and inlet sections and other points where concentrated flow enters. Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times.
- J. The Contractor shall provide temporary slope drains at all location noted on the Contract Drawings, and at other locations as may be directed by the Engineer.
1. Inspect the temporary slope drain and supporting diversion after every rainfall event and promptly make any necessary repairs. When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately.
- K. The Contractor shall provide temporary gravel construction entrances at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.
1. Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site. This may require periodic topdressing with 2-inch stone. After each rainfall, inspect each construction entrance and clean out as necessary. Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.
- L. The Contractor shall provide temporary or permanent ground cover adequate to restrain erosion on all disturbed areas that will be left unworked for periods exceeding 14 calendar days.
1. Reseed and mulch temporary seeding areas where seedling emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.
 2. Generally, a stand of vegetation cannot be determined to be fully established until soil cover has been maintained for one full year from planting. Inspect seeded areas for failure and make necessary repairs and reseedings within the same season, if possible.
 3. **Reseeding** – If a stand has inadequate cover, re-evaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand after seedbed preparation or over-seed the stand. Consider seeding temporary, annual species if the time of year is not appropriate for permanent seeding.
 4. If vegetation fails to grow, soil must be tested to determine if acidity or nutrient imbalance is responsible.

5. **Fertilization** – On the typical disturbed site, full establishment usually requires refertilization in the second growing season. Fine turf requires annual maintenance fertilization. Use soil tests if possible or follow the guidelines given for the specific seeding mixture.

M. Additional Requirements

1. All storm sewer piping shall be blocked at the end of every working day until the inlet is constructed above grade.
2. All streets around the construction area shall be scraped as necessary to prevent accumulation of dirt and debris.
3. The Contractor shall provide adequate means to prevent any sediment from entering any storm drains, curb inlets (curb inlet filter box), ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of offsite areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed.
4. The Engineer may direct the Contractor to place any additional sediment and erosion control devices at other locations not shown on the Drawings.
5. Contractor shall also adhere to all requirements indicated in the notes for each erosion control detail on the Drawings.

3.02 INSPECTIONS AND MAINTENANCE

- A. The Contractor shall designate a Qualified Person to perform inspections required by this Section. The following areas are to be inspected and maintenance performed, if needed, at least once every 7 calendar days and within 24 hours of a rainfall event that has a precipitation of 1/2 inch or greater.
 1. Disturbed areas of the construction site that have not undergone final stabilization
 2. Erosion and sediment control structures
 3. All locations where vehicles enter or exit the site
 4. Material storage and construction laydown areas that are exposed to precipitation and have not been finally stabilized
- B. Immediate action will be taken to correct deficiencies to BMP's. The State reserves the right to stop all construction activities not related to maintaining BMP's until such deficiencies are repaired.
- C. In areas that have been finally stabilized, inspections and, if necessary, maintenance by Contractor will occur at least once per month for the duration of the contract or project, whichever is longer.

- D. During inspections the following will be observed and appropriate maintenance procedures taken:
1. The conformance to specifications and current condition of all erosion and sediment control structures
 2. The effectiveness and operational success of all erosion and sediment control measures
 3. The presence of sediments or other pollutants in storm water runoff at all runoff discharge points
 4. If reasonably accessible, the presence of sediments or other pollutants in receiving waters
 5. Evidence of off-site tracking at all locations where vehicles enter or exit the site
- E. An inspection checklist must be completed during each inspection, dated, and signed by the Qualified Person conducting the inspection. Completed inspection checklist shall be kept on-site with the Contract Documents and submitted to the Engineer on a monthly basis. The Contractor will repair deficiencies within 24 hours of inspection.

3.03 REMOVAL OF TEMPORARY SEDIMENT CONTROL STRUCTURES

- A. At such time that temporary erosion and control structures are no longer required under this item, the Contractor shall notify the Engineer of its intent and schedule for the removal of the temporary structures, and obtain the Engineer's approval in writing prior to removal. Once the Contractor has received such written approval from the Engineer, the Contractor shall remove, as approved, the temporary structures and all sediments accumulated at the removed structure shall be returned upgrade. In areas where temporary control structures are removed, the site shall be left in a condition that will restore original drainage. Such areas shall be evenly graded and seeded as specified in Section 02910 - Final Grading and Landscaping.

- END OF SECTION -

SECTION 02500
SURFACE RESTORATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Provide all labor, equipment, and materials necessary for final grading, topsoil placement, and miscellaneous site work not included under other Sections but required to complete the work as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 - Earthwork
- B. Section 02276 - Erosion and Sedimentation Control
- C. Section 02910 - Final Grading and Landscaping

PART 2 -- MATERIALS

2.01 TOPSOIL

- A. Topsoil shall meet the requirements of Section 02200 – Earthwork.

PART 3 -- EXECUTION

3.01 FINAL GRADING

- A. Following approval of rough grading the subgrade shall be prepared as follows:
 - 1. For riprap, bare soil 24 inches below finish grade or as directed by Engineer.
 - 2. For topsoil, scarify 2-inches deep at 4 inches below finish grade.

3.02 TOPSOIL PLACEMENT

- A. Topsoil shall be placed over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped.
- B. Topsoil shall be spread in place for lawn and road shoulder seed areas at a 4-inch consolidated depth and at a sufficient quantity for plant beds and backfill for shrubs and trees.
- C. Topsoil shall not be placed in a frozen or muddy condition.

- D. Final surface shall be hand or mechanically raked to an even finished surface to finish grade as shown on Drawings.
- E. All stones and roots over 4-inches and rubbish and other deleterious materials shall be removed and disposed of.

- END OF SECTION -

SECTION 02510

PAVING AND SURFACING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment and materials and perform all operations in connection with the construction of asphalt concrete pavement, asphalt concrete overlay, reinforced concrete pavement, gravel roads, concrete curb and gutter, repair and reconstruction of existing asphalt concrete pavement, repair of existing gravel roads, and pavement markings complete as specified herein and as detailed on the Drawings.
- B. All new roads including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses and types as shown on the Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt and/or gravel, depending upon the material encountered, unless otherwise indicated.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 1, Division 2 and Division 3 of these Specifications.

1.03 RELATED SECTIONS

- A. Section 02200 - Earthwork
- B. Section 03300 - Cast-In-Place Concrete

1.04 STANDARD SPECIFICATIONS

- A. Except as otherwise provided in the Specifications or on the plans, all work shall be in accordance with the South Carolina Department of Transportation Standard Specifications for Highway Construction, 2007 or latest edition except that any reference to "SCDOT", "Department" or "Unit" shall mean the "Owner". When reference to these Specifications is intended, the description will reference the appropriate SCDOT Section and/or SCDOT Specifications.
- B. Except with the approval of the Engineer, the placing of concrete or asphalt concrete surface paving shall be subject to the Seasonal and Weather Restrictions set forth in SCDOT Specifications.

PART 2 -- MATERIALS

2.01 SELECT FILL

- A. The Contractor shall place select fill as necessary to complete the embankments, shoulders, subgrade foundation and replacement for removed unsuitable material in accordance with SCDOT Standard Specifications.

2.02 GRAVEL

- A. All work, including materials, associated with gravel shall be in accordance with SCDOT Standard Specifications.

2.03 AGGREGATE STABILIZATION

- A. All work, including materials, associated with Aggregate Stabilization shall be in accordance with SCDOT Standard Specifications.

2.04 AGGREGATE BASE COURSE (ABC)

- A. All work, including materials, associated with Aggregate Base Course shall be in accordance with SCDOT Standard Specifications.

2.05 ASPHALT BINDER FOR PLANT MIX

- A. All work, including materials, associated with asphalt binder shall be in accordance with Divisions 300 and 400 SCDOT Standard Specifications.

2.06 ASPHALT PAVEMENTS

- A. All work, including materials, associated with asphalt pavement shall be in accordance with Division 400, Asphalt Pavements, of the SCDOT Standard Specifications for Highway Construction.
- B. The job mix formulas shall be delivered to the Engineer at least two (2) weeks prior to beginning paving operations.

2.07 RIGID PORTLAND CEMENT CONCRETE PAVEMENT

- A. All work, including materials associated with rigid concrete pavement shall be in accordance with Division 500, Concrete Pavement.

2.08 RIGID CONCRETE PAVEMENT REINFORCING

- A. Reinforcing, if specified, shall be as shown on the Structural Drawings and as specified under Section 03200, Reinforcing Steel.

2.09 CONCRETE CURB AND GUTTERS

- A. Concrete shall be Class B in accordance with the requirements of Section 03300, Cast-In-Place Concrete, except that concrete shall be air-entrained to provide an air content of $6\% \pm 1.5\%$.
- B. Premolded expansion joint filler for expansion joints shall conform to ASTM D 1751 and shall be 1/2-inch thick, minimum.

2.10 ASPHALT TACK COAT

- A. All work, including materials, associated with asphalt tack coat shall be in accordance with Section 309, Asphalt Tack Coat, of the SCDOT Standard Specifications for Highway Construction.

PART 3 -- EXECUTION

3.01 EMBANKMENT

- A. The embankment shall be constructed in accordance with Section 02200, Earthwork.

3.02 SUBGRADE

- A. The subgrade, where shown on the Drawings, shall be aggregate stabilized by the addition and mixing of coarse aggregate with the top 3-inches of subgrade in accordance with SCDOT Specifications. Aggregate stabilization shall be applied to the subgrade at a rate of 300-pounds per square yard. Following the application of stabilizer aggregate, the subgrade shall be formed true to crown and grade, and shall be compacted with a minimum of four (4) passes of a 15-ton vibratory roller to conform to the maximum densities determined by AASHTO T99 Standard Specifications.

3.03 BASE COURSE

- A. The finished base course of all paving shall be ABC and shall be of the thickness shown on the Drawings, formed true to crown and grade. Gravel roads, including repair to existing gravel roads shall be ABC and shall be of the thicknesses shown on the Drawings, formed true to crown and grade. No fill material except new ABC shall be placed on top of existing gravel.

3.04 ASPHALT CONCRETE SURFACE COURSE

- A. Prior to placement of the asphalt concrete surface course, the base/intermediate course shall be inspected for damage or defects and repaired to the satisfaction of the Engineer. The surface of the base/intermediate course shall be approved by the Engineer.
- B. The asphalt tack coat shall be applied to the surface of the approved base/binder course as described in SCDOT Division 400. Equipment for applying the tack coat shall be power-oriented pressure spraying or distributing equipment suitable for the materials to be applied and approved by the Engineer.

- C. The Asphalt Concrete Surface Course shall be placed and compacted on the base/intermediate course in layers not to exceed 2-inches and at the rate of 110-pounds per square yard per inch. Surface Course shall be compacted in accordance with SCDOT Standard Specification for Highway Construction, Division 400. Thicknesses shall be as shown on the Drawings.

3.05 UNDERGROUND UTILITY LINES

- A. Where an underground utility line is beneath the new roadway, the backfilling shall be carried out with special care, and the final consolidation shall be accomplished by a vibratory roller. Construction of the roadway over the trench shall be deferred as long as practicable.

3.06 JUNCTION WITH OTHER PAVING

- A. Where new asphalt concrete pavement abuts existing asphalt concrete pavement, the existing pavement shall be cut back to insure obtaining the specified compaction of the new pavement courses and interlocking adjoining courses. Existing subbase courses shall be cut back from the subgrade level of the new pavement on a one-on-one slope into the existing pavement, and the asphalt courses of the existing pavement shall be removed for an additional 6-inches back from the slope. The edge of the existing asphalt courses shall be saw cut straight and true. The faces between new and existing asphalt courses shall receive an application of tack coat.
- B. Where new rigid concrete pavement abuts existing rigid concrete or asphalt concrete paving, the existing paving shall be saw cut straight and true. An expansion joint of a 1/2-inch minimum thickness with filler material and sealant shall be placed between the new concrete pavement and the existing rigid concrete or asphalt concrete paving.

3.07 ASPHALT CONCRETE OVERLAY

- A. Where asphalt concrete is proposed to be placed over an existing asphalt or rigid concrete surface, the surfaces shall be thoroughly cleaned by power brooming and a tack coat shall be applied in accordance with SCDOT Division 400, Asphalt Tack Coat, of the SCDOT Standard Specifications for Highway Construction, prior to installing the overlay. The overlay shall be applied in accordance with Standard Details shown on the Drawings.

-END OF SECTION-

SECTION 02604
UTILITY STRUCTURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, equipment, and tools required for the design, fabrication, delivery and installment of utility structures and appurtenances in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 – Earthwork
- B. Section 03200 – Reinforcing Steel
- C. Section 03250 – Concrete Accessories
- D. Section 03300 – Cast-in-Place Concrete
- E. Section 03400 – Precast Concrete
- F. Section 05540 – Castings

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ASTM C478 – Specification for Precast Reinforced Concrete Manhole Sections
 - 2. ASTM C857 – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
 - 3. ASTM C990 - Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
 - 4. ASTM A48 - Standard Specification for Gray Iron Castings
 - 5. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
 - 6. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar
 - 7. ASTM C150 - Standard Specification for Portland Cement

8. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes
9. ASTM C270 - Standard Specification for Mortar for Unit Masonry
10. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
11. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

1.04 SUBMITTALS

- A. Submit samples and/or Shop Drawings in accordance with Section 01300, Submittals.
- B. In addition to items listed in Section 03400, Precast Concrete, Shop Drawings shall include, but not be limited to:
 1. Complete layout and installation Drawings and schedules with clearly marked dimensions.
 2. Material certificates on all piping materials.
 3. Structural design calculations sealed by a P.E. registered in the State of South Carolina. Design calculations for precast manholes and vaults shall include confirmation structures adequately resist flotation when they are totally empty and subjected to groundwater full height of structure.
 4. Results of leakage test

PART 2 -- PRODUCTS

2.01 PRECAST MANHOLES, VAULTS, AND METER BOXES

- A. Precast utility structures shall be furnished with waterstops, sleeves and openings as noted on the Drawings. Box out for wall pipes shall conform accurately to the sizes and elevations of the adjoining pipes. Precast utility structures shall be watertight and conform to the requirements of ASTM C 478 and ASTM C857 with the following modifications there to:
 1. Materials shall conform to Section 03400, Precast Concrete.
 2. Manholes shall meet the following:

- a. Manhole diameter:

<i>Standard Manholes Schedule of Governing Dimensions</i>	
Pipe Size	Manhole Diameter
8" to 12"	*4' - 0"
14" to 18"	5' - 0"
21" to 30"	6' - 0"
36" or Larger	7' - 0"

*Drop manholes and manholes over 8' deep shall be a minimum of 5' in diameter.

- b. Manhole riser sections, minimum wall thickness shall be:

<i>Minimum Wall Thickness</i>	
4' Diameter Manhole	5"
5' Diameter Manhole	5"
6' Diameter Manhole	6"

Cone sections shall have a minimum wall thickness of 8" at their top.

- c. Manholes and utility structures shall include ballast concrete and/or other means necessary to insure manholes resist flotation when empty and subjected to groundwater full height of structure.
- d. Precast manholes and utility structures shall be as manufactured by Tindall Products, or equal.
- e. Minimum base slab thickness shall be:

<i>Minimum Base Slab Thickness</i>	
4' Diameter Manhole	6"
5' Diameter Manhole	8"
6' Diameter Manhole	8"

3. The date and name of manufacturer shall be marked inside each precast section.
4. No more than two lift holes may be cast or drilled in each section.

5. Dimensions shall be as shown on the Drawings.
 6. Covers and frames shall be as specified in Section 2.13.
 7. Mechanical Details such as piping, electrical, and other details shall be as shown on the Drawings.
- B. Joints between manhole and utility structures riser sections and at base slabs shall be groove type. Provide 2" non-shrink grout to joint interior tapered to the wall.
- C. Inverts:
1. Construct from cement grout with the same cross section as the invert of the sewers, which they connect.
 2. Carefully form to the required size and grade by gradual and even changes in sections.
 3. All channels shall be troweled smooth.
 4. Changes in direction to flow through the manhole shall be made to a true curve with as large a radius as the size of the manhole will permit.
 5. Concrete brick will be used to form only the invert channel walls. All other annular space shall be filled with non-shrink concrete grout.
 6. No fillers such as broken block, gravel, sand, or excavated material, are allowed in the construction of fillets (benches).
 7. Inverts shall be "U" design with top of "U" even with the crown of the pipe.
 8. Invert piping shall not extend inside manhole any farther than 2".
 9. The slope of the invert benches shall be a minimum of 2" higher than the crown of the pipe.
 10. When dissimilar pipe size occurs, the elevation of the crown of the pipes must be the same.
- D. Sections:
1. Free from large honeycombs, cracks, spalls, large chips, exposed reinforcing, and broken bells or spigots.
 2. Allowable deviation in form joints shall be 1".
 3. Edges of bells and spigots shall be even and straight.
 4. For manholes depth less than 4'-0", provide H-20 rated flat top sections.

2.02 BRICK

- A. Brick shall be sound, hard-burned common brick conforming to ASTM C32, Grade MS.

2.03 MORTAR

- A. Mortar shall conform to Section 04100 Mortar and Masonry Grout.

2.04 CONCRETE

- A. Concrete shall conform to Section 03300, Cast-in-Place Concrete.

2.05 REINFORCING

- A. Reinforcing shall conform to Section 03200, Reinforcing Steel.

2.06 PRECAST CONCRETE

- A. Precast concrete shall conform to Section 03400, Precast Concrete.

2.07 CONCRETE BLOCK

- A. Concrete block shall be solid, rectangular concrete masonry units conforming to ASTM C139.

2.08 CASTINGS

- A. Castings shall conform to Section 05540, Castings. Casting shall be of the type and size indicated on the Drawings.

2.09 STEPS

- A. No steps required.

2.10 VENT PIPES

- A. See Detail

2.11 JOINT SEALANT

- A. The manhole section shall be jointed with "Ram-Nek" joint sealer or approved equal. "Ram-Nek" shall be placed as recommended by the manufacturer.
- B. Outside of joint shall be wrapped with WrapidSeal Manhole Encapsulation System or approved equal. Material shall be 12" in width, centered on the joint. Install in accordance with manufacturer's recommendations.

2.12 FLEXIBLE RUBBER SLEEVE

- A. The spring set type shall have a stainless steel interior power sleeve or expander and shall be the PSX assembly by Press-Seal Gasket Corporation, the Kor-N-Seal assembly by National Pollution Control Systems, or Lock Joint Flexible Manhole Sleeve by Interpace Corp.
- B. The cast-in-place type shall conform to ASTM C923 and shall include stainless steel take up clamps, draw bolts and nuts.
- C. Flexible seal assemblies shall permit at least an eight (8) degree deflection from the center line of the opening in any direction while maintaining a watertight connection.

2.13 RUBBER BLADDER

- A. The rubber bladder seal shall conform to ASTM C923 suitable for pressure testing at 10 psi minimum, with a 3/8 inch minimum wall thickness.
- B. The rubber bladder seal shall contain an environmentally safe, anti-bacterial compound which turns into a high viscosity gel when in contact with pressurized water.
- C. The rubber bladder seal shall be NPC Contour Seal by Kor-N-Seal, or equal.

2.14 COVERS AND FRAMES

- A. Covers and frames shall comply with Section 05540, Castings and shall be provided by the utility structure manufacturer.
- B. Manhole covers and frames shall meet the following requirements:
 - 1. Acceptable manufacturers and models: East Jordan Iron Works Inc. Model 2029, U.S. Foundry model 480 frame and RA-SSG cover
 - 2. Clear opening shall be a minimum of 22 inches, unless otherwise indicated on the Drawings.
 - 3. Manufacture:
 - a) The covers will be water tight with no holes or perforations.
 - b) Two stainless steel pick bars will be included on cover.
 - c) Casting shall be on uniform quality, free from sand holes, gas holes, shrinkage, cracks and other surface defects.
 - d) Surfaces of the casting shall be from burned-on sand and shall be reasonable smooth.
 - e) Runners, risers, fins and other cast-on pieces shall be removed from the casting and suck areas shall be ground smooth,
 - 4. Proof Load Testing:
 - a. Traffic service castings shall have a first article proof load test conducted and the results of that proof load test shall be made available to the Owner upon request.

- b. The proof load test shall be conducted in accordance with the methods and procedures outlined in AASHTO M306-04, Section 5, Proof Load Testing.
 - 5. Materials: Gray iron castings for heavy-duty applications shall be manufactured from iron conforming to ASTM A48 Class 35B, as noted in AASHTO M306-04.
 - 6. Marking:
 - a. Each casting shall be identifiable and show, at a minimum, the following:
 - 1) Name of the producing foundry, country of manufacture (such as 'made in USA').
 - 2) ASTM material designation
 - 3) Recycle symbol
 - 4) Individual part number
 - b. Cast into the center of the cover will be the letters CPW, 2"-3" in height
 - c. Cast into the cover will be the words SANITARY SEWER, 1 ½"-2" in height
 - d. Producing foundry name will be cast with a height of 1".
 - C. All frames and covers shall be given one shop coat of asphalt or coal tar varnish, unless otherwise specified.
 - D. Frames and covers shall be identical throughout the Contract.
 - E. Exterior manhole frame to cone section shall be wrapped outside of frame to cone section with WrapidSeal Manhole Encapsulation System. Wrap shall be installed per manufacturer instructions.
- 2.15 GRATES
- A. Grates shall comply with Section 05540, Castings.
- 2.16 CONCRETE BALLAST
- A. Concrete ballast shall be Class B concrete in conformance with Section 03300, Cast-in-Place Concrete. Ballast shall be provided as necessary to insure manhole resists flotation when empty and subjected to full height groundwater conditions.
- 2.17 FLEXIBLE JOINT SEALER
- A. Flexible joint sealer shall be a rubber ring waterstop as manufactured by Fernco Joint Sealer Co., or equal.
- 2.18 EPOXY BONDING AGENT
- A. Epoxy bonding agent shall conform to Section 03250, Concrete Accessories.

2.19 DROP MANHOLE

- A. Where the difference in the invert elevation between an intersecting sewer and manhole is 24" or greater, an inside drop manhole shall be constructed. It shall be similar in construction to the standard manhole except that a drop connection of pipe and fittings of the proper size and material shall be constructed inside the manhole and supported by stainless steel clamps and bolts.

2.20 COATINGS:

- A. Provide epoxy coating at the following locations:
 - a. Force main receiving manholes and the next manhole downstream
 - b. Pump station receiving manhole
 - c. Manholes for wastewater Air Release Valves
 - d. Drop manholes
 - e. At other manholes as indicated on the Drawings
 - f. Epoxy coating not required at standard manholes
 - g. Thickness: 120 mils (minimum)
 - h. Provide Raven 405 Epoxy System

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Manholes shall be constructed to the sizes, shapes and dimensions and to the locations shown on the plans.
 - 2. The height or depth of each manhole will vary with the location, but it shall be such as will place the top at the finished grade of the pavement or ground surface or to the elevations shown on the plans and to inverts at the elevations shown on the plans and to inverts at the elevation design on the plans.
- B. Use proper bedding as specified.
- C. Set base level so that walls will be plumb.
- D. Clean inverts, spigots and pipe ends.

- E. Apply joint sealer and set firmly in place to assure watertight joints. See details on Drawings.
- F. Connect pipe boot to piping with dual stainless steel straps.
- G. Grout lift holes from the outside using non-shrink grout.
- H. Install exterior joint collar.
 - 1. Follow manufacturer's recommendations.
 - 2. Clean surface.
 - 3. Remove the protective paper and place the band around the manhole.
- I. Form the invert channels directly in the concrete of the manhole base with mortar and concrete brick. Smooth the floor of the manhole outside the channels and slope toward the channels at not less than 1" per foot, nor more than 2" per foot.
 - 1. Shape the invert channels to be smooth and semi-circular, conforming to the inside of the adjacent sewer section. Channel top shall be to crown of pipe.
 - 2. Make changes in direction of flow with a smooth curve of as large a radius as the size of the manhole will permit.
 - 3. Make changes in size and grade of channels smoothly and evenly.
 - 4. Slope invert uniformly from invert of inlet to invert of outlet.
- J. Match manhole top to finish grade utilizing concrete adjustment rings.
 - 1. Manhole tops shall be watertight and at finished grade elevation. If located in pavement, elevation shall be set to match finished grade.
 - 2. Leveling and final grading of manhole frames and covers shall be accomplished by using concrete brick or concrete grade rings. When using grade rings, a maximum of two (2) 4" grade rings or one (1) 6" grade ring shall be used.
 - a. The total number of grade rings shall not exceed 8" in thickness.
 - b. Grade rings shall be laid in a full bed of non-shrink grout and covered after laying with a smooth coating of non-shrink grout or hydraulic cement a minimum of 2" thick.
 - 3. After the manhole has been set in its final position, the cast iron frame for the cover shall be carefully set at finished grade and properly bonded using a full bed of non-shrink grout.

- a. Where manholes are constructed in paved areas, sidewalks, etc., the top surface of the frame and cover shall be tilted so as to conform to the exact slope, crown, and grade of the existing pavement.

3.2 DROP MANHOLES

- A. Where indicated, or as directed by the Engineer, construct drop manhole connections, complying with details on the Drawings.

3.3 CONNECTION TO EXISTING MANHOLE

- A. Connection of gravity sewer main to an existing system made at an existing manhole:
 - 1. Connection to an existing manhole shall be made in the presence of the Charleston Water System inspector.
 - 2. New holes in manholes shall be core drilled.
 - a. Size to be sufficient to insert pipe but as small as practical.
 - 3. When connecting to an existing manhole, temporarily block and/or divert sewage flows. Use high early strength cement to form proper channels with minimum interruption of service.
 - 4. Seal around new pipe as specified in details on the Drawings.
 - 5. Invert:
 - a. Inside the manhole, remove enough existing grout to allow smooth and complete transition from new connection to existing outlet without hindering existing inlets.
 - b. Leave bench smooth and interior clean.

3.4 COATINGS

- A. Provide epoxy coating system at locations as specified herein and as indicated on the Drawings.
- B. Coating must be applied by a Raven certified applicator.
 - 1. Provide documentation of certification to Engineer.
- C. Contractor shall verify thickness during installation by the use of a wet film thickness gauge.
- D. Testing of coating:

1. Raven Epoxy Coating shall be tested for pinholes using approved spark test method (high voltage holiday detection equipment).
2. The coating applicator must correct any defect found during the test at no additional cost to the Owner.

3.5 FIELD QUALITY CONTROL

- A. Manhole sections shall be free from large honeycomb, cracks, spalls, large chips, exposed reinforcing, and broken bells or spigots.
- B. Allowable deviation in form joints shall be 1".
- C. Edges of bells and spigots shall be even and straight.

3.6 MANHOLE VACUUM TEST

A. General:

1. Vacuum test manholes in accordance with ASTM C1244 except that the minimum test times shall be as defined in the Manhole Vacuum Test Table (test times modified from those in ASTM C-1244).
2. Vacuum testing shall not be performed until the manhole is completely finished, including applying any protective coating where specified.
3. Manholes shall be thoroughly cleaned of all silt, debris and foreign matter of any kind prior to the vacuum testing and then again prior to final inspection as required.

B. Test:

1. Vacuum tests shall be performed by placing the testing unit at the top of the manhole in accordance with the manufacturer's recommendations.
2. A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test unit closed, and the vacuum pump shut off.
3. The time shall be measured for the vacuum to drop to 9 inches of mercury.
4. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the test times indicated in Table 1 below.
5. The test times in Table 1 are modified from those in ASTM C-1244. Table 1 shall be included on the Contractor's test reports.
6. Refer to ASTM C-1244 for further requirements.

7. Any leaks found during the vacuum testing shall be repaired at no additional cost by the Contractor in a manner approved by Engineer.
 - a. The manhole shall be vacuum tested again after such repairs are made until the manhole passes the vacuum test at no additional cost to the Owner.

Table 1

Manhole Vacuum Test Table

MINIMUM VACUUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS									
Manhole Depth (feet)	Manhole Diameter (inches)								
	36	42	48	54	60	66	72	84	96
	Test Time (seconds)								
8	60	60	60	60	60	60	66	72	78
10	60	60	60	60	66	72	82	98	114
12	60	60	60	70	78	86	98	118	138
14	60	60	70	82	92	102	114	136	158
16	60	68	80	92	104	116	134	160	188
18	64	76	90	104	118	130	146	178	208
20	70	84	100	116	130	144	162	194	226
22	78	92	110	128	144	158	178	212	246
24	84	102	118	140	156	174	194	232	270
26	92	110	128	150	170	188	210	250	290
28	98	118	138	162	182	202	226	270	314
30	106	126	148	174	196	216	242	288	334

8. There shall be no groundwater infiltration or other leakage (active or evidence of being previously active) through the manhole walls, benches, inverts or pipe connections at the manholes.
 - a. If leakage is found, it shall be eliminated with an appropriate grout or non-shrink cement mortar approved by the Engineer.
 - b. Injection grouting (Avanti AV-202 Multigrout or approved equal) may be required to stop leaks around the pipe connections or in the invert channel or benches.
 - c. The Engineer's decision on how defective manholes are repaired shall be final.
9. If any defective manholes are discovered after they have been installed or during the warranty period, they shall be repaired or replaced in a satisfactory manner at no additional cost to the Owner.
 - a. Repaired manholes, including those repaired during the warranty period, shall be vacuum tested again at no additional cost to the Owner.

PART 3 -- EXECUTION

3.01 DESIGN CRITERIA

- A. Minimum structural design loading for underground precast concrete vaults shall be as indicated in ASTM C857, unless otherwise noted herein. Precast items subjected to vehicular traffic shall be designed for H-20 traffic loading. Other precast items shall be designed for a vertical live load of 300 psf.
- B. Walls of precast items shall be designed for a vertical surcharge of 100 psf.
- C. Precast manholes and vaults shall be designed to resist flotation when totally empty and subjected to groundwater full height of the manhole/vault.

3.02 FABRICATION AND CASTING

- A. Fabrication and casting shall conform to Section 03400, Precast Concrete, and to Section 03300, Cast-in-Place Concrete.
- B. All base sections designated to receive concrete ballast and all electrical manholes shall extend monolithically a minimum of 6 inches beyond the outside face of the wall for the entire periphery. All other utility structures shall have a standard base.
- C. Utility structures built around existing pipe shall have a cast-in-place base slab.

3.03 HANDLING, TRANSPORTING, AND STORING

- A. Handling, transporting and storing of precast items shall comply with Section 03400, Precast Concrete.

3.04 INSTALLATION

- A. Installation shall conform with Section 03400, Precast Concrete and with the manufacturer's recommendations or to Section 03300, Cast-in-Place Concrete.
- B. Frames and covers or grates shall be set so that tops are at elevations indicated on the Drawings or flush with finished grade where no elevation is indicated.
- C. Joints between riser sections shall be sealed with joint sealant.
- D. All openings in utility structures shall have flexible rubber sleeves sized to fit the connecting pipe and installed to provide watertight joints in accordance with the manufacturer's recommendations. The interior of the sleeve shall be filled with Class B concrete.
- E. Openings that are too large for flexible rubber sleeves shall utilize rubber bladder seals which are expanded by water injected using a pressure pump.
- F. All units shall be installed plumb and level.
- G. All lift holes and joints shall be filled with non-shrink grout conforming to Section 03600, grout inside and out.

- H. The manhole frames shall be set to their required elevations either with grade rings or with two or three courses of brick masonry laid around the top of the upper wall section. Such brick work shall be given a 1-inch mortar coat on the inside and out.
- I. Concrete ballast shall be placed so that it bears directly on the utility structure base against the outer wall monolithically encircling the structure for the full height indicated on the Drawings. Additional ballast may be required where the depth or elevation of the structure varies from the Drawings.

J. Brick or Concrete Block

Brick or concrete block shall be laid with broken joints and all horizontal and vertical joints filled with cement-sand mortar. Outside of walls shall be plastered with a minimum 1-inch thick coat of cement-sand mortar troweled smooth.

K. Connection to Existing Pipe

1. Verify the diameter and invert elevation of existing pipe to be connected to new utility structures prior to beginning work on the structures.
2. Provide adequate protection to prevent damage to the existing pipe.
3. Provide adequate means for plugging and/or transferring the existing flow in the pipe to allow for the construction of inverts and grouting.
4. Cut off the existing pipe sufficiently for connection to the new structure and remove.
5. Thoroughly clean all foreign matter and coat the pipe surface with epoxy adhesive where the pipe joins the new structure.
6. Install a flexible joint sealer around the pipe.
7. Grout inside and outside of wall penetration with nonshrink grout.

L. Backfill structures in accordance with Section 02200, Earthwork.

M. Clean all structures of any accumulation of silt, debris, or foreign matter and keep clean until final acceptance of the work.

N. Excavation shall conform to Section 02200, Earthwork.

O. Structure bases shall bear on a minimum of 8 inches of compacted stone unless otherwise indicated on the Drawings.

P. Channel Inverts

1. Inverts shall be placed using Class B concrete with forms sufficient to provide a smooth half-round shape as shown on the Drawings. Manhole bases employing full depth precast inverts are acceptable.

2. Where the slope of the line does not change through a manhole, a constant slope shall be maintained in the invert. Where slope changes occur within a given manhole, the transition shall be smooth and shall occur at the approximate center of the manhole.
3. Inverts shown on the Drawings are taken at the center of the manhole unless otherwise noted.

3.05 ADJUSTMENTS TO EXISTING UTILITY STRUCTURES

- A. Adjust structures as indicated on the Drawings using concrete or cast iron adjustment rings by approved methods.
- B. Clean covers and inlet castings of all foreign material and paint with one coat of coal tar epoxy.

3.06 ADJUSTING COLLARS AND FINAL ADJUSTMENTS

- A. Adjusting collars shall be as shown on the Drawings. Final adjustments shall be made so that the manhole ring and cover will be smooth and flush with the finished grade of the adjacent surface, or as otherwise indicated on the Drawings for manholes shown above grade.

3.07 FLUSHING AND TESTING

- A. Obstruction - After backfilling, all sewers shall be inspected for obstructions and shall be flushed with water. Flushing shall be a minimum velocity of 2.5 feet per second for a duration acceptable to the Engineer. Flushing shall remove all dirt, stones, pieces of wood and other debris which accumulated in the sewer during construction. The Contractor shall provide a means acceptable to the Engineer for removal of debris flushed from each section of sewer. If after flushing, any obstructions remain, they shall be removed at the Contractor's expense.
- B. Visual Inspection - Sewer lines shall be visually inspected from every manhole by use of mirrors, television cameras, or other devices for visual inspection, and the lines shall all exhibit a fully circular pattern when viewed from one manhole to the next. Lines which do not exhibit a true line and grade or have structural defects shall be corrected to meet these qualifications.
- C. Leakage - Sewers shall be tested for leakage. The program of testing shall fit the conditions as mutually determined by the Engineer and the Contractor. The Contractor shall take all necessary precautions to prevent any joints from drawing while the sewers or their appurtenances are being tested. The Contractor shall, at his own expense, correct any excess leakage and repair any damage to the pipe and their appurtenances, or to any structures resulting from or caused by these tests.
- D. Leakage Test Procedure - Each section of sewer shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers and filling the pipe and manhole with water to a point 6 feet above the crown of the open sewer in the upper manhole, or, if ground water is present, 6 feet above the sections average adjacent ground water level as indicated by a monitor well installed adjacent to each manhole. The line shall be filled with water prior to testing and allowed to stand until the

pipe has reached its maximum absorption, but not less than two (2) hours. After maximum absorption has been reached, the head shall be re-established and tested for at least six (6) hours maintaining the head specified above by measured additions of water. The sum of these additions shall be the leakage for the test period.

If ground water is present to a height of at least 6 feet above the crown of the sewer at the upper end of the pipe section to be tested, the leakage test may be made by measuring the rate of infiltration using a suitable weir or other measuring device approved by the Engineer. Whether the test is made by infiltration or exfiltration, the allowable leakage shall not exceed 100 gallons per day per inch of diameter per mile of sewer being tested.

Where the actual leakage exceeds the allowable, the Contractor shall discover the cause and correct it before the sewer will be accepted. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

- E. Low Pressure Compressed Air Test - If the leakage cannot be located by infiltration or exfiltration testing, this type test may be used. The pipeline shall be considered acceptable, when tested at an average pressure of 3.0 psi greater than the average back pressure of any groundwater that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.0030 cfm per sq. ft. of internal pipe surface.
- F. Deflection Test - No sooner than thirty (30) days after final backfill installation, each section of PVC pipe shall be checked for vertical deflection using an electronic deflecto-meter or a rigid "Go-No-Go" device. Vertical deflection shall not exceed five (5) percent of the inside pipe diameter for PVC pipe.

Where the actual deflection exceeds the allowable, the Contractor shall discover the cause and correct it before the pipe will be acceptable. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

- G. Cost of Testing and Repairs - Any and all work necessary to bring the line into conformance with the infiltration and deflection specifications shall be performed by the Contractor at no extra cost to the Owner. All apparent sources of infiltration and excessive deflection shall be repaired by the Contractor.

The Contractor shall provide all water, plugs, hoses, pumps, equipment, etc. necessary for the proper flushing and testing of the sewers.

3.08 LEAKAGE TEST FOR PRECAST MANHOLES

A. Hydrostatic Test – Manholes and (other structures where scheduled) shall be hydrostatically tested by plugging all pipes in the manhole and filling manhole with water to the rim. Allow the level to equalize due to saturation. Refill manhole to begin test. Test shall be 2-hour minimum. Allowable leakage is three (3) gallons per hour, total six (6) gallons for test. If manhole fails test, drain manhole, repair leak(s) and re-test until manhole passes leakage test.

B. Vacuum Test – With approval from Owner/Engineer, manholes that cannot reasonably be hydrostatically tested may be vacuum tested.

1. Testing shall be done in accordance with ASTM C1244-05 (or latest revision).
2. Prior to testing, all pipes, holes, and vents entering manhole shall be plugged and braced.
3. Contractor shall have an approved test head and copy of instructions for use by the manufacturer.
4. A vacuum of 10-inch hg shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut-off. The time for the vacuum pressure to drop to 9-inch hg shall be measured. If the test time meets or exceeds the test time as specified in the table below, the manhole is acceptable; otherwise, the test has failed and the manhole should be checked for leaks, corrected, and re-tested. For sizes and depths of manholes not given in the table, test time shall be calculated as specified herein.

- END OF SECTION -

SECTION 02665

TEMPORARY BYPASS PUMPING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Under this item the Contractor is required to design and furnish all materials, labor, equipment, power, fuel, fuel storage, maintenance, etc. to implement a temporary pumping system for the purpose of diverting the existing flow around the work area on a daily basis, for the duration of the project.
- B. The design, installation, and operation of the temporary pumping system shall be the Contractor's responsibility throughout the duration required. All components of the temporary bypass pumping system shall be provided by the Contractor.
- C. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction. Contractor shall also be responsible for any fines imposed by local, state, and/or federal agencies for failure to maintain flows or contain spills and/or overflows.
- D. The Contractor shall implement best management practices to prevent and minimize erosion and resultant sedimentation during all bypass pumping activities in accordance with Section 02276 – Erosion and Sedimentation Control.

1.02 SUBMITTALS

- A. Bypass Pumping Plan: The Contractor shall submit to the Engineer for review and approval detailed drawings and descriptions outlining all provisions and precautions to be taken by the Contractor regarding the handling of existing wastewater flows. The plan must be specific and complete, including such items as schedules, locations, elevations, capacities of equipment, materials, and all other incidental items necessary and/or required to insure proper protection of the facilities, including protection of the access and bypass pumping locations from damage due to the discharge flows, and compliance with the requirements and permit conditions specified in these Contract Documents. No construction shall begin until all provisions and requirements have been reviewed by the Engineer. The plan shall include, but is not limited to, the following details:
 - 1. Staging areas for pumps
 - 2. Plugging methods and types of plugs
 - 3. Number and size of pumps and basis of selection
 - 4. Number, size, material, method of installation, and location of suction piping
 - 5. Number, size, material, method of installation, and location of discharge piping
 - 6. Bypass pump sizes, capacity, number of each size to be on site, and power requirements

7. Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range are to be submitted)
8. Standby power generator size (if necessary), location
9. Thrust and restraint block sizes and locations
10. Sections showing suction and discharge pipe depth, embedment, select fill, and special backfill
11. Method of noise control for each pump and/or generator
12. Any temporary pipe supports and anchoring required
13. Design for access to bypass pumping locations indicated on the drawings
14. Selection of bypass pumping pipe size and material (include method of connections to pump and other piping)
15. Schedule for installation of and maintenance of bypass pumping lines
16. Describe how bypass pumping system will be monitored
17. Demonstrate upstream manholes will not overflow from surcharging and that upstream service connections will not be surcharged
18. Show discharge from force main will not surcharge downstream discharge manhole
19. Show 100% standby for pumps, power, controls, suction piping, and discharge piping
20. Show force main pipe material and thickness can withstand all normal operating and surge pressures with a safety factor of 2.0
21. Denote any conditions that will cause pumps to lose suction lift (prime) and describe procedures to rectify
22. Show that the emergency switchover from primary to secondary pumping will be automatic should equipment fail
23. Show suction and discharge piping is protected from possible damage from construction activities
24. Show any planned shifting of bypass equipment during construction
25. Provide for additional facilities as may be required at Specification 01520 – Maintenance of Plant Operation.

B. Sequence of Construction Plan: Furnish in accordance with Section 01300 – Submittals.

1. Contractor's Sequence of Construction defining work to be performed, including the following items:
 - a. Definition of the start date, duration and end date
 - b. Define activities to be performed by or witnessed by the Owner and date on which these activities are to be performed.
 - c. Scheduling/timing of manufacturers field services, as specified.
2. Interruption of the operation of the existing facilities is required to perform the Work. Define the purpose for the interruption, date and time of interruption, and duration of interruption.
3. Provide complete list of equipment and material that is required to perform each segment of work.

PART 2 -- PRODUCTS

2.01 PUMPING EQUIPMENT

A. General:

1. Plant influent and effluent flows must be kept in service at all times unless approved by the Owner and Engineer. It is essential to the operation of the existing wastewater system that there shall be minimal interruption in the conveyance of flows throughout the duration of the project. To this end, the Contractor shall provide, maintain and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the outfall flow before it reaches the point where it would interfere with his work, carry it past his work and return it to the existing system downstream of his work.
2. It is the Contractor's responsibility to provide equipment that is adequate for the performance of the Work under this Contract within the time specified. All equipment shall be kept in satisfactory operating condition, shall be capable of safely and efficiently performing the required Work, and shall be subject to review by the Owner's representative at any time within the duration of the Contract. All Work hereunder shall conform to the applicable requirements of the OSHA Standards for Construction.
3. Treatment plant operational requirements take precedence over Contractor activities. Therefore, interruption of treatment plant operations must be coordinated and are subject to the operational requirements of the Owner. Contractor shall assume that any interruption of treatment plant operations may be deferred by up to one (1) week from the requested time due to operational constraints.

4. The Contractor shall provide for utilities and services for its own operations. The Contractor shall furnish, install and maintain all temporary utilities during the contract period including removal upon completion of the Work.
5. The pumps shall be diesel powered and shall be equipped with sound attenuation equipment capable of reducing noise to 90 dB.
- c. Contractor shall be responsible for providing and storing a sufficient quantity of diesel fuel on-site to continually operate the pumps for the duration of the temporary bypass pumping period.
- d. Contractor shall check the pump fuel levels and shall re-fill the tanks to full capacity on a daily basis.
6. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of the flows.
7. Each pump and driver shall be rated for continuous duty operation over the specified range of conditions without cavitating or overheating, and without excessive vibration or noise. In addition, each pump and driver shall be rated to operate intermittently at shut-off head against a closed discharge valve for periods of not less than 5 minutes without excessive cavitation, overheating, or vibration.
8. Furnish each pump with the necessary stop/start controls.
9. Contractor will not be permitted to stop or impede the main flows under any circumstances.

B. Temporary Bypass Pumping Requirements: The Contractor is responsible for the construction of the bypass facilities as described herein. Requirements for the bypass pumping system is as follows:

1. Bypass pumping system is required to be operated continuously during daily construction activities while the existing outfall pipeline is modified.
2. Contractor shall determine the number of pumps required to convey the bypass pumping flows listed in this Section. Contractor shall provide a backup unit for all components (pumps, power, controls, piping, etc.) of the bypass pumping system. The backup pump shall be piped into the suction and discharge headers and shall be on-line, isolated from the primary system by a valve.
3. The bypass pumping equipment shall be capable of pumping treated plant flows at the below rates (MGD).

	Avg Daily Flow	Wet Weather Flow
Existing Pump Station	100 gpm	250 gpm

Contractor will have by-pass pumping facilities manned at all time during operation.

4. Provide all pipeline plugs, pumps of adequate size to handle the peak daily flow, and temporary discharge piping to ensure that the total interceptor flow can be safely diverted around the work area while the sanitary sewer interceptor is modified. Wet weather flow projections are estimated. Contractor has the options of either sizing by-pass pumps for the wet weather flow, or provide contingency plan of placing pipe or keeping pipe in service in the event of wet weather flow.
5. The Contractor shall make all arrangements for bypass pumping during the time when the existing outfall pipeline is being modified for any reason.
6. Discharge piping shall be constructed of steel, ductile iron, or polyethylene pipe with positive, restrained joints. Under no circumstances will aluminum "irrigation" type piping or glued PVC pipe be allowed. Discharge hose will only be allowed in short sections and by specific permission from the Engineer.
7. Operation: The bypass pumps are to have variable capacity by controlling the speed of operation. Each pump shall have a separate control panel.
8. Provide pressure and vacuum gauges on the suction and discharge headers.
9. Provide pressure switches to start and stop the pumps and a pressure transmitter to vary the speed of the pumping units.

PART 3 -- EXECUTION

3.01 PREPARATION

- A. The Contractor is responsible for locating any existing utilities in the area where the Contractor selects to locate the bypass pumps and pipelines. The Contractor shall locate his bypass pipelines to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from the Owner and the Engineer. All costs associated with relocating utilities and obtaining all approvals shall be paid by the Contractor under Bid Item for By-Pass Pumping.
- B. During bypass pumping operations, the Contractor shall protect the existing outfall pipeline, including the manholes, from damage inflicted by his equipment. The Contractor shall be responsible for all physical damage to the existing system caused by human or mechanical failure.
- C. Contractor shall keep spare parts for pumps and piping on-site as requested. Adequate hoisting equipment for each pump and accessories shall be maintained on the site.

3.02 INSTALLATION AND REMOVAL

- A. The Contractor shall pipe sections or make connections to the existing interceptor and construct temporary bypass pumping structures only at the access location and as may be required to provide an adequate suction conduit.
- B. The temporary bypass pumping system shall be tested before placing the system in operation. Testing periods shall occur only between the hours of 8:30 a.m. and 3:00 p.m., Monday through Thursday. Testing of bypass pumping system shall NOT be allowed

Friday through Sunday, on the Owner's scheduled Holidays, or on the day immediately prior to an Owner's scheduled Holiday. In addition, testing of bypass pumping system shall only be performed during the Owner's normally scheduled work days. Testing shall include leakage testing, pressure testing, and operational testing.

1. Leakage and pressure test: Contractor shall perform leakage and pressure testing for a minimum of two (2) hours on the pump duty suction piping and duty discharge piping in accordance with Article 3.03, Paragraph A. Contractor shall then remove the duty piping and shall install the standby suction piping and standby discharge piping and perform the same test for an additional two (2) hours.
 2. Operation test: Contractor shall operate the temporary bypass pumping system for as long as necessary to demonstrate reliable operation of the entire system, including but not limited to pumps and controls, to the satisfaction of the Owner.
- C. Plugging or blocking of outfall flows shall incorporate primary and secondary plugging devices. When plugging or blocking is no longer needed for performance of the work, the plugs are to be removed in a manner that permits the outfall flow to slowly return to normal without surge, surcharging, or causing other major disturbances downstream.
- D. At the conclusion of the bypass pumping operation and once written permission is granted by the Owner and Engineer, Contractor shall remove all temporary bypass components and restore the site to original conditions to the satisfaction of the Owner and Engineer.

3.03 QUALITY CONTROL AND MAINTENANCE

- A. Testing: Contractor shall perform leakage and pressure tests of the bypass pump suction and discharge piping using clean water prior to actual operation. Low pressure air test shall be conducted at a test pressure of 5 psi. The Engineer will be given 24 hours notice prior to testing.
- A. Inspection: During the time the Contractor is working at the project site, Contractor shall inspect the bypass pumping system every two (2) hours to ensure that the system is working correctly and shall keep a written log of the pump inspection results. Contractor shall inspect the bypass pumping system a minimum of either one (1) time per day or as often as necessary to ensure full fuel tanks for the bypass pumps.
- B. Maintenance Service: Contractor shall insure that the temporary pumping system is properly maintained and a responsible and competent mechanic/operator shall be on call at all times.

3.04 SEQUENCE OF CONSTRUCTION

- A. Contractor shall propose a Sequence of Construction incorporating all constraints detailed in this Section and shall secure concurrence of Owner prior to starting work.

- B. The Contractor shall submit a construction plan and schedule, which details the methods, means, techniques, and sequences to be used to establish a base element of surety against a wastewater spill, to the Engineer for review and approval by the Owner at least two (2) weeks prior to any connections to existing pipes or structures. Such plan shall provide assurance against a wastewater spill, with at least one level of backup. Any and all fines or fees imposed upon the Owner resulting from spills or process interruptions shall be assessed solely upon Contractor. One week prior to connections being made to existing structures or pipes, a coordination meeting shall be held between the Contractor, Engineer, and Owner to discuss the construction plan previously submitted by the Contractor.
- C. Schedule of construction, interconnecting details, and other revisions necessary for proper interfacing of the Work are to be subsequently modified by Contractor accounting for results of said coordination meeting. The Engineer and Owner are to be notified 24 hours prior to any actual interruptions or connections being made. Begin no work prior to securing Owner's approval of respective connection plan and work schedule.

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SECTION 02831

STEEL FENCING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install steel fencing, posts, gates, etc., where shown on the Drawings and in compliance with these Specifications.
- B. Fencing shall be of the chain link type 2" mesh. The 6-foot high fabric (ends twisted and barbed) shall clear the final grade by 2 inches. All materials shall be vinyl-coated green or black coating including fabric, posts, rails and associated appurtenances.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete.

1.03 SUBMITTALS

- A. Shop Drawings shall be furnished in accordance with Section 01300, Submittals.

PART 2 -- PRODUCTS

2.01 CHAIN LINK FABRIC

- A. Fabric shall be 9-gauge aluminum coated wire woven in a 2-inch diamond mesh conforming to ASTM A491. Top and bottom selva to have a barbed finish. Minimum weight of coating shall be 0.40 ounce per square foot of wire surface. The coated wire shall have a minimum tensile strength of 80,000 lbs. per square inch.
- B. Install fabric 2 inches above ground level. Fence shall be stretched tight and securely fastened to posts at points spaced 12 inches apart maximum.

2.02 POSTS

- A. Posts and rails shall be galvanized standard weight pipe conforming to the requirements of ASTM F1083.
 - 1. Line Posts: Line posts shall be Schedule 40, 2-3/8 inch O.D. galvanized pipe with minimum bending strength of 201 pounds under a 6-foot cantilever load. Line posts shall be spaced at a maximum 10-foot O.C.

2. Terminal Posts: All end, corner, intermediate, and pull posts and gate leaves 6'0" wide and less shall be 2-7/8 inch O.D. galvanized Schedule 40 pipe with minimum bending strength of 381 pounds on 6-foot cantilever load. Gate posts for gate leaves shall be Schedule 40 pipe complying with ASTM F1083 of diameters as follows:

<u>Gate Leaf Width</u>	<u>Pipe O.D.</u>	<u>Weight per Ft.</u>
0' to 6'	2-7/8"	5.79 lbs.
Over 6' to 13'	4"	9.1 lbs.
Over 13' to 18'	6-5/8"	18.97 lbs.
Over 18'	8-5/8"	24.7lbs.

2.03 TENSION WIRE

- A. Top and bottom tension wire shall be No. 7 gauge aluminum coated steel wire. Fabric shall be securely tied to tension wire at intervals not to exceed 24-inches.

2.04 POST TOPS

- A. Gate, end, corner and line post tops shall be malleable iron or pressed steel and shall be hot dipped galvanized conforming to ASTM A153.
- B. Angles for line post extension arms shall be approximately 45 degrees from the vertical and the top slot for barbed wire shall be a minimum of 12 inches above the fabric and a minimum of 10 inches from the fence line.

2.05 BRACES AND TOP RAILS

- A. Braces and top rails (where shown on the Drawings) shall be 1.66-inch O.D., Schedule 40 galvanized pipe with minimum vertical bending strength of 202 pounds on 10-foot span.
- B. Top rails shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion. Brace rails shall be provided at all terminal posts, located between the top and grade lines and extend from the terminal post to the first adjacent post. Braces shall be securely fastened at both ends. Brace ends for receiving brace rails shall be malleable iron or castings of 356.0 (formerly SG70A) alloy, or equivalent of ASTM B26 or B108.
- C. Truss and stretcher bands shall be 1/8-inch x 7/8-inch pressed steel, supplied with carriage bolts and nuts. Bolts shall be 5/16-inch by 1 1/4-inch. Truss rods shall be 3/8-inch nominal diameter.

2.06 FABRIC TIES

- A. Wire ties shall be preformed 0.148-inch diameter (9 gauge) aluminum. Flat band type ties shall be 1100-H18 or 3003-H14, .064-inch thick by 1/2-inch wide.
- B. Hog rings for attaching tension wire to fabric shall be 0.105-inch diameter, Alloy 1100-H14.

2.07 GATES

- A. Gate frames shall be made of 2-inch O.D. ASTM F1083 pipe, 2.72 lbs. per foot hot dipped galvanized. Fabric shall match fence. Gate frames shall be welded or assembled with riveted corner castings. Gate frames shall be equipped with 3/8-inch diameter adjustable truss bars. Hinges shall be ball and socket.
- B. Vehicle access gate shall be a pair of 7' long by 6' high sections constructed of 2" O.D. pipe. Frame members shall not exceed 6" in length.
- C. Gate shall be equipped with a prop post center latch and hasp assembly. A ground anchor cast in concrete shall be provided.
- D. Gate shall be factory fabricated and equipped with gate hold backs. Panel shall have a horizontal brace at center of fabric.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. All line posts shall be spaced equidistant in the fence line on a maximum of 10-foot centers. Posts shall be set plumb in concrete bases as detailed on Drawings. The top of the posts shall be brought to a smooth grade line. The wire fence shall be set accurately to line and grade and shall be plumb.
- B. End, corner, pull or intermediate posts shall be placed in the following locations: corners; changes in direction; abrupt changes in grade; intervals no greater than 500 feet in the fence line. Each end or gate post shall have one brace assembly and each corner or intermediate post shall have two brace assemblies.
- C. Horizontal braces shall be provided at all terminal posts, corner posts, and intermediate posts between top rail and ground and shall extend from the above-mentioned posts to the first adjacent line posts. Braces shall be securely fastened to the line posts by brace ends and brace bands and to the terminal posts by approved rail end connectors. Diagonal brace rods shall be trussed from the brace end on the line post back to the terminal post, corner post or intermediate post and fastened to it by an approved connector.

3.02 POST FOUNDATIONS

- A. Post holes shall be in true alignment and of sufficient size to provide a permanent foundation of concrete. Holes shall be well centered on the posts. A minimum diameter of 12 inches shall be required for all posts.
- B. Post foundations shall be carefully rodded or tamped into place. The top of concrete shall extend 2 inches above ground line and shall be neatly troweled and leveled up from edges to the posts so as to have a pitch outward in all directions.
- C. No materials shall be installed on the posts, nor shall any load be applied to the posts within 3 days after the individual post foundation is completed.
- D. All concrete shall be Class "B" in conformance with Section 03300, Cast-in-Place Concrete.

3.04 PADLOCK AND KEYS

- A. One solid brass padlock shall be furnished with each gate. Padlocks shall be master keyed to the system specified under Section 08710, Finish Hardware.

3.05 TEMPORARY FENCING

- A. The Contractor shall furnish and install all temporary fencing and appurtenances as shown on the Drawings or as required during construction to adequately secure the site prior to installation of the permanent fence.

- END OF SECTION -

SECTION 02910

FINAL GRADING AND LANDSCAPING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, equipment, and materials necessary for final grading, topsoiling, seeding, and miscellaneous site work not included under other Sections, but required to complete the work as shown on the Drawings and specified herein. Under this Section, all areas of the project site disturbed by excavation, materials storage, temporary roads, etc., shall be reseeded as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02276 - Erosion and Sedimentation Control.
- B. Section 02500 - Surface Restoration.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Product Data
 - 2. Certification of all materials
 - 3. Three (3) copies of composition and germination certification and of test results for grass seed.

PART 2 -- PRODUCTS

2.01 CONTRACTOR'S RESPONSIBILITIES

- A. Furnish and submit certification for the materials used as specified in the General Conditions, Division 1 and Division 2.

2.02 TOPSOIL

- A. Upon completion and approval of the rough grading, the Contractor shall place the topsoil over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped. Topsoil shall not be placed in a frozen or muddy condition and shall contain no toxic materials harmful to grass growth. Topsoil shall be as defined under Section 02200, Earthwork.

2.03 WATER

- A. Water shall be furnished to the Contractor by the Owner from existing facilities as directed by the Engineer.
- B. The Contractor shall furnish all hoses and connections necessary to complete the landscaping work.

2.04 FERTILIZER

- A. Fertilizer shall be a complete commercial fertilizer with components derived from commercial sources. Fertilizer analysis shall be determined from field soil sampling in appropriate number taken by the Contractor and analyzed by the Clemson University Cooperative Extension Service or other independent laboratory. Contractor shall furnish fertilizer in accordance with the recommendations of the Clemson University Cooperative Extension Service.
- B. One-quarter of the Nitrogen shall be in the form of nitrates, one-quarter in the form of ammonia salts, and one-half in the form of natural organic Nitrogen. Available Phosphoric Acid shall be free from superphosphate, bone, or tankage. Potash shall be Sulphate of Potash. Elements shall conform to the standards of Association of Official Agricultural Chemists.
- C. Fertilizer shall be delivered in standard size bags marked with the weight, analysis of contents, and the name of the manufacturer. Fertilizer shall be stored in weatherproof storage areas and in such a manner that its effectiveness will not be impaired.

2.05 LIME

- A. At least 50% shall pass a No. 200 U.S.S. mesh sieve. At least 90% shall pass a No. 100 U.S.S. mesh sieve and 100% shall pass a No. 10 U.S.S. mesh sieve. Total carbonates shall not be less than 80% or 44.8% Calcium Oxide equivalent. For the purpose of calculation, total carbonates shall be considered as Calcium Carbonate.

2.06 GRASS SEED

- A. The Contractor shall furnish the kinds and amounts of seed to be seeded in all areas disturbed by the construction work. All seed shall be labeled to show that it meets the requirements of the South Carolina Code of Laws, Title 46, Chapter 21. All seed must have been tested within six (6) months immediately preceding the planting of such material on the job.
- B. The inoculant for treating legume seed shall be a pure culture of nitrogen-fixing bacteria prepared specifically for the species. Inoculants shall not be used later than the date indicated on the container. The quality of the seed shall conform to the following:

Type	Minimum Seed Purity (%)	Minimum Germination (%)	Maximum Weed Seed (%)
Fescue (fungus free)	98	90	1.00
Rye	98	85	0.10
Bahia grass	98	85	0.25
Millet	98	85	0.50

C. Seed containing prohibited noxious weed seed shall not be accepted. Seed shall be in conformance with South Carolina Code of Law restrictions for restricted noxious weeds.

D. Seed mixtures to be used on the project shall be as follows:

Schedule No.	Common Seed Name	Application Rate (lb/acre)	Planting Dates
TEMPORARY SEEDING			
1	Browntop Millet (Alone)	40	April 15 – August 31
2	Browntop Millet (Mix)	10	April 15 – August 31
3	Rye Grain (Alone)	56	September 1 – December 15 and February 1 – April 15
4	Rye Grain (Mix)	10	September 1 – December 15 and February 1 – April 15
5	Rye Grass (Alone)	50	September 1 – November 15
6	Rye Grass (Mix)	8	September 1 – November 15
FOR STEEP SLOPES/CUT SLOPES			
1	Weeping Lovegrass (Alone)	4	April 15 – July 31
2	Weeping Lovegrass (Mix)	2	April 15 – July 31

Notes

1. If pH in soil is less than 5.0, add 3,000 lb/acre of lime.
2. Add 500 lb/acre 10-10-10 fertilizer.
3. Add 3,000-4,000 lb/acre straw mulch.

Schedule No.	Common Seed Name	Application Rate (lb/acre)	Planting Dates
PERMANENT SEEDING			
1	Bahia Grass (Alone)	40	April 15 – July 20
2	Bahia Grass (Mix)	30	April 15 – July 20
3	Bermuda Grass, hulled (Alone)	8-12	May 10 – August 20
4	Bermuda Grass, hulled (Mix)	4-6	May 15 – August 31
5	Fescue, Tall (KY31) Alone	40	September 25 – December 20
6	Fescue, Tall (KY31) Mix	20	September 25 – December 20
7	Sericea Lespedeza (Scarified) Alone or Mix (inoculate with EL Inoculant)	40	May 1 – August 15
8	Ladino Clover (Mix only) Inoculate with AB Inoculant	2	September 25 – December 20
FOR STEEP SLOPES/CUT SLOPES			
1	Weeping Lovegrass (Alone)	4	May 1 – August 31
2	Weeping Lovegrass (Mix)	2	May 1 – August 31
3	Crownvetch (Mix) Inoculate with Type M Inoculant	8-10	March 20 – May 25

Notes

1. Add 3,000 lb/acre of ground course textured agricultural limestone.
2. Add 1,000 lb/acre 10-10-10 fertilizer.
3. Add 4,000 lb/acre straw mulch.

2.07 WOOD CELLULOSE FIBER MULCH

- A. For use in hydroseeding grass seed in combination with fertilizers and other approved additions, shall consist of especially prepared wood cellulose fibers such as "Conwed", "Mat-Fiber", or equal, and have no growth or germination inhibiting factors, and be dyed green.
- B. The wood cellulose fiber shall have the additional characteristic of dispersing rapidly in water to form a homogeneous slurry and remain in such state when agitated in the hydraulic mulching unit, or adequate equal, with the specified materials.

- C. When applied, the wood cellulose fiber with additives will form an absorptive mat but not a plant inhibiting membrane, which will allow moisture, natural or mechanical, to percolate into underlying soil.
- D. The mulch shall be supplied, compressed in packages containing 50 pounds of material having an equilibrium air dry moisture content at time of manufacture of 12% plus or minus 3%. Wood cellulose fiber mulch shall be stored in a weatherproof storage area and in such a manner that effectiveness will not be impaired.

2.08 STRAW MULCH

- A. Straw used for mulch shall be small grain hay. Hay shall be undamaged, air dry, threshed straw, free of undesirable weed seed. Straw mulch is not required for seeded areas treated with a temporary soil stabilizer.

2.09 TEMPORARY SOIL STABILIZER

- A. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as "Enviroseal 2001" by Enviroseal Corporation, "Terra Control" by Quattro Environmental, Inc., or "CHEM-CRETE ECO-110" by International CHEM-CRETE Corporation, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.

2.10 ROLLED EROSION CONTROL PRODUCTS

- A. The rolled erosion control products (RECPs) shall be as specified in Section 02276 - Erosion and Sedimentation Control.

2.11 RIPRAP

- A. Furnish and install sufficient quantity of landscape gravel or riprap to cover over the ground to a minimum 4-inch depth for gravel and 24-inch depth for riprap, unless otherwise noted, or indicated on the Drawings.
- B. During placing, the stone shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone.
- C. All topsoil and vegetative matter shall be removed from the subgrade surfaces prior to the placement of landscape gravel or riprap.

PART 3 -- EXECUTION

3.01 GRADING

- A. After approval of the rough grading, the Contractor shall commence his preparations of the subgrade for the various major conditions of the work as follows:

1. Bare soil for riprap area at subgrade (24-inches below final grade, or as directed by the Engineer).
 2. Topsoil for lawn and road shoulder seed area - scarify 2-inch depth of subgrade (4-inches below final grade) prior to placing topsoil.
- B. Final surface grading of the topsoiled, landscape graveled, and riprapped areas shall be mechanically raked or hand raked to an even finished surface alignment.

3.02 TOPSOIL

- A. Topsoil shall be spread in place for quantity required for lawn and road shoulder seed areas at 4-inch consolidated depth, and sufficient quantity for certain plant beds and backfill for shrubs and trees as specified.

3.03 SEEDBED PREPARATION

- A. Contractor shall prepare all areas to receive temporary or permanent seeding measures prior to planting.
- B. Topsoil shall be placed in areas to be seeded and roughened with tracked equipment or other suitable measures. Slopes steeper than 3:1 may be roughened by grooving, furrowing, tracking, or stairstep grading. Slopes flatter than 3:1 should be grooved by disking, harrowing, raking, operating planting equipment on the contour.
- C. Soil amendments including, but not limited to, lime and fertilizer shall be spread as necessary, and at the rates specified in this Section. Seeding shall be as per the type and rates specified in this Section. Seed shall be broadcast as soon as possible following roughening, before surface has been sealed by rainfall.

3.04 HYDROSEEDING AND GRASS

- A. The Contractor shall grow a stand of grass by hydroseeding method on all disturbed areas. The Contractor shall be responsible for the satisfactory growth of grass throughout the period of the one-year guarantee.
- B. The Contractor's work shall include the preparation of the topsoil and bare soil seed bed, application of fertilizer, limestone, mulching, inoculant, temporary soil stabilizer, watering, and all other operations necessary to provide a satisfactory growth of sod at the end of the one-year maintenance period. Areas without satisfactory sod at the end of one (1) year shall be replanted until satisfactory growth is obtained and acceptable to the Engineer.
- C. All areas to be seeded shall be done by the hydraulic seeding method including all additives and amendments required. A "Reinco", "Finn", or "Bowie" type hydromulcher with adjustable nozzles and extension hoses, or equal, shall be utilized. General capacity of tank should range from 500 to 2,500 gallons, or as approved by the Engineer.

- D. Hydraulic seeding shall be carried out in three steps. Step one shall consist of the application of lime. In step two the seed mixture shall be mixed with the fertilizer, wood cellulose fiber mulch, and any required inoculants and applied to the seed bed. Step three shall consist of application of top dressing during the first spring or fall, whichever comes first, after step two.
- E. Top dressing shall consist of a commercial grade fertilizer plus Nitrogen or other analysis as may be recommended by soil testing. Types and application rates of seed mixtures, lime, fertilizer, and wood cellulose fiber mulch, shall be as shown in the Seeding Schedule.
- F. Ingredients for the mixture and steps should be dumped into a tank of water and thoroughly mixed to a homogeneous slurry and sprayed out under a minimum of 300-350 pounds pressure, in suitable proportions to accommodate the type and capacity of the hydraulic machine to be used. Applications shall be evenly sprayed over the ground surface. The Contractor shall free the topsoil of stones, roots, rubbish, and other deleterious materials and dispose of same off the site. The bare soil, except existing steep embankment area, shall be rough raked to remove stones, roots, and rubbish over 4-inches in size, and other deleterious materials and dispose of same off the site.
- G. No seeding should be undertaken in windy or unfavorable weather, when the ground is too wet to rake easily, when it is in a frozen condition, or too dry. Any bare spots shown in two to three weeks shall be recultivated, fertilized at half the rate, raked, seeded, and mulched again by mechanical or hand broadcast method acceptable to the Engineer.
- H. Areas that have been seeded with a temporary seed mixture shall be mowed to a height of less than 2-inches and scarified prior to seeding with the permanent seed mixture.
- I. The Contractor shall provide, at his own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.
- J. The Contractor shall water newly seeded areas of the lawn and road shoulder mix once a week until the grasses have germinated sufficiently to produce a healthy turf, or unless otherwise directed by the Engineer. Each watering shall provide three (3) gallons per square yard. The Contractor shall furnish all necessary hoses, sprinklers, and connections.
- K. The first and second cutting of the lawn grasses only shall be done by the Contractor. All subsequent cuttings will be done by the Owner's forces in a manner specified by the Contractor.

3.05 DITCH AND SWALE EROSION PROTECTION

- A. All ditches and swales indicated on the Drawings shall be lined with a rolled erosion control product (RECP). The area to be covered shall be properly graded and hydroseeded before the RECP is installed. Installation shall be in accordance with Section 02276, Erosion and Sedimentation Control.

3.06 MAINTENANCE

- A. The Contractor shall be responsible for maintaining all seeded areas through the end of his warranty period. Maintenance shall include but not be limited to, annual fertilization, mowing, repair of seeded areas, irrigation, and weed control. The Contractor shall provide, at his own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.
- B. Annual fertilization shall consist of an application of 500#/acre of 10-10-10 commercial grade fertilizer, or its equivalent and 60#/acre of nitrogen in early fall, or other analysis as may be determined by soil test. Annual fertilization shall be in addition to top dressing and shall be performed by the Contractor each fall season after planting until the work is substantially complete.
- C. Mowing shall be scheduled so as to maintain a minimum stand height of 4-inches or as directed by the Engineer. Stand height shall be allowed to reach 8 to 10-inches prior to mowing.
- D. All seeded areas shall be inspected on a regular basis and any necessary repairs or reseeds made within the planting season, if possible. If the stand should be over 60% damaged, it shall be re-established following the original seeding recommendations.

3.07 CLEANUP

- A. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.
- B. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

3.08 SEEDING SCHEDULE

- A. All seeding and mulching to be completed by the Contractor shall conform to the schedule specified herein and on the Contract Drawings. Areas seeded with temporary seed mixtures shall be reseeded by the Contractor at no additional cost to the Owner with permanent seed as directed by the Engineer.
- B. Application rates of seed mixtures, lime, fertilizer, mulch and top dressing are provided in the schedule.

- END OF SECTION -

SECTION 03100
CONCRETE FORMWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03200 - Reinforcing Steel
- B. Section 03250 - Concrete Accessories
- C. Section 03290 - Joints in Concrete
- D. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. ACI 318 - Building Code Requirements for Structural Concrete
 - 3. ACI 301 - Specifications for Structural Concrete for Buildings
 - 4. ACI 347 - Recommended Practice for Concrete Formwork
 - 5. U.S. Product Standard for Concrete Forms, Class I, PS 1
 - 6. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Manufacturer's data on proposed form release agent
 - 2. Manufacturer's data on proposed formwork system including form ties

1.05 QUALITY ASSURANCE

- A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

PART 2 -- PRODUCTS

2.01 FORMS AND FALSEWORK

- A. All forms shall be smooth surface forms unless otherwise specified.
- B. Wood materials for concrete forms and falsework shall conform to the following requirements:
 - 1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.
 - 2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.
- C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

2.02 FORMWORK ACCESSORIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed mechanical EPDM rubber plug shall be used to seal the hole left after the removal of the taper tie. Plug shall be X-Plug by the Greenstreak Group, Inc., or approved equal. Friction fit plugs shall not be used.
- C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

PART 3 -- EXECUTION

3.01 FORM DESIGN

- A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.
- B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
- C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

3.02 CONSTRUCTION

- A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.
- B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.
- C. Forms shall be true to line and grade, and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.
- D. Forms shall be mortar tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form.
- E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that

it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

- F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.
- G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.
- H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.
- I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.
- J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.
- K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

3.03 TOLERANCES

- A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.
- B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.

- C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- D. Regardless of the tolerances specified, no portion of the building shall extend beyond the legal boundary of the building.

3.04 FORM ACCESSORIES

- A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.
- B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to water or enclosed surfaces above the water surface, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 - Concrete Finishing. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

3.05 APPLICATION - FORM RELEASE AGENT

- A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

3.06 INSERTS AND EMBEDDED ITEMS

- A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

3.07 FORM CLEANING AND REUSE

- A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.08 FORM REMOVAL AND SHORING

- A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.
- B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

Ambient Temperature (°F.) During Concrete Placement

	<u>Over 95°</u>	<u>70°-95°</u>	<u>60°-70°</u>	<u>50°-60°</u>	<u>Below 50°</u>
Walls	5 days	2 days	2 days	3 days	Do not remove until directed by Engineer (7 days minimum)
Columns	7 days	2 days	3 days	4 days	
Beam Soffits	10 days	7 days	7 days	7 days	
Elevated Slabs	12 days	7 days	7 days	7 days	

- C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.
- D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall be available for inspection at all times at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.

3.09 RESHORING

- A. When reshoring is permitted or required the operations shall be planned in advance and subjected to approval by the Engineer.
- B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.

- C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.
- D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.
- E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

- END OF SECTION -

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SECTION 03200
REINFORCING STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

- A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.
- B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 03400 - Precast Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice
 - 3. ACI SP66 - ACI Detailing Manual
 - 4. ACI 315 - Details and Detailing of Concrete Reinforcing
 - 5. ACI 318 - Building Code Requirements for Structural Concrete
 - 6. WRI - Manual of Standard Practice for Welded Wire Fabric
 - 7. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing
 - 8. ASTM A 1064 - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.
2. Mill test certificates - 3 copies of each.
3. Description of the reinforcing steel manufacturer's marking pattern.
4. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.
5. Proposed supports for each type of reinforcing.
6. Request to use splices not shown on the Drawings.
7. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.
8. Request for placement of column dowels without the use of templates.
9. Request and procedure to field bend or straighten partially embedded reinforcing.
10. International Code Council–Evaluation Services Evaluation Services Report (ICC-ES ESR) for dowel adhesives.
11. Certification that all installers of dowel adhesive are certified as Adhesive Anchor Installers in accordance with the ACI-CRSI Anchor Installer Certification Program.
12. Adhesive dowel testing plan.

1.05 QUALITY ASSURANCE

- A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.
- B. Installer Qualifications for Drilled-In Rebar: Drilled-in rebar shall be installed by an Installer with at least three years of experience performing similar installations. Installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.

- C. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process for drilled-in anchors, to include but not be limited to the following:
1. Hole drilling procedure.
 2. Hole preparation and cleaning technique.
 3. Adhesive injection technique and dispenser training/maintenance.
 4. Rebar doweling preparation and installation.
 5. Proof loading/torquing.
- D. Special inspections for adhesive dowels shall be conducted in accordance with the manufacturer's instructions and Specification Section 01450. Downward installations require periodic inspection and horizontal and overhead installations require continuous inspection.

PART 2 -- PRODUCTS

2.01 REINFORCING STEEL

- A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type and grade. All reinforcing bars shall be deformed bars. Smooth reinforcing bars shall not be used unless specifically called for on Drawings.
- B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 1064 and the details shown on the Drawings.
- C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.
- D. Field welding of reinforcing steel will not be allowed.
- E. Use of coiled reinforcing steel will not be allowed.

2.02 ACCESSORIES

- A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers and other devices to position reinforcing during concrete placement. Wire bar supports shall be plastic protected (CRSI Class 1).

- B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

2.03 DOWEL ADHESIVE SYSTEM

- A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions.
- B. All holes shall be drilled in accordance with the manufacturer's instructions except that core drilled holes shall not be permitted unless specifically allowed by the Engineer. Cored holes, if allowed by the manufacturer and approved by the Engineer, shall be roughened in accordance with manufacturer's requirements.
- C. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with manufacturer's instructions with compressed air and a wire brush prior to installation of adhesive and reinforcing bar.
- D. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water-saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer.
- E. Injection of adhesive into the hole shall be performed in a manner to minimize the formation of air pockets in accordance with the manufacturer's instructions.
- F. Embedment Depth:
 - 1. The embedment depth of the bar shall be as shown on the Drawings. Although all manufacturers listed below are permitted, the embedment depth shown on the Drawings is based on "Pure 110+" by Powers Fasteners" ESR 3298 issued 7/2016. If the Contractor submits one of the other named dowel adhesives from the list below, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.
 - 2. Where the embedment depth is not shown on the Drawings, the embedment depth shall be determined to provide the minimum allowable bond strength equal to the tensile strength of the rebar according to the manufacturer's ICC-ES ESR.
 - 3. The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long term temperature of 110 degrees F, and maximum short term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum, or more than the maximum, embedment depths stated in the manufacturer's ICC-ES ESR.
- G. Engineer's approval is required for use of this system in locations other than those shown on the Drawings.
- H. The adhesive system shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories and shall be "Epcon C6+ Adhesive Anchoring System" as manufactured by ITW Redhead, " HIT-HY 200 Adhesive Anchoring System" as

manufactured by Hilti, Inc. "SET-XP Epoxy Adhesive Anchors" as manufactured by Simpson Strong-Tie Co. or "Pure 110+ Epoxy Adhesive Anchor System" by Powers Fasteners. Fast-set epoxy formulations shall not be acceptable. No or equal products will be considered, unless pre-qualified and approved.

- I. All individuals installing dowel adhesive system shall be certified as an Adhesive Anchor Installer in accordance with the ACI-CRSI Anchor Installation Certification Program.

PART 3 – EXECUTION

3.01 TEMPERATURE REINFORCING

- A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.0033 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0020 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 18 inches.

3.02 FABRICATION

- A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.
- B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.
- C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved to be bent in the field. Reinforcing bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars will not be permitted.
- D. Welded wire fabric with longitudinal wire of W9.5 size or smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches. Welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.

3.03 DELIVERY, STORAGE AND HANDLING

- A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.
- B. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.
- C. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

- D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

3.04 PLACING

- A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or plastic protected (CRSI Class 1) metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.
- B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8 inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.
- C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
- D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.
- E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.
- F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.
- G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.
- H. Reinforcing shall not be straightened or rebent unless specifically shown on the drawings. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.
- I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations and as required in Article 2.04 above. A representative of the manufacturer must be on site prior to adhesive dowel installation to provide instruction on proper installation procedures for all adhesive dowel installers. Testing of adhesive dowels shall be as indicated below. If the dowels have a hook at the end to be embedded in subsequent work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate adhesive dowel testing while maintaining required hook embedment in subsequent work.

J. Adhesive Dowel Testing

1. At all locations where adhesive dowels are shown on the Drawings, at least 25 percent of all adhesive dowels installed shall be tested to the value indicated on the Drawings, with a minimum of one tested dowel per group. If no test value is indicated on the Drawings but the installed dowel is under direct tension, the Contractor shall notify the Engineer to verify the required test value.
2. Contractor shall submit a plan and schedule indicating locations of dowels to be tested, load test values and proposed dowel testing procedure (including a diagram of the testing equipment proposed for use) prior to conducting any testing. The testing equipment shall have a minimum of three support points and shall be of sufficient size to locate the edge of supports no closer than two times the anchor embedment depth from the center of the anchor.
3. Where Contract Documents indicate adhesive dowel design is the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of dowels to be tested and load test values, sealed by a Professional Engineer currently registered in the State of South Carolina. The Contractor shall also submit documentation indicating the Contractor's testing procedures have been reviewed and the proposed procedures are acceptable.
4. Adhesive Dowel shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the dowel after loading shall be considered a failure. Dowels exhibiting damage shall be removed and replaced. If more than 5 percent of tested dowels fail, then 100 percent of dowels shall be proof tested.
5. Proof testing of adhesive dowels shall be performed by an independent testing laboratory hired directly by the Contractor. The Contractor shall be responsible for costs of all testing, including additional testing required due to previously failed tests.

3.05 SPLICING

- A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.
- B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.
- C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

3.06 INSPECTION

- A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.

- B. The Contractor shall advise the Engineer of his intentions to place grout in masonry walls and shall allow him adequate time to inspect all reinforcing steel before grout is placed.

3.07 CUTTING OF EMBEDDED REBAR

- A. The Contractor shall not cut embedded rebar cast into structural concrete without prior approval.

- END OF SECTION -

SECTION 03250
CONCRETE ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, contraction joint inserts, and epoxy bonding agent.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03290 - Joints in Concrete
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Fillers, Sealants, and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- | | | |
|----|-------------|---|
| 1. | ASTM C881 | Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |
| 2. | ASTM D412 | Standard Tests for Rubber Properties in Tension |
| 3. | ASTM D 624 | Standard Test method for Rubber Property - Tear Resistance |
| 4. | ASTM D 638 | Standard Test Method for Tensile Properties of Plastics |
| 5. | ASTM D1751 | Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (nonextruding and resilient bituminous types) |
| 6. | ASTM D 1752 | Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |
| 7. | ASTM D 1171 | Standard Test Method for Ozone Resistance at 500 pphm |
| 8. | ASTM D 471 | Standard Test Method for Rubber Properties |

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Manufacturer's literature on all products specified herein including material certifications.
 - 2. Proposed system for supporting PVC waterstops in position during concrete placement
 - 3. Samples of products if requested by the Engineer.

PART 2 -- PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

- A. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.
- B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.
- C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.
- D. The required minimum physical characteristics for this material are:
 - 1. Tensile strength - 1,750 psi (ASTM D-638).
 - 2. Ultimate elongation - not less than 280% (ASTM D-638).
- E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.
- F. PVC waterstops shall be as manufactured by BoMetals, Inc., DuraJoint Concrete Accessories, or Sika Greenstreak.
- G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

2.02 RETROFIT WATERSTOPS

- A. Retrofit waterstops shall be used where specifically shown on Drawings for sealing joints between existing concrete construction and new construction.

- B. Retrofit waterstops shall be PVC waterstops fabricated from material as described in Section 2.01 of this Specification.
- C. Retrofit waterstop shall be attached to existing concrete surface as shown on Drawings.
- D. Use of split waterstop in lieu of specially fabricated retrofit waterstop will not be acceptable.
- E. Retrofit Waterstop manufacturer must provide a complete system including all Waterstop, stainless steel anchoring hardware, and epoxy for installation.
- F. For construction joints, retrofit waterstop shall be style number 609 by Sika Greenstreak, RF-638 by BoMetals, Inc., Type 18 kit by DuraJoint Concrete Accessories, or approved equal. For expansion joints, retrofit waterstop shall be style number 667 by Sika Greenstreak, RF-912 by BoMetals, Inc., Type 18-9 kit by DuraJoint Concrete Accessories, or approved equal.

2.03 HYPALON RUBBER WATERSTOPS

- A. Hypalon rubber waterstops shall be Sikadur Combiflex by Sika Corporation or approved equal. Minimum width of waterstop material shall be twelve (12) inches unless shown otherwise on Contract Drawings.

2.04 EXPANDING RUBBER WATERSTOP

- A. Expanding rubber shall be designed to expand under hydrostatic conditions. Waterstops shall be Adeka Ultra Seal MC-2010MN by Adeka Ultra Seal/OCM, Inc., or Hydrotite CJ-1020-2K by Sika Greenstreak, for concrete thickness greater than nine inches. For thicknesses less than nine inches, Adeka Ultra Seal KBA-1510FF or Hydrotite CJ-1020-2K shall be used.
- B. Waterstop shall be a chemically modified natural rubber product with a hydrophilic agent.
- C. Waterstop has a stainless steel mesh or coextrusion of non-hydrophilic rubber to direct expansion in the thickness direction and restrict the expansion in the longitudinal direction.

2.05 WATERSTOP ADHESIVE

- A. Adhesive between waterstops and existing concrete shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.
- B. Hydrophilic, non-bentonite water swelling elastic sealant shall be used to bond expanding rubber waterstops to rough surfaces. Hydrophilic elastic sealant shall be P-201 by Adeka Ultra Seal/OCM, Inc., Leakmaster LV-1 by Sika Greenstreak, or approved equal.

2.06 JOINT SEALANTS

- A. Joint sealants shall comply with Section 07900, Joint Fillers, Sealants, and Caulking.

2.07 EXPANSION JOINT MATERIAL

- A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:

1. Type I - Sponge rubber, conforming to ASTM D1752, Type I.
2. Type II - Cork, conforming to ASTM D1752, Type II.
3. Type III - Self-expanding cork, conforming to ASTM D1752, Type III.
4. Type IV - Bituminous fiber, conforming to ASTM Designation D1751.

2.08 CONTRACTION JOINT INSERTS

- A. Contraction joint inserts shall be Zip-Cap by Greenstreak Plastic Products, Zip-Joint by BoMetals, Inc. control joint formers.

2.09 EPOXY BONDING AGENT

- A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, MasterInject 1500 by BASF Master Builder Solutions (BASF).

2.10 EPOXY RESIN BINDER

- A. Epoxy resin binder shall conform to the requirements of ASTM C-881, Type III, Grade 3, Class B and C for epoxy resin binder and shall be Sikadur 23, Low-Mod-Gel, manufactured by the Sika Corporation, Lyndhurst, N.J., Flexocrete Gel manufactured by DuraJoint Concrete Accessories or Euco #352 Gel, Euclid Chemical Company, MasterEmaco ADH 327 or 327 RS by BASF Master Builder Solutions.

PART 3 -- EXECUTION

3.01 PVC WATERSTOPS

- A. PVC waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.
- B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.
- C. Splices in PVC waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and

transitions shall be used at all intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.

- D. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, discoloration, charring, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.
- E. Retrofit waterstops shall be installed as shown on Contract Drawings using approved waterstop adhesive and Type 316 stainless steel batten bars and expansion anchors.
- F. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:
 - 1. Tensile strength not less than 80 percent of parent material.
 - 2. Overlapped (not spliced) Waterstop.
 - 3. Misalignment of Waterstop geometry at any point greater than 1/16 inch.
 - 4. Visible porosity or charred or burnt material in weld area.
 - 5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

3.02 EXPANDING RUBBER WATERSTOPS

- A. Waterstops shall be installed only where shown on the Drawings.
- B. Waterstops shall be installed in strict accordance with manufacturer's recommendations.

3.03 WATERSTOP ADHESIVE

- A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.
- B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

3.04 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS

- A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.

- B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.
- C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.
- E. Type 1 joint sealant shall be used in all expansion and contraction joints in concrete, except where Type 7 or Type 8 is required as stated below, and wherever else specified or shown on the Drawings. It shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.
- F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.
- G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

3.05 CONTRACTION JOINT INSERTS

- A. For contraction joints in slabs, inserts shall be floated in fresh concrete during finishing.
- B. For contraction joints in walls, inserts shall be secured in place prior to casting wall.
- C. Inserts shall be installed true to line at the locations of all contraction joints as shown on the Drawings.
- D. Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290, Joints in Concrete.
- E. Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

3.06 EPOXY BONDING AGENT

- A. The Contractor shall use an epoxy bonding agent for bonding fresh concrete to existing concrete as shown on the Drawings.
- B. Bonding surface shall be clean, sound and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.

- C. Application of bonding agent shall be in strict accordance with manufacturer's recommendations.
- D. Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

3.07 EPOXY RESIN BINDER

- A. Epoxy resin binder shall be used to seal all existing rebar cut and burned off during demolition operations. Exposed rebar shall be burned back 1/2-inch minimum into existing concrete and the resulting void filled with epoxy resin binder.

- END OF SECTION -

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SECTION 03290

JOINTS IN CONCRETE

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

- A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.
- B. Types of joints in concrete shall be as follows:
 - 1. Construction Joints - Joints between adjacent concrete placements continuously connected with reinforcement.
 - 2. Expansion Joints - Joints in concrete which allow thermal expansion and contraction of concrete. Reinforcement terminates within concrete on each side of joint.
 - 3. Contraction Joints - Joints formed in concrete to provide a weakened plane in concrete section to control formation of shrinkage cracks.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 318 - Building Code Requirements for Structural Concrete
 - 3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
 - 4. ACI 224.3 – Joints in Concrete Construction

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Layout drawings showing location and type of all joints to be placed in each structure.
 - 2. Details of proposed joints in each structure.
 - 3. For sawcut contraction joints submit documentation indicating the following:
 - a. Proposed method of sawcutting indicating early entry or conventional sawing.
 - b. Description of how work is to be performed including equipment to be utilized, size of crew performing the work and curing methods.
 - c. Description of alternate method in case of time constraint issues or failure of equipment.

PART 2 -- MATERIALS

2.01 MATERIALS

- A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories, and Section 07900 - Joint Fillers, Sealants and Caulking.

PART 3 -- EXECUTION

3.01 CONSTRUCTION JOINTS

- A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and its location to Engineer for approval.
- B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- C. Maximum distance between horizontal joints in slabs and vertical joints in walls shall be 45'-0". For exposed walls with fluid or earth on the opposite side, the spacing between vertical and horizontal joints shall be a maximum of 25'-0".
- D. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.

- E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.
- F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

3.02 EXPANSION JOINTS

- A. Size and location of expansion joints shall be as shown on the Drawings.
- B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250, Concrete Accessories.

3.03 CONTRACTION JOINTS

- A. Location of contraction joints shall be as shown on the Drawings.
- B. Contraction joints shall be formed either by sawcutting or with contraction joint inserts as specified in Section 03250, Concrete Accessories. Sawcutting of joints will not be permitted unless specifically approved by the Engineer.
- C. If approved by the Engineer, sawcutting of contraction joints in lieu of forming shall conform to the following requirements:
 - 1. Joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.
 - 2. Curing shall be performed using wet curing methods as indicated in Section 03370 – Concrete Curing. Curing mats, fabrics or sheeting materials shall remain in place to the extent possible while cutting of joint is being performed. Curing materials shall only be removed as required and shall be immediately reinstalled once cutting of the joint has been completed.
 - 3. Depth of joint shall be as shown on the drawings or noted in these specifications. At locations where the joint cannot be installed to full depth due to curbs or other stopping points hand tools shall be used to complete joints.
 - 4. Saw cut joints shall meet the requirements of ACI 224.3, Section 2.8, Jointing Practice.
- D. Unless noted otherwise on Drawings, depth of contraction joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

3.04 JOINT PREPARATION

- A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.
- C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.
- D. All joints shall be sealed as shown on the Drawings and specified in Section 03250, Concrete Accessories.

- END OF SECTION -

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Provide all labor, equipment, materials and services necessary for the manufacture, transportation and placement of all plain and reinforced concrete work, as shown on the Drawings or as ordered by the Engineer.
- B. The requirements in this section shall apply to the following types of concrete:
 - 1. Class A1 Concrete: Normal weight structural concrete to be used in all structures qualifying as environmental concrete structures that are designed in accordance with ACI 350 including pump stations, tanks, basins, process structures, and any structures containing fluid or process chemicals or other materials used in treatment process.
 - 2. Class A2 Concrete: Normal weight structural concrete in all structures other than structures qualifying as environmental concrete structures as described above, and for all sidewalks and pavement.
 - 3. Class A4 Concrete: Normal weight structural concrete to be used where specifically called for on Contract Drawings or areas where specifically requested by Contractor and approved by Engineer. Class A4 concrete is identical to Class A2 concrete except that coarse aggregate specified in Article 2.05 below shall be Size #8 in accordance with ASTM C33.
 - 4. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03200 - Reinforcing Steel
- C. Section 03250 - Concrete Accessories
- D. Section 03290 - Joints in Concrete
- E. Section 03350 - Concrete Finishes
- F. Section 03370 - Concrete Curing

G. Section 03600 - Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. International Building Code with SC Modifications
2. ACI 214 Guide to Evaluation of Strength Test Results of Concrete
3. ACI 301 Specifications for Structural Concrete
4. ACI 304 Guide for Measuring, Mixing, Transporting, and Placing Concrete
5. ACI 305 Guide to Hot Weather Concreting
6. ACI 306 Guide to Cold Weather Concreting
7. ACI 309 Guide for Consolidation of Concrete
8. ACI 318 Building Code Requirements for Structural Concrete and Comentary
9. ACI 350 Code Requirements for Environmental Engineering Concrete Structures
10. ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
11. ASTM C 33 Standard Specification for Concrete Aggregates
12. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
13. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
14. ASTM C 88 Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
15. ASTM C 94 Standard Specification for Ready-Mixed Concrete
16. ASTM C 114 Standard Test Method for Chemical Analysis of Hydraulic Cement
17. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

18.	ASTM C 138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
19.	ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
20.	ASTM C 150	Standard Specification for Portland Cement
21.	ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
22.	ASTM C 192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
23.	ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
24.	ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
25.	ASTM C 295	Standard Guide for Petrographic Examination of Aggregates for Concrete
26.	ASTM C 457	Standard Test Method for Microscopical Determination of the Air-Void System in Hardened Concrete
27.	ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
28.	ASTM C 595	Standard Specification for Blended Hydraulic Cements
29.	ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
30.	ASTM C 989	Standard Specification for Slag Cement for Use in Concrete and Mortars
31.	ASTM C 1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
32.	ASTM C 1260	Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
33.	ASTM C 1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
34.	ASTM C 1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
35.	ASTM C 1778	Reducing the Risk of Deleterious Alkali – Aggregate Reaction in Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Sources of all materials and certifications of compliance with specifications for all materials.
2. Certified current (less than 1 year old) chemical analysis of the Portland Cement or Blended Cement to be used.
3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.
4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, potential reactivity, aggregate soundness tests, petrographic analysis, mortar bar expansion testing, etc.
5. Manufacturer's data on all admixtures stating compliance with required standards.
6. Concrete mix design for each class of concrete specified herein.
7. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.

1.05 QUALITY ASSURANCE

- A. Tests on materials used in the production of concrete shall be required as specified in PART 2 -- PRODUCTS. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.
- B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner.
- C. Field quality control tests, as specified in Article 3.10, unless otherwise stated, will be performed by a materials testing consultant employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

1.06 CONCRETE COORDINATION CONFERENCE

- A. Unless waived by the Engineer, prior to any concrete submittals and at least 35 days prior to the start of the concrete construction schedule, the Contractor shall conduct a meeting at the site. The purpose of the meeting is to review the proposed concrete mix designs, to discuss the proposed approaches and procedures for mixing, transporting, placing, testing, finishing, and curing of all aspects of concrete work to ensure the concrete construction is performed in accordance with the Specifications, and to clarify roles of the parties involved. The Contractor shall send a concrete coordination conference agenda to all attendees 20 days prior to a mutually agreed upon date for the conference.

- B. As a minimum the agenda shall include:
1. Concrete Materials and Mix Designs
 2. Inspection Responsibilities
 3. Concrete Sampling and Testing Specification Requirements
 4. Cylinder Storage and Transportation
 5. Acceptance/Rejection Responsibility and Authority for Fresh Concrete
 6. Concrete finishing
 7. Concrete Curing
 8. Test Report Distribution
 9. Miscellaneous Items
- C. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:
1. Contractor's superintendent
 2. Engineer
 3. Owner's representative (if he chooses to attend)
 4. Laboratory retained for trial batching and construction quality control testing for the concrete.
 5. Any subcontractors involved in placing, finishing, and curing of concrete
 6. Concrete supplier
 7. Concrete pumping subcontractor (if pumping is being proposed)
- D. Minutes of the meeting shall be recorded, typed, and printed by the Contractor and distributed to all attendees and any other concerned parties within five days of the meeting.

PART 2 -- PRODUCTS

2.01 HYDRAULIC CEMENT

- A. Portland Cement

1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.02 or 2.03 respectively.
2. When potentially reactive aggregates as defined in Article 2.05 are to be used in concrete mix, cement shall meet the following requirements:
 - a. For concrete mixed with only Portland Cement, the total alkalies in the cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.60%.
 - b. For concrete mixed with Portland Cement and an appropriate amount of fly ash (Article 2.02) or slag cement (Article 2.03) the total alkalies in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%.
3. When non-reactive aggregates as defined in Article 2.05 are used in concrete mix, total alkalies in the cement shall not exceed 1.0%.
4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

B. Blended Cement

1. Blended cements shall be Type IP (Portland Fly Ash Cement) or Type IS (Portland Slag Cement) conforming to ASTM C 595.
2. Type IP cement shall be an interground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.
3. Type IS cement shall be an interground blend of Portland Cement and slag cement in which the slag constituent is between 35% and 50% of the weight of the total blend.
4. Fly ash and slag cement used in the production of blended cements shall meet the requirements of Articles 2.02 and 2.03, respectively.
5. When reactive aggregates as defined in Article 2.05 are used in concrete mix, the total alkalies in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%. The percentage of fly ash or slag cement shall be set to meet provisions of Article 2.05.G.3.

C. Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

D. Cement shall be stored in a suitable weather-tight building so as to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

2.02 FLY ASH

- A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618.
- B. For fly ash to be used in the production of type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.
- C. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.
- D. For Type A1 concrete as required for use in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

2.03 SLAG CEMENT

- A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.
- B. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the slag cement constituent shall be between 35% and 40% of the total weight of the combined Portland Cement and slag. The percentage of slag cement shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.
- C. For Type A1 concrete as required for use in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- D. Additional slag cement shall not be included in concrete mixed with type IS or IP cement.

2.04 WATER

- A. Water used for mixing concrete shall be clear, potable and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts and other impurities.
- B. Water shall not contain more than 100 PPM chloride.
- C. Water shall not contain more than 500 PPM dissolved solids.
- D. Water shall have a pH in the range of 4.5 to 8.5.
- E. Water shall meet requirements of ASTM C 1602.

2.05 AGGREGATES

- A. All aggregates used in normal weight concrete shall conform to ASTM C 33.
- B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.
- C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.
- D. For Class A4 concrete, coarse aggregate shall be Size #8 in accordance with ASTM C33.
- E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.
- F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using either magnesium sulfate or sodium sulfate.
- G. All aggregates shall be evaluated in accordance with ASTM C 1778 to determine potential reactivity. All aggregates shall be considered reactive unless they meet the requirements below for non-reactive aggregates. Aggregates with a lithology essentially similar to sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.

- 1. Non-reactive aggregates shall meet the following requirements:

A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:

- (a) Optically strained, microfractured, or microcrystalline quartz, 5.0%, maximum.
- (b) Chert or chalcedony, 3.0%, maximum.
- (c) Tridymite or cristobalite, 1.0%, maximum.
- (d) Opal, 0.5%, maximum.
- e) Natural volcanic glass in volcanic rocks, 3.0%, maximum.

- 3. Concrete mix with reactive aggregate shall meet the following requirements:

If aggregates are deemed potentially reactive as per ASTM C-1778 and fly ash or slag cement is included in proposed concrete mix design, proposed concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.

If aggregates are deemed potentially reactive as per ASTM C-1778 and a straight cement mix without fly ash or slag cement is proposed for concrete mix design, aggregates shall be evaluated by ASTM C-1260. Mean mortar bar expansions at 16 days shall be less than 0.08%.

- H. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

2.06 STRUCTURAL MACRO FIBERS

- A. Structural macro fibers shall meet requirements of ASTM C 1116 with a minimum length of 2 inches, an aspect ratio between 50 and 90, and a minimum toughness rating R10, 50=60 (approximate) in accordance with ASTM C 1609. Fibers shall be used only where specifically required on Contract Drawings or where specifically approved by Engineer.
- B. Acceptable structural macro fibers are Tuf Strand SF by the Euclid Chemical Company, Strux 90/40 by W.R. Grace, or equal.

2.07 ADMIXTURES

- A. Air entraining agent shall be added to all concrete unless noted otherwise. The agent shall consist of a neutralized vinsol resin solution or a purified hydrocarbon with a cement catalyst which will provide entrained air in the concrete in accordance with ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be obtained and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.
- B. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set. Admixtures permitted shall conform to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.
 - 1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are "Eucon Series" by the Euclid Chemical Company, "Master Pozzolite Series" by BASF, and "Plastocrete Series" by Sika Corporation.
 - 2. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at either the batch plant or at the job site and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100

mixer revolutions after the addition of the high range water reducer. Acceptable products are "Eucon 37" or Plastol 5000 by the Euclid Chemical Company, "Master Rheobuild 1000 or Master Glenium Series" by BASF, and "Daracem 100 or Advaflow Series" by W.R. Grace.

3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E, and shall not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are "Accelguard 80/90 or NCA" by the Euclid Chemical Company and "Daraset" by W.R. Grace.
 4. A water reducing retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type D and shall not contain more than 0.05% chloride ions. Acceptable products are "Eucon NR or Eucon Retarder 100" by the Euclid Chemical Company, "Pozzolith Retarder" by BASF, and "Plastiment" by Sika Corporation.
- C. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted. The addition of admixtures to prevent freezing is not permitted.
- D. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review.

2.08 CONCRETE MIX DESIGN

- A. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete strength results shall be from concrete mixed with all of the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. Contractor shall submit verification confirming this stipulation has been followed. Field experience records and/or trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.
- B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.

1. Compressive Strength (28-Day)

- | | |
|--------------------------|---------------------|
| a. Concrete Class A1 | 4,500 psi (minimum) |
| b. Concrete Class A2, A4 | 4,000 psi (minimum) |
| c. Concrete Class B | 3,000 psi (minimum) |

2. Water/cementitious materials ratio, by weight

	Maximum	Minimum
a. Concrete Class A1	0.42	0.39
b. Concrete Class A2, A4	0.45	0.39
c. Concrete Class B	0.50	0.39

3. Slump range 4" nominal unless high range water reducing admixture is used.
8" max if high range water reducing admixture is used.

4. Air Content

a. Class A1, A2, A4	6% ±1.5%
b. Class B	3% Max (non air-entrained)

PART 3 -- EXECUTION

3.01 TRIAL MIXES

- A. When trial mixes are used to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350, an independent qualified testing laboratory designated and retained by the Contractor shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PART 2 -- PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.
- B. The independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and unit weight (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. _____, Product _____." If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

3.02 PRODUCTION OF CONCRETE

- A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready mix plant or from a site mixed plant. In selecting the source for concrete production the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.
- B. Ready-Mixed Concrete
1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.
 2. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
 3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
 4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
 5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed before the drum has been revolved 300 revolutions and within the time requirements stated in Article 3.03 of this Section.
 6. Each and every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:
 - a. Date and truck number
 - b. Ticket number
 - c. Mix designation of concrete
 - d. Cubic yards of concrete
 - e. Cement brand, type and weight in pounds
 - f. Weight in pounds of fine aggregate (sand)
 - g. Weight in pounds of coarse aggregate (stone)

- h. Air entraining agent, brand, and weight in pounds and ounces
 - i. Other admixtures, brand, and weight in pounds and ounces
 - j. Water, in gallons, stored in attached tank
 - k. Water, in gallons, maximum that can be added without exceeding design water/cementitious materials ratio
 - l. Water, in gallons, actually used (by truck driver)
 - m. Time of loading
 - n. Time of delivery to job (by truck driver)
7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.
 8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Scales for weighing concrete ingredients shall be accurate when in use within ± 0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.
2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:

a. Cement, fly ash, or slag cement	± 1 percent
b. Water	± 1 percent
c. Aggregates	± 2 percent
d. Admixtures	± 3 percent
3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.
4. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.
5. Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

6. Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.
7. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.
8. Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.
9. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.
10. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.
11. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.
12. Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.
13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

3.03 CONCRETE PLACEMENT

- A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.
- B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures which are subsequently required.
- C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture or cement grout shall be placed with a

slump not less than 8 inches for the initial placement at the base of the wall. Concrete or cement grout shall meet all strength and service requirements specified herein for applicable class of concrete. This concrete shall be worked well into the irregularities of the hard surface.

- D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.
- E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided that the design water-cementitious materials ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix that meets all specified requirements.
- F. Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.09 of this Section.
- G. Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise.
- H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds. Concrete shall be placed in all forms in such way as to prevent any segregation.
- I. Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.
- J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet and a sufficient number shall be placed in the form to ensure the concrete is kept level at all times.
- K. When placing concrete which is to be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.
- L. Concrete shall be placed so as to thoroughly embed all reinforcement, inserts, and fixtures.

- M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. To achieve this, concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.
- N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in the area of freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.
- O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration, however, shall not be continued in any one location to the extent that pools of grout are formed.
- P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.
- Q. To prevent feathered edges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.
- R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators so as to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations from the aforementioned to the Engineer for review and approval.
- S. Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

3.04 PLACING FLOOR SLABS ON GRADE

- A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed

until the depth and character of the foundation soils have been inspected and approved by the materials testing consultant.

- B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50° long enough to remove all frost from the subgrade.
- C. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.
- D. Thirty-pound felt paper shall be provided between edges of slab-on-grade and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.
- E. Contraction joints shall be provided in slabs-on-grade at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03290 - Joints in Concrete.
- F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03350 - Concrete Finishes. Interior floor slabs shall be placed with non-air-entrained concrete (Class A3) if a steel troweled or hardened finish is required.

3.05 PLACING CONCRETE UNDERWATER (CLASS A5 CONCRETE)

- A. Placing concrete underwater (tremie concrete) will be permitted only when shown on the Drawings. Concrete deposited under water shall be carefully placed in a compacted mass in final position by means of a tremie, a closed bottom dump bucket or other approved method. Care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. Underwater formwork shall be watertight. The consistency of the concrete shall be regulated to prevent segregation of materials. The method of depositing concrete shall be regulated such that the concrete enters the mass of the previously placed concrete from within, displacing water with a minimum disturbance to the surface of the concrete.
- B. Tremie shall consist of a tube having a diameter of not less than 10 inches and constructed in sections having flanged couplings fitted with gaskets. The tremie shall be supported to permit free movement of the discharge and over the entire top surface of the work and shall permit rapid lowering when necessary to choke off or retard the flow. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The flow shall be continuous until the placement has been completed.

3.06 PLACING CONCRETE UNDER PRESSURE

- A. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be

used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

- B. Priming of the concrete pumping equipment shall be with cement grout only. Use of specialty mix pump primers or pumping aids will not be allowed.
- C. No aluminum parts shall be in contact with the concrete during the entire placing of concrete under pressure at any time.
- D. Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a materials testing consultant proving the proposed mix meets all requirements. In addition, an actual pumping test under field conditions is required prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used; the same pump and operator shall be present and the pipe and pipe layouts will reflect the maximum height and distance contemplated. All submissions shall be subject to approval by the Engineer.
- E. If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- F. The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.
- G. The minimum diameter of the hose (conduits) shall be four inches.
- H. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.
- I. Concrete samples for quality control in accordance with Article 3.10 will be taken at the placement (discharge) end of the line.

3.07 ORDER OF PLACING CONCRETE

- A. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

3.08 CONCRETE WORK IN COLD WEATHER

- A. Cold weather concreting procedures shall conform to the requirements of ACI 306.
- B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed

shall not exceed the aforementioned minimum values by more than 20°F, unless otherwise approved by the Engineer.

- C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature in excess of 100°F. in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.09 CONCRETE WORK IN HOT WEATHER

- A. Hot weather concreting procedures shall conform to the requirements of ACI 305.
- B. When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the Contractor and his concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation and the Engineer reserves the right to modify the proposed measures consistent with the requirements of this Section of the Specifications. All necessary materials and equipment shall be on hand and in position prior to each placing operation.
- C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.
- D. The temperature of the concrete mix when placed shall not exceed 90°F.
- E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.
- F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched.
- G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

3.10 QUALITY CONTROL

- A. Field Testing of Concrete
 - 1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the materials testing consultant personnel as required for concrete testing.

2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall provide assistance to the materials testing consultant in obtaining samples. The Contractor shall dispose of and clean up all excess material.

B. Consistency

1. The consistency of the concrete will be checked by the materials testing consultant by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer and/or the materials testing consultant may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material or labor costs due to such eventualities.
2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.
3. Concrete with a specified nominal slump shall be placed having a slump within 1" (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Unit Weight

1. Samples of freshly mixed concrete shall be tested for unit weight by the materials testing consultant in accordance with ASTM C 138.
2. Unit weight tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the materials testing consultant in accordance with ASTM C 231.
2. Air content tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.
3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the materials testing consultant and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein.

2. In general, one sampling shall be taken for each placement in excess of five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.
3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The materials testing consultant will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.
4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders for testing. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens from falling over, being jarred or otherwise disturbed during the period of initial curing. The box shall be erected, furnished and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds and such that all specimen are shielded from direct sunlight and/or radiant heating sources. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.
5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of test specimens with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day curing box contains test specimens. Temperature shall be recorded a minimum of three times a day with one recording at the start of the work day and one recording at the end of the work day.
6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.
7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.
2. The strength level of concrete will be considered satisfactory if all of the following conditions are satisfied.

- a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.08).
 - b. No individual compressive strength test results falls below the minimum specified strength by more than 500 psi.
- 3. In the event any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.
- 4. In the event that condition 2B is not met, additional tests in accordance with Article 3.10, paragraph H shall be performed.
- 5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:
 - a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.
 - b. Maintain or add temporary structural support as required.
 - c. Correct the mix for the next concrete placement operation, if required to remedy the situation.
- 6. All concrete which fails to meet the ACI requirements and these specifications is subject to removal and replacement at no additional cost to the Owner.
- G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.
- H. Additional Tests
 - 1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.
 - 2. In the event the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.10, paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.
 - a. Three cores shall be taken for each sample in which the strength requirements were not met.
 - b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by a materials testing consultant approved by the Engineer.
 - c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is

perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.

- d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.
 - e. The diameter of core specimens should be at least 3 times the maximum nominal size of the coarse aggregate used in the concrete, but must be at least 2-inches in diameter.
 - f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.
 - g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.
 - h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.
3. In the event that concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage a materials testing consultant approved by the Engineer, to obtain and test samples for air content in accordance with ASTM Specification C 457.

3.11 CARE AND REPAIR OF CONCRETE

- A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.
- B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed.
- C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed.
- D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the

concrete. Structural cracks shall be repaired using an approved epoxy injection system. Non-structural cracks shall be repaired using an approved hydrophilic resin pressure injected grout system, unless other means of repair are deemed necessary and approved. All repair work shall be performed at no additional cost to the Owner.

- E. Concrete which fails to meet the strength requirements as outlined in Article 3.10, paragraph F, will be analyzed as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be as directed by the Engineer.

- END OF SECTION -

SECTION 03350
CONCRETE FINISHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 – Concrete Formwork
- B. Section 03300 – Cast-in-Place Concrete
- C. Section 03600 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 – Specifications for Structural Concrete for Buildings
 - 2. ACI 318 – Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300 – Submittals.
 - 1. Manufacturer's literature on all products specified herein.

PART 2 -- PRODUCTS

2.01 CONCRETE FLOOR SEALER

- A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, MasterKure CC 300 SB by BASF Master Builder Solutions.

2.02 CONCRETE LIQUID DENSIFIER AND SEALANT

- A. Concrete liquid densifier and sealant shall be a high performance, deeply penetrating concrete densifier and sealant. Product shall be odorless, colorless, VOC-compliant, non-yellowing silicate based solution designed to harden, dustproof and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete surfaces. The product must contain a minimum solids content of 20% of which 50% is silicate. Acceptable products are Diamond Hard by the Euclid Chemical Company, Seal Hard by L&M Construction Chemicals and MasterKure HD 210 WB by BASF Master Builder Solutions.

2.03 NON-METALLIC FLOOR HARDENER

- A. The specified non-metallic mineral aggregate hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a factory-blended mixture of specifically processed graded mineral aggregate, selected Portland cement, and necessary plasticizing agents. Acceptable products shall be "Surflex" by the Euclid Chemical Company, "Harcot" by Sonneborn, "Maximent" by BASF, and "Mastercon" by BASF.

2.04 NON-OXIDIZING HEAVY DUTY METALLIC FLOOR HARDENER

- A. Non-oxidizing heavy duty metallic floor hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specifically processed non-rusting aggregate, selected Portland cement, and necessary plasticizing agents. Product shall be "Diamond-Plate" by the Euclid Chemical Company, or Masterplate by BASF Construction Chemicals.

2.05 NON-SLIP FLOORING ADDITIVE

- A. Non-slip flooring additives for slip resistant floors shall be non-metallic. Non-slip flooring additives shall be Frictex NS by BASF Construction Chemicals, A-H Aloxy by Anti-Hydro, or Euco Grip by the Euclid Chemical Company.

PART 3 -- EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

- A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.
 - 1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than 1/4-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than 1/4-inch in any dimension. Honeycombs shall be chipped

back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.
3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type II finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

- A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.
 1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a concrete rake to 1/2" minimum deep grooves prior to final set.
 2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.
 3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.

4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.
5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.
6. Type "F" - Swept in Grout Topping: This finish shall be applied after a completion of a Type "A" finish. The concrete surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. Cement grout in accordance with Section 03600 shall then be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention shall be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation and obtain approval and recommendations.
7. Type "G" Hardened Finish: This finish shall be applied after completion of a Type "B" or Type "C" finish and prior to application of a Type "D" finish. Hardeners shall be applied in strict accordance with the manufacturer's requirements. Hardeners shall be applied using a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type "D" finish shall be applied following completion of application of the hardener.
 - a. Non-metallic floor hardener shall be applied where specifically required on the Contract Drawings at the rate of 1.0 pounds/ft.².
 - b. Non-oxidizing heavy duty metallic floor hardener shall be applied at the loading docks and where specifically required on the Contract Drawings or specified herein at the rate of 1.5 pounds/ft.².
8. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip flooring additive concurrently with the application of a Type "D" finish and/or installation of floor sealants. Application procedure shall be in accordance with manufacturer's instructions. Finish shall be applied where specifically required on the Contract Drawings or specified herein.
9. Type "J" - Raked Finish: This finish shall be provided by raking the surface as soon as the condition of the concrete permits by making depressions of $\pm 1/4$ inch.

3.03 CONCRETE SEALERS

- A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.
- B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.
- C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.
- D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.
- E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 FINISHES ON EQUIPMENT PADS

- A. Formed surfaces of equipment pads shall receive a Type III finish.
- B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 CONCRETE FINISH SCHEDULE

Item	Type of Finish
Concrete surfaces indicated to receive textured coating (as noted on Drawings and in Section 09800, Special Coatings)	I
Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures:	
From 1 feet below water surface to bottom of wall	II
From top of wall to 1 feet below water surface	II
Exterior concrete walls below grade	I
Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere	II
All interior exposed concrete walls and vertical surfaces	III
Interior exposed ceiling, including beams	III
Floors of process equipment tanks or basins, wetwells, flow channels and slabs to receive roofing material or waterproof membranes	B

All interior finish floors of buildings and structures and walking surfaces which will be continuously or intermittently wet	D
All interior finish floors of buildings and structures which are not continuously or intermittently wet	D
Floors to receive tile, resilient flooring, or carpeting	D
Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather	E
Floors of process equipment tanks indicated on Drawings to receive grout topping	F
Garage, storage area floors, and loading docks	G
Precast concrete form panels, hollow core planks, double tees	J

- END OF SECTION -

SECTION 03370
CONCRETE CURING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 – Concrete Formwork
- B. Section 03300 – Cast-In-Place Concrete
- C. Section 03350 – Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 – Specifications for Structural Concrete for Buildings
 - 2. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 3. ACI 305 – Hot Weather Concreting
 - 4. ACI 306 – Cold Weather Concreting
 - 5. ACI 308 – Standard Practice for Curing Concrete
 - 6. ASTM C171 – Standard Specifications for Sheet Materials for Curing Concrete
 - 7. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 8. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.

1. Proposed procedures for protection of concrete under wet weather placement conditions.
2. Proposed normal procedures for protection and curing of concrete.
3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.
4. Proposed method of measuring concrete surface temperature changes.
5. Manufacturer's literature and material certification for proposed curing compounds.

PART 2 -- PRODUCTS

2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

- A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m² when applied at 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, MasteKure CC 300 SB by BASF Master Builder Solutions, and Cure & Seal 30 Plus by Symons Corporation.
- B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurez DR VOX" or "Kurez W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

2.02 EVAPORATION REDUCER

- A. Evaporation reducer shall be BASF, "MasterKure ER 50", or Euclid Chemical "Euco-Bar".

PART 3 -- EXECUTION

3.01 PROTECTION AND CURING

- A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.
- B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.
- C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.

- D. The Contractor shall use one of the following methods to insure that the concrete remains in a moist condition for the minimum period stated above.
 - 1. Ponding or continuous fogging or sprinkling.
 - 2. Application of mats or fabric kept continuously wet.
 - 3. Continuous application of steam (under 150°F).
 - 4. Application of sheet materials conforming to ASTM C171.
 - 5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.
- E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.
- F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

- A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.
- B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.
- C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.
- D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

- A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sun shades and/or windbreakers shall be erected to

guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.

- B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.
- C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.
- D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least six (6) additional days using one of the methods listed in paragraph 3.01D.
- E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

- A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.
- B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.
- C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

3.05 EARLY TERMINATION OF CURING

- A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:
 - 1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.

2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

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SECTION 03400

PRECAST CONCRETE

PART 1 -- GENERAL

1.01 REQUIREMENTS

- A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02604 - Utility Structures
- B. Section 03200 - Reinforcing Steel
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 03350 - Concrete Finishes
- E. Section 03370 - Concrete Curing
- F. Section 03600 - Grout
- G. Section 05010 - Metal Materials
- H. Section 05035 - Galvanizing
- I. Section 05050 - Metal Fastening
- J. Section 05830 - Bearing Devices

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the end of the Bid.
 - 1. International Building Code with SC Modifications
 - 2. ACI 318-Building Code Requirements for Structural Concrete
 - 3. PCI Standard MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products
 - +

4. PCI Design Handbook

1.04 SUBMITTALS

- A. The Contractor shall submit the following for review in accordance with Section 01300, Submittals.
 1. Shop drawings for all precast concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.
 2. A list of the design criteria used by the manufacturer for all manufactured, precast items.
 3. Design calculations, showing at least the design loads and stresses on the item, shall be submitted. Calculations shall be signed and sealed by a Professional Engineer registered in the State of South Carolina.
 4. Certified reports for all lifting inserts, indicating allowable design loads.
 5. Information on lifting and erection procedures.

1.05 QUALITY ASSURANCE

- A. All manufactured precast concrete units shall be produced by an experienced manufacturer regularly engaged in the production of such items. All manufactured precast concrete and site-cast units shall be free of defects, spalls, and cracks. Care shall be taken in the mixing of materials, casting, curing and shipping to avoid any of the above. The Engineer may elect to examine the units at the casting yard or upon arrival of the same at the site. The Engineer shall have the option of rejecting any or all of the precast work if it does not meet with the requirements specified herein or on the Drawings. All rejected work shall be replaced at no additional cost to the Owner.
- B. Manufacturer Qualifications

The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of production. Certification is only required for plants providing prestressed structural members such as hollow core planks, double-T members, etc.
- C. Plant production and engineering must be under direct supervision and control of an Engineer who possesses a minimum of five years experience in precast concrete work.

PART 2 -- PRODUCTS

2.01 CONCRETE

- A. Concrete materials including portland cement, aggregates, water, and admixtures shall conform to Section 03300, Cast-in-Place Concrete.

- B. For prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 5,000 psi unless otherwise specified. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi unless otherwise specified.
- C. For non-prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 4000 psi unless otherwise specified.

2.02 GROUT

- A. Grout for joints between panels shall be a cement grout in conformance with Section 03600, Grout.
- B. Minimum compressive strength of grout at 7 days shall be 3,000 psi.

2.03 REINFORCING STEEL

- A. Reinforcing steel used for precast concrete construction shall conform to Section 03200, Reinforcing Steel.

2.04 STEEL INSERTS

- A. Steel inserts shall be in accordance with Section 05010, Metal Materials.
- B. All steel inserts protruding from or occurring at the surface of precast units shall be galvanized in accordance with Section 05035, Galvanizing.

2.05 WELDING

- A. Welding shall conform to Section 05050, Metal Fastening.

2.06 BEARING PADS

- A. Neoprene bearing pads shall conform to Section 05830, Bearing Devices and Anchors.
- B. Plastic bearing pads shall be multi-monomer plastic strips which are non-leaching and support construction loads with no visible overall expansion, manufactured specifically for the purpose of bearing precast concrete.

PART 3 -- EXECUTION

3.01 FABRICATION AND CASTING

- A. All precast members shall be fabricated and cast to the shapes, dimensions and lengths shown on the Drawings and in compliance with PCI MNL-116. Precast members shall be straight, true and free from dimensional distortions, except for camber and tolerances permitted later in this clause. All integral appurtenances, reinforcing, openings, etc., shall be accurately located and secured in position with the form work system. Form materials shall be steel and the systems free from leakage during the casting operation.
- B. All cover of reinforcing shall be the same as detailed on the Drawings.

- C. Because of the critical nature of the bond development length in prestressed concrete panel construction, if the transfer of stress is by burning of the fully tensioned strands at the ends of the member, each strand shall first be burned at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.
- D. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.
- E. Concrete shall be finished in accordance with Section 03350, Concrete Finishes. Grout all recesses due to cut tendons which will not otherwise be grouted during erection.
- F. Curing of precast members shall be in accordance with Section 03370, Concrete Curing. Use of a membrane curing compound will not be allowed.
- G. The manufacturer shall provide lifting inserts or other approved means of lifting members.

3.02 HANDLING, TRANSPORTING AND STORING

- A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28 day compressive strength and a period of at least 5 days has elapsed since casting, unless otherwise permitted by the Engineer.
- B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.
- C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.
- D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.
- E. Precast concrete members shall not be used as storage areas for other materials or equipment.
- F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

3.03 ERECTION

- A. Erection shall be carried out by the manufacturer or under his supervision using labor, equipment, tools and materials required for proper execution of the work.
- B. Contractor shall prepare all bearing surfaces to a true and level line prior to erection. All supports of the precast members shall be accurately located and of required size and bearing materials.
- C. Installation of the precast members shall be made by leveling the top surface of the assembled units keeping the units tight and at right angles to the bearing surface.

- D. Connections which require welding shall be properly made in accordance with Section 05050, Metal Fastening.
- E. Grouting between adjacent precast members and along the edges of the assembled precast members shall be accomplished as indicated on the drawings, care being taken to solidly pack such spaces and to prevent leakage or droppings of grout through the assembled precast members. Any grout which seeps through the precast members shall be removed before it hardens.
- F. In no case shall concentrated construction loads, or construction loads exceeding the design loads, be placed on the precast members. In no case shall loads be placed on the precast members prior to the welding operations associated with erection, and prior to placing of topping (if required).
- G. No Contractor, Subcontractor or any of his employees shall arbitrarily cut, drill, punch or otherwise tamper with the precast members.
- H. Precast members damaged while being erected will be rejected or shall be repaired in a manner approved by the Engineer.

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SECTION 03600

GROUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work and as bearing surfaces for base plates, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- | | | |
|----|-------------|---|
| 1. | ASTM C 109 | Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens) |
| 2. | ASTM C 531 | Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing |
| 3. | ASTM C 579 | Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing |
| 4. | ASTM C 827 | Standard Test Method for Early Volume Change of Cementitious Mixtures |
| 5. | ASTM C 144 | Standard Specification for Aggregate for Masonry Mortar |
| 6. | ASTM C 1107 | Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink) |

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300 - Submittals.
 - 1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.

2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of grout used in the work.

1.05 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. The specimens will be made by the Engineer or its representative.
 - a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.
 - b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.
2. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Engineer in obtaining specimens for testing. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens, at no additional cost to the Owner.
3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall consist of one part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White Portland Cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.
2. The minimum compressive strength at 28 days shall be 4000 psi.

3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness.

4. Sand shall conform to the requirements of ASTM C144.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "Euco N-S" by the Euclid Chemical Company, "SikagROUT 212" by Sika Corporation, "Conspec 100 Non-Shrink Non-Metallic Grout" by Conspec, "Masterflow 555 Grout" by BASF Master Builder Solutions.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "Euco #452 Series" by Euclid Chemical, "MasterEmaco ADH 1090 RS" by BASF Master Builder Solutions.
2. Epoxy grout shall be modified as required for each particular application with aggregate per manufacturer's instructions.

D. Epoxy Base Plate Grout

1. Epoxy base plate grout shall be "Sikadur 42, Grout-Pak" by Sika Corporation, or "Masterflow 648" by BASF Master Builder Solutions.

2.02 CURING MATERIALS

- A. Curing materials shall be as specified in Section 03370, Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

PART 3 -- EXECUTION

3.01 GENERAL

- A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.
1. Cement grout shall be used for grout toppings and for patching of fresh concrete.
 2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing.

- 3. Epoxy grout shall be used for bonding new concrete to hardened concrete.
 - 4. Epoxy base plate grout shall be used for precision seating of base plates including base plates for all equipment such as engines, mixers, pumps, vibratory and heavy impact machinery, etc.
- B. New concrete surfaces to receive cement grout shall be as specified in Section 03350, Concrete Finishes, and shall be cleaned of all dirt, grease and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03370, Concrete Curing.
 - C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
 - D. The Contractor, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the Owner.
- 3.02 CONSISTENCY
- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.
- 3.03 MEASUREMENT OF INGREDIENTS
- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.
 - B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.
- 3.04 GROUT INSTALLATION
- A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be poured from one side only and thence flow across to the open side to avoid air-entrapment.

- END OF SECTION -

SECTION 05010
METAL MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Materials for fasteners are included in Section 05050, Metal Fastening.
- B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM A36 Standard Specification for Structural Steel
- B. ASTM A47 Standard Specification for Malleable Iron Castings
- C. ASTM A48 Standard Specification for Gray Iron Castings
- D. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- E. ASTM A167 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- F. ASTM A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
- G. ASTM A307 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
- H. ASTM A446 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality
- I. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- J. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

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| K. | ASTM A529 | Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness) |
| L. | ASTM A536 | Standard Specification for Ductile Iron Castings |
| M. | ASTM A570 | Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality |
| N. | ASTM A572 | Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| O. | ASTM A992 | Standard Specification for Structural Steel Shapes |
| P. | ASTM A666 | Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications |
| Q. | ASTM A1085 | Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS) |
| R. | ASTM B26 | Standard Specification for Aluminum-Alloy Sand Castings |
| S. | ASTM B85 | Standard Specification for Aluminum-Alloy Die Castings |
| T. | ASTM B108 | Standard Specification for Aluminum-Alloy Permanent Mold Castings |
| U. | ASTM B138 | Standard Specification for Manganese Bronze Rod, Bar, and Shapes |
| V. | ASTM B209 | Standard Specification for Aluminum-Alloy Sheet and Plate |
| W. | ASTM B221 | Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes |
| X. | ASTM B308 | Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded |
| Y. | ASTM B574 | Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod |
| Z. | ASTM F468 | Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use |
| a. | ASTM F593 | Standard Specification for Stainless Steel Fasteners |
- 1.04 SUBMITTALS
- A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

- A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 -- PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

- A. Material types and ASTM designations shall be as listed below:

1.	Steel W Shapes	A992
2.	Steel HP Shapes	A572 Grade 50
3.	Steel M, S, C, and MC shapes and Angles, Bars, and Plates	A36
4.	Rods	F 1554 Grade 36
5.	Pipe - Structural Use	A53 Grade B
6.	Hollow Structural Sections	A500 Grade C or A1085
7.	Cold-Formed Steel Framing	A 653

2.02 STAINLESS STEEL

- A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.
- B. Material types and ASTM designations are listed below:

1.	Plates and Sheets	ASTM A167 or A666 Grade A
2.	Structural Shapes	ASTM A276
3.	Fasteners (Bolts, etc.)	ASTM F593

2.03 ALUMINUM

- A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

- | | | |
|----|---------------------------------|------------------------|
| 1. | Structural Shapes | ASTM B308 |
| 2. | Castings | ASTM B26, B85, or B108 |
| 3. | Extruded Bars | ASTM B221 - Alloy 6061 |
| 4. | Extruded Rods, Shapes and Tubes | ASTM B221 - Alloy 6063 |
| 5. | Plates | ASTM B209 - Alloy 6061 |
| 6. | Sheets | ASTM B221 - Alloy 3003 |

C. All aluminum structural members shall conform to the requirements of Section 05140, Structural Aluminum.

D. All aluminum shall be provided with mill finish unless otherwise noted.

E. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.

F. Aluminum in contact with dissimilar materials shall be insulated with an approved dielectric.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

- | | | |
|----|-----------|--------------------------|
| 1. | Gray | ASTM A48 Class 30B |
| 2. | Malleable | ASTM A47 |
| 3. | Ductile | ASTM A536 Grade 60-40-18 |

2.05 BRONZE

A. Material types and ASTM designations are listed below:

- | | | |
|----|-----------------------|--------------------------|
| 1. | Rods, Bars and Sheets | ASTM B138 - Alloy B Soft |
|----|-----------------------|--------------------------|

2.06 HASTELLOY

A. All Hastelloy shall be Alloy C-276.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 05035

GALVANIZING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. International Building Code with SC Modifications
2. ASTM A123 - Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. ASTM A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
4. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
5. ASTM A780 - Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings
6. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

PART 2 -- PRODUCTS

2.01 GALVANIC COATING

A. Material composition of the galvanic coating shall be in accordance with the applicable ASTM standards specified herein.

PART 3 -- EXECUTION

3.01 FABRICATED PRODUCTS

- A. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.
- B. Components with partial surface finishes shall be commercial blast cleaned prior to pickling.
- C. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

3.02 HARDWARE

- A. Iron and steel hardware which is to be galvanized shall be galvanized in accordance with ASTM A153 and ASTM F2329.

3.03 ASSEMBLED PRODUCTS

- A. Assembled steel products which are to be galvanized shall be galvanized in accordance with ASTM A123. All edges of tightly contacting surfaces shall be completely sealed by welding before galvanizing.

- B. Assemblies shall be provided with vent and drain holes as required by the fabricator. Vent and drain hole sizes and locations shall be included in the structural steel shop drawings required in Specification 05120 Structural Steel for approval. All vent and drain holes shall be plugged and finished to be flush with and blend in with the surrounding surface. Where water intrusion can occur, the plug shall be carefully melted into the surrounding zinc coating using an appropriate fluxing agent.

3.04 METAL DECK

- A. Unless noted otherwise, metal deck shall be galvanized in accordance with ASTM A653 G60 minimum. In moist environments or as indicated on the Contract Drawings, galvanizing shall meet the requirements of ASTM A653 G90.
- B. Galvanized metal deck shall meet the requirements of ASTM A924.

3.05 REPAIR OF GALVANIZING

- A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

- END OF SECTION -

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SECTION 05050
METAL FASTENING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05061 – Stainless Steel
- D. Section 05120 - Structural Steel
- E. Section 05140 – Structural Aluminum

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. AC 193 Acceptance Criteria for Mechanical Anchors in Concrete Elements
 - 3. AC 308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
 - 4. ACI 318 Building Code Requirements for Structural Concrete
 - 5. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete
 - 6. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete

7.	AISC 348	The 2009 RCSC Specification for Structural Joints
8.	AISC	Code of Standard Practice
9.	AWS D1.1	Structural Welding Code - Steel
10.	AWS D1.2	Structural Welding Code - Aluminum
11.	AWS D1.6	Structural Welding Code – Stainless Steel
12.	Aluminum Association	Specifications for Aluminum Structures
13.	ASTM A572/A572M-94C	Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
14.	ASTM A36	Standard Specification for Carbon Structural Steel
15.	ASTM A325	Standard Specification for High-Strength Bolts for Structural Steel Joints
16.	ASTM A489	Standard Specification for Eyebolts
17.	ASTM A490	Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
18.	ASTM A563	Standard Specifications for Carbon and Alloy Steel Nuts
19.	ASTM D1785	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
20.	ASTM E488	Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
21.	ASTM F436	Standard Specification for Hardened Steel Washers
22.	ASTM F467	Standard Specification for Nonferrous Nuts for General Use
23.	ASTM F593	Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
24.	ASTM F594	Standard Specification for Stainless Steel Nuts
25.	ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.
2. Anchor design calculations sealed by a Professional Engineer currently registered in the State of South Carolina. Only required if design not shown on Contract Drawings.
3. Manufacturer's installation instructions.
4. Copy of valid certification for each person who is to perform field welding.
5. Certified weld inspection reports, when required.
6. Welding procedures.
7. Installer qualifications.
8. Certification of Installer Training.
9. Inspection Reports.
10. Results of Anchor Proof Testing.

1.05 QUALITY ASSURANCE

- A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.
- B. Installer Qualifications: All concrete anchors shall be installed by an Installer with at least three years of experience performing similar installations. Concrete adhesive anchor installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.
- C. Installer Training: For concrete adhesive anchors, conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process to include but not be limited to the following:
1. Hole drilling procedure.
 2. Hole preparation and cleaning technique.
 3. Adhesive injection technique and dispenser training/maintenance.
 4. Concrete adhesive anchor preparation and installation.
 5. Proof loading/torquing.

- D. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.
- E. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.
- F. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.
- G. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.
- H. Special inspections for concrete adhesive anchors shall be conducted in accordance with the manufacturer's instructions and Specifications Section 01450. Downward installations require periodic inspection and horizontal and overhead installations require continuous inspection.

 NOTE TO SPECIFIER: If special inspections are not included in a project replace the paragraph with "Inspections of the adhesive dowel system shall be made by the Engineer or other representatives of the Owner in accordance with the requirements of the ESR published by the manufacturer. Provide adequate time and access for inspections of products and anchor holes prior to injections, installation, and proof testing."

PART 2 -- PRODUCTS

2.01 ANCHOR RODS (ANCHOR BOLTS)

- A. Anchor rods shall conform to ASTM F1554 Grade 36 except where stainless steel or other approved anchor rods are shown on the Drawings. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.
- B. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot-dip galvanized in accordance with ASTM F1554.
- C. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.02 HIGH STRENGTH BOLTS

- A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC 348 "The 2009 RCSC Specification for Structural Joints".
- B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.
- B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

2.04 CONCRETE ANCHORS

A. General

- 1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by an approved independent testing laboratory. There are two types used:
 - a. Expansion anchors shall be mechanical anchors of the wedge, sleeve, drop-in or undercut type.
 - b. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.
- 2. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.
- 3. Unless otherwise noted, all concrete anchors which are submerged or are used in hanging items or have direct tension induced upon them, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.

4. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Expansion or mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to the International Building Code and ACI 318 Appendix D requirements as applicable, including seismic test requirements.
5. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or anchor non-structural elements.
6. Engineer's approval is required for use of concrete anchors in locations other than those shown on the Drawings.

B. Concrete Anchor Design:

An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, it shall be considered an engineered design and anchors shall be installed to the prescribed size, spacing, embedment depth and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the anchors will be considered an engineered design and the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated by the Engineer on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

1. Structural Anchors: All concrete anchors shall be considered structural anchors if they transmit load between structural elements; transmit load between non-structural components that make up a portion of the structure and structural elements; or transmit load between life-safety related attachments and structural elements. Examples of structural concrete anchors include but are not limited to column anchor bolts, anchors supporting non-structural walls, sprinkler piping support anchors, anchors supporting heavy, suspended piping or equipment, anchors supporting barrier rails, etc. For structural anchors, the Contractor shall submit an engineered design with signed and sealed calculations performed by an Engineer currently registered in the State of South Carolina. Structural anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Appendix D.
2. Non-Structural Anchors: All other concrete anchors may be considered non-structural concrete anchors. The Contractor shall perform an engineered design for non-structural anchors. The Engineer may request the Contractor provide anchor design details for review, but submission of a signed, sealed design is not required. Non-structural anchors shall be designed by the contractor for use in uncracked concrete.

3. Embedment Depth

- a. Minimum anchor embedment shall be as indicated on the Drawings or determined by the Contractor's engineered design. Although all manufacturers listed are permitted, the embedment depth indicated on the Drawings is based on "Pure 110+ by Powers Fasteners" ESR 3298 issued 7/2016.
- b. Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer's standard embedment (expansion or mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod according to the manufacturer (adhesive anchors).
- c. The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long term temperature of 110 degrees F, and maximum short term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum or more than the maximum stated in the manufacturer's literature.

C. Structural Anchors:

1. Mechanical Anchors:

- a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Powerstud SD-1" or "Powerstud SD-2" by Powers Fasteners.
- b. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Wedge-Bolt +" by Powers Fasteners. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
- c. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by Powers Fasteners.
- d. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by Powers Fasteners

2. Adhesive Anchors:

- a. Adhesive anchors shall be "Epcon C6+ Adhesive Anchoring System" by ITW Redhead, "HIT HY-200 Adhesive Anchoring System" by Hilti, Inc., "SET-XP Epoxy Adhesive Anchors" by Simpson Strong-Tie Co., or "Pure 110+ Epoxy Adhesive Anchor System" by Powers Fasteners.

- b. Structural adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**
- D. Non-Structural Anchors: In addition to the acceptable non-structural anchors listed below, all structural anchors listed above may also be used as non-structural anchors.
 - 1. Mechanical Anchors:
 - a. Wedge Anchors: Wedge anchors shall be “Kwik Bolt 3” by Hilti, Inc., “Wedge-All” by Simpson Strong-Tie Co. or “TruBolt” by ITW Redhead.
 - b. Screw Anchors: Screw anchors shall be “Kwik HUS” by Hilti, Inc., “Wedge-Bolt” by Powers Fasteners “Large Diameter Tapcon (LDT) Anchor” by ITW Redhead, or “Titen HD” by Simpson Strong-Tie Co. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
 - c. Sleeve Anchors: Sleeve anchors shall be “HSL Heavy Duty Sleeve Anchors” by Hilti, Inc. “Power-Bolt” by Powers Fasteners “Dynabolt Sleeve Anchor” by ITW Redhead, or “Sleeve-All” by Simpson Strong-Tie Co.
 - d. Drop-In Anchors: Drop-in anchors shall be “Drop-In” by Simpson Strong-Tie Co., “HDI Drop-In Anchor” by Hilti, Inc. or “Multi-Set II Drop-In Anchor” by ITW Redhead.
 - e. Undercut Anchors: Undercut anchors shall be “HDA Undercut Anchor” by Hilti, Inc., or “Torq-Cut” by Simpson Strong-Tie Co.
 - 2. Adhesive Anchors:
 - a. Adhesive anchors shall be “Epcon A7” or “Epcon C6+ Adhesive Anchoring System” by ITW Redhead, “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET Epoxy Tie High Strength Anchoring Adhesive” or “AT High Strength Anchoring Adhesive” by Simpson Strong-Tie Co., or “Powers AC 100+ Gold Vinylester Injection Adhesive Anchoring System” or “T308+ Epoxy Adhesive Injection System” by Powers Fasteners.
 - b. Non-structural adhesive anchors systems shall be IBC compliant and capable of resisting short term wind and seismic (Seismic Design Categories A and B) as well as long term and short term sustained static loads in uncracked concrete.

- c. Non-structural adhesive anchor embedment depth of the rod shall provide a minimum allowable bond strength that is equal to the allowable yield capacity of the rod unless noted otherwise on the Drawings.
- d. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

E. Concrete Anchor Rod Materials:

- 1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.
- 2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.
- 3. Nuts, washers, and other hardware shall be of a material to match the anchors.

2.05 MASONRY ANCHORS

- A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.
- B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust with nylon (not wire) brush prior to installation of adhesive and anchor. Contractor shall follow manufacturer's installation instructions. The adhesive system shall be "HIT HY-70 System" as manufactured by Hilti, Inc., or "SET-XP Epoxy-Tie or "AT-XP Acrylic-Tie" as manufactured by Simpson Strong-Tie Co.
- C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, masonry anchors shall also be galvanized.
- D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

2.06 WELDS

- A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).
- B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.
- C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.07 WELDED STUD CONNECTORS

- A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.08 EYEBOLTS

- A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.09 HASTELLOY FASTENERS

- A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

2.10 ANTISEIZE LUBRICANT

- A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

PART 3 -- EXECUTION

3.01 MEASUREMENTS

- A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 ANCHOR INSTALLATION

- A. Anchor Rods, Concrete Anchors, and Masonry Anchors
 - 1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.
 - 2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.

3. Concrete anchors shall not be used in place of anchor rods without Engineer's approval.
4. All stainless steel threads shall be coated with antiseize lubricant.

B. High Strength Bolts

1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". All bolted joints shall be Type N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

C. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days, have a minimum compressive strength of 2500 psi, and shall be at least 50 degrees F.
2. Concrete anchors designed by the Contractor shall be classified as structural or non-structural based on the requirements indicated above.
3. Concrete Anchor Testing:
 - a. At all locations where concrete anchors meet the requirements for structural anchors at least 25 percent of all concrete anchors installed shall be proof tested to the value indicated on the Drawings, with a minimum of one tested anchor per anchor group. If no test value is indicated on the Drawings but the installed anchor meets the requirements for structural anchors, the Contractor shall notify the Engineer to allow verification of whether anchor load proof testing is required.
 - b. Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Proof testing of anchors shall be in accordance with ASTM E488 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.
 - c. Where Contract Documents indicate anchorage design to be the Contractor's responsibility and the anchors are considered structural per the above criteria, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the State of South Carolina. The Contractor's Engineer shall also submit documentation indicating the Contractor's proof testing procedures have been reviewed and the proposed procedures are acceptable. Proof testing procedures shall be in accordance with ASTM E488.

- d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.
 - e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all proof testing, including additional testing required due to previously failed tests.
- 4. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.
- 5. All holes shall be drilled in accordance with the manufacturer's instructions except that cored holes shall not be allowed unless specifically approved by the Engineer. If cored holes are allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with the manufacturer's instructions prior to installation of adhesive and threaded rod unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water-saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer. . Injection of adhesive into the hole shall be performed to minimize the formation of air pockets in accordance with the manufacturer's instructions. Wipe rod free from oil that may be present from shipping or handling.

D. Other Bolts

- 1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.
- 2. All stainless steel bolts shall be coated with antiseize lubricant.

3.03 WELDING

- A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.
- B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.04 INSPECTION

- A. High strength bolting will be visually inspected in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Rejected bolts shall be either replaced or retightened as required.

B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.05 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

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SECTION 05061
STAINLESS STEEL

PART 1 -- GENERAL

1.01 SECTION INCLUDES

- A. The Contractor shall furnish, install and erect the stainless steel work as shown on the Contract Drawings and specified herein.
- B. Stainless steel work shall be furnished complete with all accessories, mountings and appurtenances of the type of stainless steel and finish as specified or required for a satisfactory installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 - Submittals
- B. Section 05010 - Metal Materials
- C. Section 05050 - Metal Fastening
- D. Section 05500 - Metal Fabrications

1.03 REFERENCES

- A. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
- B. ASTM A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
- C. ASTM A262 - Practice for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel.
- D. ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.
- E. ASTM A314 - Stainless and Heat-Resisting Steel Billets and Bars for Forging.
- F. ASTM A380 - Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.
- G. ASTM A473 - Stainless and Heat-Resisting Steel Forgings.
- H. ASTM A666 - Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar.
- I. ASTM A774 - Stainless Steel Pipe Fittings

- J. ASTM A778 - Stainless Steel Pipe
- K. ASTM F593 - Stainless Steel Bolts, Hex Cap Screws and Studs.
- L. ASTM F594 - Stainless Steel Nuts.
- M. ANSI/ASME B1.1 - Unified Inch Screw Thread (UN and UNR Thread Form).

1.04 TESTS

- A. All stainless steel materials including stainless test welds, shall be checked for compliance with tests for susceptibility to intergranular attack. Such tests shall be Practices A, B and E of ASTM A262. Detailed procedures for the tests shall be submitted to the Engineer for approval prior to start of work. Practice A shall be used only for acceptance of materials but not for rejection of materials, and shall be used for screening material intended for testing in Practice B and Practice E. The maximum acceptable corrosion rate under Practice B shall be 0.004 inch per month, rounded off to the third decimal place. If the certified mill report indicates that such test has been satisfactory performed, the fabricator may not be required to repeat the test. Material passing Practice E shall be acceptable.
- B. Sample selection for the susceptibility to intergranular attack tests shall be as follows:
 - 1. One (1) sample per heat treatment lot for plates and forgings;
 - 2. One (1) sample per each Welding Procedure Qualification regardless of the joint design;
 - 3. If tests indicate a reduction in corrosion resistance, welding procedure shall be adjusted or heat treatment determined as needed to restore required corrosion resistance.
 - 4. The samples so chosen shall have received all the post-weld heat treatments identical to the finished part.

1.05 SUBMITTALS

- A. The Contractor shall prepare and submit for approval shop drawings for all stainless steel fabrication in accordance with Section 01300, Submittals.
- B. Submittals shall include, but not be limited to, the following:
 - 1. Certified test reports for susceptibility to intergranular attack.
 - 2. Affidavit of compliance with type of stainless steel shown on the Contract Drawings or specified herein.
 - 3. Certified weld inspection reports.
 - 4. Cleaning and handling of stainless steel in accordance with Paragraph 3.04,

Cleaning and Handling.

- C. Samples of finish, on each type of stainless steel to be furnished, shall be submitted to the Engineer upon request.

1.06 QUALITY ASSURANCE

- A. Shop inspections may be made by the Engineer. The Contractor shall give ample notice to the Engineer prior to the beginning of any stainless steel fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the works.
- B. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of the Contract Drawings or the Specifications.
- C. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship.

1.07 HANDLING, STORAGE AND DELIVERY

- A. Mechanical damage (e.g., scratches and gouges) to the stainless steel material shall not be permitted and is cause for rejection. Care shall be taken in the material handling since such mechanical damage will result in the passive oxide film being "punctured" leading to a possible lower resistance to the initiation of corrosion than the surrounding chemically-passivated surface.
- B. Stainless steel plates and sheets shall be stored vertically in racks and not be dragged out of the racks or over one another. Racks shall be protected to prevent iron contamination.
- C. Heavy stainless steel plates shall be carefully separated and chocked with wooden blocks so that the forks of a fork-lift could be inserted between plates without mechanically damaging the surface.
- D. Stainless steel plates and sheets laid out for use shall be off the floor and be divided by wooden planks to prevent surface damage and to facilitate subsequent handling.
- E. Plate clamps, if used, shall be used with care as the serrated faces can dig in, indent and gouge the surface.
- F. Stainless steel fabrications shall be loaded in such a manner that they may be transported and unloaded without being overstressed, deformed or otherwise damaged.
- G. Stainless steel fabrications and packaged materials shall be protected from corrosion and deterioration and shall be stored in a dry area. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with approved effective and durable covers.

- H. Stainless steel fabrications shall not be placed in or on a structure in a manner that might cause distortion or damage to the fabrication. The Contractor shall repair or replace damaged stainless steel fabrications or materials as directed by the Engineer.

1.08 FIELD MEASUREMENTS

- A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.
- B. The Contractor shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

PART 2 -- PRODUCTS

2.01 MATERIALS AND FINISHES

- A. Stainless steel shall be Type 304 unless it is used for underwater service. Stainless steel for underwater service shall be Type 316. Minimum mechanical finish shall be No. 4 as stated in Table 2 unless otherwise noted on the Contract Drawings.
- B. The basic mill forms (sheet, strip, plate and bar) are classified by size as shown on Table 1. Tables 2, 3 and 4 identify finishes and conditions in which sheet, bar and plate are available.
- C. Tables 2, 3 and 4 show numbered finishes and conditions for sheet, bar and plate. While there are no specific designations for polished finishes on bar or plate, the sheet finish designations are used to describe the desired effect. This also applies to finishes on ornamental tubing.
- D. There are three standard finishes for strip, which are broadly described by the finishing operations employed:
 - 1. No. 1 Strip Finish

No. 1 strip finish is approximately the same as No. 2D Sheet Finish. It varies in appearance from dull gray matte to a fairly reflective surface, depending largely on alloy composition and amount of cold reduction.
 - 2. No. 2 Strip Finish is approximately the same as a No. 2B sheet finish. It is smoother, more reflective than No. 1, and likewise varies with alloy composition.
 - 3. Bright annealed finish is a highly reflective finish that is retained by final annealing in a controlled atmosphere furnace.

Table 1

Classification of Stainless Steel Product Form

Item	Description	Dimensions		
		Thickness	Width	Diameter or Size
Sheet	Coils and cut length: Mill finishes Nos. 1, 2D and 2B Polished finishes Nos. 3, 4, 6, 7 & 8	under 3/16" under 3/16"	24" and over all widths	-- --
Strip	Cold finished, coils or cut lengths Polished finishes Nos. 3, 4, 6, 7 & 8	under 3/16" under 3/16"	under 24" all widths	-- --
Plate	Flat rolled or forged	3/16" and over	over 10"	--
Bar	Hot finished rounds, squares, octagons and hexagons Hot finished flats	-- 1/8" to 8" incl.	-- 1/4" to 10" incl.	1/4" and over --
	Cold finished rounds, squares, octagons and hexagons Cold finished flats	-- 1/8" to 4-1/2"	-- 3/8" to 4-1/2"	over 1/8" --
Wire	Cold finishes only: (in coil) Round, square, octagon, hexagon and flat wire	under 3/16"	under 3/8"	--
Pipe & Tubing	Several different classifications, with differing specifications, are available.			
Extrusion	Not considered "standard" shapes. Currently limited in size to approximately 6-1/2" diameter or structurals.			

Table 2

Standard Mechanical Sheet Finishes

Unpolished or Rolled Finishes:	
No. 1 A rough dull surface which results from hot rolling to the specified thickness followed by annealing and descaling.	No. 4 A polished surface obtained by finishing with a 120-150 mesh abrasive, following initial grinding with coarser abrasives. This is a general purpose bright finish with a visible "grain" which prevents mirror reflection.
No. 2D A dull finish which results from cold rolling followed by annealing and descaling, and may perhaps get a final light roll pass through unpolished rolls. A 2D finish is used where appearance is of no concern.	No. 6 A dull satin finish having lower reflectivity than No. 4 finish. It is produced by Tampico brushing the No. 4 finish in a medium of abrasive and oil. It is used for architectural applications and ornamentation where a high luster is undesirable, and to contrast with brighter finishes.
No. 2B A bright cold-rolled finish resulting in the same manner as No. 2D finish, except that the annealed and descaled sheet receives a final light roll pass through polished rolls. This is the general purpose cold-rolled finish that can be used as is, or as a preliminary step to polishing.	No. 7 A high reflective finish that is obtained by buffing finely ground surfaces but not to the extent of completely removing the "grit" lines. It is used chiefly for architectural and ornamental purposes.
Polished Finishes:	
No. 3 An intermediate polish surface obtained by finishing with a 100 grit abrasive. Generally used where a semi-finished polished surface is required. A No. 3 finish usually receives additional polishing during fabrication.	No. 8 The most reflective surface, which is obtained by polishing with successively finer abrasives and buffing extensively until all grit lines from preliminary grinding operations are removed. It is used for applications such as mirrors and reflectors.

Table 3
Conditions and Finishes for Bar

Conditions	Surface Finishes ¹
Hot worked only	(a) Scale not removed (excluding spot conditioning) (b) Rough turned ² (c) Pickled or blast cleaned and pickled.
Annealed or otherwise heat treated.	(a) Scale not removed (excluding spot conditioning) (b) Rough turned (c) Pickled or blast cleaned and pickled (d) Cold drawn or cold rolled (e) Centerless ground (f) Polished
Annealed and cold worked to high tensile strength ³	(d) Cold drawn or cold rolled (e) Centerless ground (f) Polished

¹ Surface finishes (b), (e) and (f) are applicable to round bars only.

² Bars of the 4xx series stainless steels which are highly hardenable, such as Types 414, 420, 420F, 431, 440A, 440B and 440C, are annealed before rough turning. Other hardenable grades, such as Types 403, 410, 416 and 416Se, may also require annealing depending on their composition and size.

³ Produced in Types 302, 303Se, 304 and 316.

Table 4
Conditions and Finishes for Plate

Condition and Finish	Description and Remarks
Hot rolled	Scale not removed. Not heat treated. Plates not recommended for final use in this condition. ⁴
Hot rolled, annealed or heat treated	Scale not removed. Use of plates in this condition is generally confined to heat resisting applications. Scale impairs corrosion resistance. ¹
Hot rolled, annealed or heat treated, blast cleaned or pickled	Condition and finish commonly preferred for corrosion resisting and most heat resisting applications.
Hot rolled, annealed, descaled and temper passed	Smoother finish for specialized applications.
Hot rolled, annealed, descaled cold rolled, annealed, descaled, optionally temper passed	Smooth finish with greater freedom from surface imperfection than the above.
Hot rolled, annealed or heat treated, surface cleaned and polished	Polished finishes refer to Table 2.

⁴ Surface inspection is not practicable on plates which have not been pickled or otherwise descaled.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. Holes for bolts and screws shall be drilled. Fastenings shall be concealed where practicable. Joints exposed to the weather shall be formed to exclude water.
- B. As far as practicable, all fabricated units shall be fitted and assembled in the shop, with all cuts and bends made to precision measurements in accordance with details shown on approved shop drawings.
- C. Work shall be fabricated so that it is installed in a manner that will provide for expansion and contraction, prevent the shearing of bolts, screws and other fastenings, ensure rigidity, and provide close fitting of sections.
- D. All finished and/or machined faces shall be true to line and level. Stainless steel sections shall be well formed to shape and size with sharp lines and angles; curved work shall be sprung evenly to curves.
- E. All work shall be fitted together at the shop as far as possible, and delivered complete and ready for erection. Proper care shall be exercised in handling all work so as not to

injure the finished surfaces.

3.02 WELDING

- A. Welding shall be done in a manner that will prevent buckling and in accordance with Specification 05050 – Metal Fastening, and as modified hereinafter.
- B. All welds exposed in the work shall be ground smooth and finished to match the finish of the adjacent stainless steel surfaces.
- C. Select weld rods that provide weld filler metal having corrosion resistant properties as nearly identical or better than the base metal to insure preservation of the corrosion-resistant properties. Provide heat treatment at welds where testing of weld procedure indicates it is required to restore the corrosion resistance.
- D. Thermal conductivity of stainless steel is about half that of other steels; and the following methods may be used to accommodate this situation:
 - 1. Use lower weld current setting.
 - 2. Use skip-weld techniques to minimize heat concentration.
 - 3. Use back-up chill bars or other cooling techniques to dissipate heat.
- E. Edges of the stainless steel to be welded shall be cleaned of contaminants.

3.03 FASTENERS

- A. Stainless steel fasteners shall be used for joining stainless steel work.
- B. Stainless steel fasteners shall be made of alloys that are equal to or more corrosion resistant than the materials they join.

3.04 CLEANING AND HANDLING

- A. All stainless steel surfaces shall be precleaned, descaled, passivated and inspected before, during and after fabrication in accordance with the applicable sections of ASTM A380 and as detailed in the procedures to be submitted to the Engineer for approval prior to start of work. Degreasing and passivation of stainless steel articles shall be conducted as the last step after fabrication.
- B. Measures to protect cleaned surfaces shall be taken as soon as final cleaning is completed and shall be maintained during all subsequent handling, storage and shipping.
 - 1. The Contractor shall submit for approval specific procedures listing all the steps to be followed in detecting contamination and in descaling, cleaning, passivation and protecting of all stainless steel.
 - 2. Area showing clear indications of contamination shall be recleaned, repassivated and reinspected.

- C. At approved stages in the shop operations, contaminants such as scale, embedded iron, rust, dirt, oil, grease and any other foreign matter shall be removed from the metal, as directed or approved by the Engineer. The adequacy of these operations shall be checked by the Engineer. Operations in the shop shall be conducted so as to avoid contamination of the stainless steel and to keep the metal surfaces free from dirt and foreign matter.
- D. In order to prevent incipient corrosion during fabrication, special efforts shall be made at all times to keep all stainless steel surfaces from coming in contact with other metals.
 - 1. Stainless steel and stainless steel welds shall be cleaned with clean sand free of iron, stainless steel wool, stainless steel brushes, or other approved means and shall be protected at all times from contamination by any materials, including carbon steel, that shall impair its resistance to corrosion.
 - 2. Approved methods of cutting, grinding and handling shall be used to prevent contamination. If air-arc, or carbon-arc cutting is used, additional metal shall be removed by approved mechanical means so as to provide clean, weldable edges. All grinding of stainless steel shall be performed with aluminum oxide or silicon carbide grinding wheels bonded with resin or rubber. Grinding wheels used on carbon steel shall not be used on stainless steel.
 - 3. Sand, grinding wheels, brushes and other materials used for cleaning stainless steel shall be checked periodically by the Engineer for contaminants. Cleaning aids found to contain contaminants shall not be used on the work.

3.05 INSTALLATION

- A. All stainless steel fabrications shall be erected square, plumb and true, accurately fitted, adequately anchored in place, set at proper elevations and positions.
- B. All inserts, anchor rods and all other miscellaneous work specified in the Detailed Specifications or shown on the Contract Drawings or required for the proper completion of the work, which are embedded in concrete, shall be properly set and securely held in position in the forms before the concrete is placed.
- C. All stainless steel fabrications shall be installed in conformance with details shown on the Contract Drawings or on the approved shop drawings.

-END OF SECTION -

SECTION 05120
STRUCTURAL STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.
 - 1. International Building Code with SC Modifications
 - 2. AISC - "Code of Standard Practice."
 - 3. AISC - "Specification for Structural Steel Buildings".
 - 4. AISC 348 - "The 2009 RCSC Specification for Structural Joints".
 - 5. AWS - "Structural Welding Code".

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Certified Mill Test Reports
 - 2. Affidavit of Compliance with grade specified
 - 3. Shop Drawings which include the following:
 - a. Layout drawings indicating all structural shapes, sizes, and dimensions.
 - b. Beam and column schedules.

- c. Detailed drawings indicating jointing, anchoring and connection details and vent and drain holes where required.

1.05 QUALITY ASSURANCE

- A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.
- B. The erector shall be a qualified installer who participates in the AISC Certification program and is designated an AISC Certified Erector, Category ACSE.
- C. The fabricator shall be a qualified fabricator who participates in the AISC Certification program and is designated an AISC Certified Plant, Category STD.

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Structural Steel
 - 1. Structural steel for W shapes shall conform to ASTM A992 unless otherwise indicated.
 - 2. Structural steel for HP shapes shall conform to ASTM A572 Grade 50 unless otherwise indicated.
 - 3. Structural steel for S, M, C, and MC shapes and angles and plates shall conform to ASTM A36 unless otherwise indicated.
 - 4. Steel pipe shall be ASTM A53, Grade B.
 - 5. HSS shall be ASTM A500, Grade C or ASTM A1085. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.
 - 6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Contractor, all at the expense of the Contractor.
 - 7. Fasteners for structural steel shall be in accordance with Section 05050, Metal Fastening.

B. Welds

1. Electrodes for welding shall be in accordance with Section 05050, Metal Fastening.

PART 3 -- EXECUTION

3.01 MEASUREMENT

- A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

- A. Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.
- B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.
- C. All holes in structural steel members required for anchors, anchor rods, bolts, sag rods, vent and drain holes or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.
- D. All materials shall be properly worked and match-marked for field assembly.
- E. Where galvanizing of structural steel is required, it shall be done in accordance with Section 05035, Galvanizing.

3.03 DELIVERY, STORAGE AND HANDLING

- A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.
- B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

- A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

- B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.
- C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.
- D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.
- E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.
- F. All bolted connections shall use high strength bolts in accordance with Section 05050, Metal Fastening. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Bolts specified or noted on the Drawings to be a tension or slip critical "SC" type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.
- G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.
- H. Misfits at Bolted Connections
 - 1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.
 - 2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.
 - 3. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

- 1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.
- 2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.
 4. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.
- J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

- A. Painting shall be performed according to Section 09900, Painting and the following additional requirements.
1. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.
 2. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.
 3. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.
 4. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

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SECTION 05140
STRUCTURAL ALUMINUM

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to provide all structural aluminum work in accordance with the Contract Documents. The term "structural aluminum" shall include items as defined in the Aluminum Association "Specifications for Aluminum Structures".

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05050 - Metal Fastening
- C. Section 09900 - Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of the Bid.
 - 1. International Building Code with SC Modifications
 - 2. Aluminum Association "Specifications for Aluminum Structures"
 - 3. AWS D1.2 - "Structural Welding Code".

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Certified Mill Test Reports
 - 2. Affidavit of Compliance with grade specified
 - 3. Shop Drawings which include the following:
 - a. Layout drawings indicating all structural shapes, sizes, and dimensions.
 - b. Beam and column schedules.
 - c. Detailed drawings indicating jointing, anchoring and connection details.

1.05 QUALITY ASSURANCE

- A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Structural aluminum shall comply with Section 05010, Metal Materials.
- B. Fasteners for structural aluminum shall be in accordance with Section 05050, Metal Fastening.
- C. Electrodes for welding shall be in accordance with Section 05050, Metal Fastening.

PART 3 -- EXECUTION

3.01 MEASUREMENT

- A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

- A. Fabrication shall be in accordance with the Aluminum Association "Specifications for Aluminum Structures". Fabrication shall begin only after Shop Drawing approval.
- B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.
- C. All holes in structural aluminum members required for anchors, anchor rods, bolts, or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.
- D. All materials shall be properly worked and match-marked for field assembly.

3.03 DELIVERY, STORAGE AND HANDLING

- A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.
- B. Structural aluminum members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

- A. All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.
- B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before being permanently fastened.
- C. No cutting of structural aluminum members in the field will be allowed except by the written approval of the Engineer.
- D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.
- E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.
- F. All bolted connections shall comply with Section 05050, Metal Fastening.
- G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.
- H. Misfits at Bolted Connections
 - 1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.
 - 2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.
 - 3. Where misalignment between anchor bolts and bolt holes in aluminum members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.
2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.
3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.
4. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

- J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

- A. Painting shall be performed according to Section 09900, Painting.
- B. Aluminum surfaces in contact with concrete or dissimilar metals shall be thoroughly protected with two coats of epoxy paint with a minimum total thickness of 16 mils or other approved isolating material in accordance with the requirements of Section 09900 - Painting.

- END OF SECTION -

SECTION 05500
METAL FABRICATIONS

PART 1 -- GENERAL

1.01 REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all metal fabrications not specifically included in other Sections, complete and in accordance with the requirements of the Contract Documents.
- B. Work shall include but may not be limited to lintels, guard posts, hoppers, and chutes.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05050 - Metal Fastening
- C. Section 05035 - Galvanizing
- D. Certain specific items are included in other Sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. AISC - Specification for Structural Steel Buildings
 - 3. AISI - Specifications for the Design of Cold-Formed Steel Structural Members
 - 4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Complete fabrication and erection drawings of all metalwork specified herein.
 - 2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used in metal fabrications shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used in metal fabrication shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 LINTELS

- A. Provide lintels as shown on the Drawings and specified herein with 8 inches minimum bearing each side unless noted otherwise.
- B. All lintels shall be steel in accordance with Section 05120, Structural Steel, and shall be galvanized in accordance with Section 05035, Galvanizing, unless noted otherwise.

2.04 GUARD POSTS (BOLLARDS)

- A. Guard posts shall be 6-inch diameter Schedule 40 galvanized steel pipe in accordance with ASTM A53.
- B. Guard posts shall be concrete filled and crowned, as detailed in the Drawings.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.
- G. Fabricated items shall be shop painted when specified in Section 09900, Painting.

3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions
- C. Metal work shall be field painted when as specified in accordance with Section 09900, Painting.

- END OF SECTION -

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SECTION 05510

METAL STAIRS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all metal stairs in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening
- D. Section 05120 - Structural Steel
- E. Section 05520 - Handrails and Railings
- F. Section 05531 - Gratings, Access Hatches, and Access Doors
- G. Section 05550 - Stair Treads and Nosings

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. AISC Specification for Structural Steel Buildings
 - 3. AISI Specification for the Design of Cold-Formed Steel Structural Members
 - 4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300 - Submittals.
 - 1. Complete fabrication and erection drawings of all metal work specified herein.

2. Other submittals as required in accordance with Section 05010 - Metal Materials, and Section 05050 - Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for metal stairs shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used in metal stairs shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 METAL STAIRS AND LANDINGS

- A. Stair stringers and structural framing of landings shall be fabricated from steel or aluminum as indicated on the Drawings.
 1. Steel stairs shall be fabricated from steel in accordance with Section 05120, Structural Steel.
 2. Aluminum stairs shall be fabricated from aluminum alloy 6061-T6 in accordance with Section 05140, Structural Aluminum.
- B. Regardless of material of stringers, all stair treads shall be aluminum in accordance with Section 05550, Stair Treads and Nosing.
- C. Where metal landings are required as indicated on the Drawings, gratings at landings shall conform to Section 05531, Gratings, Access Hatches, and Access Doors.
- D. Handrails for metal stairs shall conform to Section 05520, Handrails and Railings. Contractor shall coordinate attachment of handrails to metal stairs.
- E. All clips, anchors, and necessary appurtenances shall be provided for a complete and rigid installation.
- F. Closure plates shall be provided for all exposed ends of stringers.
- G. All exposed connections shall be welded and ground smooth, unless otherwise indicated on the Drawings.
- H. Stairs and landings shall be designed to support a 100 psf live load, minimum, unless otherwise indicated on the Drawings.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.
- G. Fabricated items shall be shop painted when specified in accordance with Section 09900, Painting.

3.02 INSTALLATION

- A. Assembly and installation of metal stairs shall be performed in strict accordance with manufacturer's recommendations.
- B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.
- C. Metal stairs shall field painted when specified in accordance with Section 09900, Painting.

- END OF SECTION -

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SECTION 05515

LADDERS

PART 1 -- GENERAL

1.01 REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all ladders in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.
 - 1. International Building Code with SC Modifications
 - 2. Aluminum Association Specifications for Aluminum Structures
 - 3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Complete fabrication and erection drawings of all metalwork specified herein.
 - 2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for ladders shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used for ladders shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 LADDERS

- A. Ladders shall be furnished with all mounting brackets, baseplates, fasteners, and necessary appurtenances for a complete and rigid installation.
- B. All ladders shall be aluminum alloy 6061-T6 or 6063-T5, with a clear, anodized finish, Aluminum Association M12C22A41.
- C. All ladders shall conform to dimensions indicated on the Drawings and shall comply with OSHA requirements.
- D. Side rails shall be 1-1/2 inch diameter Schedule 80 pipe, minimum.
- E. Rungs shall be serrated 3/4 inch diameter, minimum.
- F. All exposed connections shall be welded and ground smooth.
- G. Ladders shall be as manufactured by Thompson Fabricating Company, or equal.

2.04 FALL PREVENTION SYSTEM

- A. Ladders shall be installed with a fall prevention system, unless indicated otherwise on the drawings. For all ladders with an uninterrupted length exceeding 20 ft. between landings or floors, fall prevention system is mandatory.
- B. Fall prevention system shall comply with OSHA requirements.
- C. Fall prevention system shall include all necessary components to provide a fully operational system, including one full body safety harness with a 310 lb. weight capacity for each fall prevention system. System shall have a fall locking device, impact attenuator, and rail system. Rail extension with dismounting system, which allows detachment from the system while not standing on the ladder, shall be provided for ladders accessed thru hatch openings. All components shall be stainless steel with a non-metallic cable guide.
- D. Fall Prevention Systems shall be RTC 2000 Climb-Rite System, Research and Trading Corporation, or Saf-T-Climb Fall Prevention System, Norton by Honeywell.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.

- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.
- G. Fabricated items shall be shop painted when specified in accordance with Section 09900, Painting.

3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.
- C. Metalwork shall be field painted when specified in accordance with Section 09900, Painting.

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SECTION 05520
HANDRAILS AND RAILINGS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all handrails and railings in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. Aluminum Association Specifications for Aluminum Structures
 - 3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Complete fabrication and erection drawings of all metal work specified herein.
 - 2. Other submittals as required in accordance with Section 05010, Metal Materials and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for handrails and railings shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used in handrails and railings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 HANDRAILS AND RAILINGS

- A. General - Handrail systems shall consist of all railings, posts, toeboards, baseplates, anchors, and accessories required for a complete and rigid installation.
 - 1. All handrail systems shall be fabricated from extruded aluminum alloy 6061-T6 or 6105-T5, with Aluminum Association M12C22A41 finish, unless otherwise noted.
 - 2. Metal railings shall be fabricated from 1-1/2 inch Schedule 40 pipe. Metal railing support posts shall be fabricated from 1-1/2 inch Schedule 80 pipe.
 - 3. The centerline of the top guard rail shall be 42 inches above the walking surface for level rail. For stair rail, the centerline of the top guard rail shall be 42 inches above the leading edge of the tread nosing. Stair handrail shall be 34 inches above the leading edge of the tread nosing. See Standard Detail 0552000.
 - 4. Posts
 - a. Maximum horizontal spacing between posts for level rail shall be six feet.
 - b. Maximum horizontal spacing between posts for stair rail shall be five feet.
 - 5. All rail joints shall be finished flush and shall occur only at supports. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.
 - 6. Toeboards
 - a. Toeboards shall project 4-inches above the walking surface and shall not infringe on the minimum required walkway width.
 - b. Aluminum toeboards shall be extruded from aluminum alloy 6063-T6 unless otherwise noted.
 - c. Toeboards shall have a minimum thickness of 1/8" at any point. Geometry of toeboard shall closely resemble geometry shown on Drawings.
 - 7. Expansion joint splices shall be provided at 30 foot maximum spacing and at all expansion joints in the structure supporting the handrail.
 - 8. The handrail system shall be designed to resist the design loads specified by both OSHA and the International Building Code with SC Modifications.
 - 9. Provide handrail extensions at top and bottom of stairs and ramps in accordance with the International Building Code with SC Modifications.

- B. For metal handrail, the Contractor shall have the option of providing a handrail system of either an all welded type construction or a component type construction.
 - 1. With both the all welded or component type construction, the baseplates and toeboards shall be furnished as shown on the Drawings.
 - 2. Component Type System
 - a. All fittings and brackets shall be designed for stainless steel concealed set screws with internal type connectors.
 - b. Exposed fittings shall be cast or extruded aluminum, or stainless steel to match ladder material, except where corrosion-resistant steel is employed as a standard fabricator's item for use.
 - c. Component type handrail shall be as manufactured by Thompson Fabricating Company, Inc., or Hollaender Manufacturing Company, Inc.
 - 3. Welded handrail may be field assembled using component type fittings as described herein.
- C. Handrail shall be either Type I or Type II handrail as shown on the Drawings. If no type is indicated on Drawings, handrail shall be Type I.
 - 1. Type I handrail shall be a two-rail system. The centerline of the intermediate rail shall be 21 inches above the walking surface.
 - 2. Type II handrail shall be a three-rail system with vertical posts spanning between the two intermediate rails.
 - a. The centerline of the lower intermediate rail shall be 7 inches above the walking surface.
 - b. The centerline of the upper intermediate rail shall be 5-3/4" below the centerline of the top rail.
 - c. Vertical posts spanning between the intermediate rails shall be 1/2" diameter schedule 40 pipe or fiberglass rod.
 - d. Spacing of vertical posts shall be as required to prevent passage of a 4-inch sphere at any point.
- D. Where gates are required in handrails as shown on the Drawings, they shall be self-closing and shall be provided by the same manufacturer as the handrail. Gates shall swing away from the opening being protected by the handrail.
- E. Where safety chains are required in handrails as shown on the Drawings, chains shall be constructed of Type 304 stainless steel. Chains shall be straight link style, 3/16-inch diameter, with at least twelve links per foot, and with snap hooks on each end. Snap hooks shall be boat type and eye bolts for attachment of chains shall be 3/8-inch bolts with 3/4-

inch eye diameter welded to the railing posts. Two (2) chains, four inches longer than the anchorage spacing shall be supplied for each guarded area.

2.04 FREE STANDING RAILING SYSTEM

- A. Free standing railing system shall be installed on roof ledges where accessible equipment is provided on roof and roof does not have a perimeter parapet wall of a minimum height of 42 inches. Free standing railing system shall be Safety Rail 2000 Guardrail System by BlueWater Mfg., Inc. or approved equal.
- B. Toe Board brackets shall be used when the parapet wall is less than 3-1/2" in height.
- C. Performance Characteristics: Shall meet and exceed OSHA (Standards - 29 CFR) 1926.502 (b).
 - 1. Railing System shall be designed to withstand a minimum 200 pounds of test load in any direction.
 - 2. Railing System shall consist of a top rail and rail at mid height between top rail and walking surface.
 - 3. Railing system shall extend to a height of at least 42" from the finished roof deck.
 - 4. Railing system shall be free of sharp edges and snag points.
- D. Railing and Base
 - 1. Rail shall be 1 5/8" O.D. Hot Rolled Pickled Electric Weld Tubing
 - 2. Each support post shall have a free standing base cast from Class 30 Gray Iron material.
 - 3. Each base shall have four (4) receiver posts for accepting the rails.
 - 4. The receiver posts shall have a positive locking system. A friction locking system will not be acceptable.
 - 5. The receiver posts shall have a slot to enable the rails to be mounted in any direction.
- E. Hardware
 - 1. The securing pins shall be made from 1010 carbon steel. The pins shall be zinc plated and yellow chromate dipped. The pins shall consist of a collared pin and a lanyard that connects to a lynch pin.
 - 2. For Gate Assemblies Only. Bolts and washers shall be 3/8" x 3 1/2" and 3/8" x 3" grade 5, zinc plated.
 - 3. Finish: Rails: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

Bases: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. Concrete anchors and bolts for attachment of handrail baseplates to supporting members shall conform to Section 05050, Metal Fastening.
- G. All fabricated items shall be shop painted in accordance with Section 09900, Painting.

3.02 INSTALLATION

- A. Assembly and installation of handrails and railings shall be performed in strict accordance with manufacturer's recommendations.
- B. All handrails and railings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

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SECTION 05531

GRATINGS, ACCESS HATCHES, AND ACCESS DOORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all gratings, floor plates, and hatches in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. Aluminum Association Specifications for Aluminum Structures
 - 3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Complete fabrication and erection Drawings of all gratings, access hatches, and access doors specified herein.
 - 2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for gratings, floor plates, and hatches shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used for gratings, floor plates, and hatches shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 GRATING

- A. General - Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.

1. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.
2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No fasteners shall be permitted to project above the walking surface.
3. Grating shall be designed for a loading of 150 psf unless otherwise required by the Drawings. Grating deflection shall not exceed 1/4 inch under a uniform load of 100 psf. Minimum grating depth shall be 1-1/2 inches, unless structural requirements based on clear span require more depth.
4. Grating installed in cast-in-place concrete shall be provided with embedded support frames on all perimeter and bearing edges. Support frames shall include anchor straps or headed studs at a maximum of 18" on-center, a minimum of two each side. Support frames shall be fabricated from the same material as the grating.

B. Aluminum Grating

1. Aluminum grating shall be of I-bar type and shall consist of extruded bearing bars positioned and locked by crossbars. All supports, cross members, etc. shall be aluminum. Plank clips for grating holddowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.
2. Grating shall be "19-SI-4 I-Bar Swage Locked" by Alabama Metal Industries Corporation (AMICO), "IB" by Harsco Industrial IKG, "I-Bar 19SGI4", by Ohio Grating Inc., or "I-Bar" by Thompson Fabricating LLC.

C. Aluminum Plank Grating

1. Aluminum plank grating shall be unpunched planks of extruded aluminum welded together to form panels. Panel ends shall have an extruded aluminum end bar welded in place. All support members shall be aluminum. Plank clips for grating holddowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.
2. Aluminum plank grating shall be HD-P manufactured by Harsco Industrial IKG., Heavy Duty Series manufactured by Ohio Gratings, Inc., or Unpunched Duo-Grip Extruded Series manufactured by Alabama Metal Industries Corporation (AMICO).

D. Heavy Duty Steel Grating

1. Heavy duty steel grating shall be galvanized according to Section 05035, Galvanizing.
2. Main bearing bars shall conform to ASTM A36. Cross bars shall be flush with the top of the grating. Provide embedded galvanized steel support frames for cast-in-place concrete installations.
3. Grating span shall be 36 inches maximum and shall satisfy AASHTO loading for H-20 truck.
4. Grating shall be manufactured by Harsco Industrial IKG, Alabama Metal Industries Corporation (AMICO), and Ohio Gratings, Inc.

2.04 ACCESS DOORS

A. General

1. Door opening sizes, number and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings shall indicate the clear opening dimensions.
2. All doors shall be aluminum unless otherwise noted.
3. Openings larger than 42 inches in either direction shall have double leaf doors.
4. Doors shall be designed for flush mounting and for easy opening from both inside and outside.
5. All doors shall be provided with an automatic hold-open arm with release handle.
6. Double leaf doors shall be provided with safety bars to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.
7. All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be Type 316L stainless steel.
8. All doors shall be watertight with a continuous gasket. All single door applications shall include a continuous EPDM odor reduction gasket.
9. Door frames shall be extruded and equipped with a 1-1/2 inch minimum drain pipe located by the manufacturer. The drain pipe shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.

B. Floor, Wet Well and Dry Pit Access Doors

1. Door leaves shall be 1/4 inch, minimum, diamond pattern plate with an approved raised pattern, non-skid surface. Plate shall be stiffened as required to maintain allowable stress and deflection requirements. Stiffeners shall consist of angles or bars welded to the bottom of plate.
2. Doors shall be designed for a 300 psf live load minimum, unless noted otherwise.
3. Doors shall be designed for flush mounting and for easy opening from both inside and outside.
4. All doors shall have an enclosed compression spring assist and open to 90 degrees.
5. Exterior doors shall be Type "J-AL" or "JD-AL", by Bilco Company, Type "W1S" or "W2S" by Halliday Products Inc., Type "TPS" or "TPD", by U.S.F. Fabrication Inc., Type "THG" or "THG-D", by Thompson Fabricating LLC..
6. Interior doors shall be Type "K" or "KD", by Bilco Company, Type "S1S" or "S2S" by Halliday Products Inc., Type "APS300" or "APD300", by U.S.F. Fabrication Inc., Type "TH" or "TH-D", by Thompson Fabricating LLC.
7. Doors rated for H-20 traffic loading shall be "JAL-HD" or "JDAL-HD" by the Bilco Company, Type "H1C" or "H2C" by Halliday Products, Inc., or Type "THS" or "THD" by U.S.F. Fabrication Inc.

C. Roof Access Doors

1. Doors shall be designed for 50 psf live load unless noted otherwise.
2. Doors for service stairs shall be Bilco Type L roof Scuttles.
3. Doors for ladder access shall be Bilco Type S or SS Roof Scuttles.

D. Fixed Ladders

1. Where the Contract Documents indicate fixed ladders are required under access doors, they shall be provided with "LadderUp, Model LU-4" by Bilco Company, "L1E Ladder Extension" by Halliday Products Inc., or "Ladder Climb-out Device" by Thompson Fabricating.
2. The safety posts shall be manufactured of the same material as the access door with telescoping tubular sections that lock automatically when fully extended.
3. Upward and downward movement shall be controlled by a stainless steel balancing mechanism.
4. Safety posts shall be assembled in strict accordance with manufacturer's recommendations.

2.05 FALL THROUGH PREVENTION SYSTEM

- A. All access hatches and access doors covering openings measuring 12 inches or more in its least dimension through which persons may fall shall be equipped with a fall through prevention system, except where noted on the Contract Drawings. Access hatches and access doors shall be provided with a permanent installed fall through prevention grate system that provides continuous safety assurance in both its closed and open positions. The grate system shall be made with 6061-T6 aluminum or FRP and be designed for a 300 psf minimum liveload, unless noted otherwise.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All gratings, access hatches, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions. Embedded support frames shall be set level and square.
- C. Grating shall not be field cut or modified unless approved by Engineer.
- D. Grating shall not be used for equipment support or anchorage.

- END OF SECTION -

SECTION 05540

CASTINGS

PART 1 -- GENERAL

1.01 REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all castings in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02604 – Utility Structures
- B. Section 05010 - Metal Materials

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Complete fabrication and erection drawings of all castings specified herein.
 - 2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for castings shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used for castings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 IRON CASTINGS

- A. General - Iron Castings shall include, but not be limited to frames, covers, and grates for trench drains, catch basins, and inlets/.
 - 1. Castings shall be of gray iron of uniform quality, free from defects, smooth and well cleaned by shotblasting.
 - 2. Catalog numbers on the Drawings are provided only to show required types and configuration. All covers shall be cast with raised letters as designated on the Drawings.
 - 3. Castings shall be as manufactured by Dewey Brothers, or Neenah Foundry Company.
- B. Covers and Grates
 - 1. Covers and grates shall be provided with matching frames. Cover shall fit flush with the surrounding finished surface. The cover shall not rock or rattle when loading is applied.
 - 2. Round covers and frames shall have machined bearing surfaces.
 - 3. Design loadings:
 - a. Where located within a structure, a minimum design loading of 300 psf shall be used, unless noted otherwise.
 - b. At all locations not within a structure, the design loading shall be a standard AASHTO H-20 truck loading, unless otherwise noted.
- C. Watertight gasketing, bolting, locking devices, patterns, lettering, pickholes, vents, or self-sealing features shall be as detailed on the Drawings.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All castings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -

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SECTION 05550
STAIR TREADS AND NOSINGS

PART 1 -- GENERAL

1.01 REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all stair treads and nosings in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05050 - Metal Fastening
- C. Section 05510 - Metal Stairs
- D. Section 06610 - Glass Fiber and Resin Fabrications

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code with SC Modifications
 - 2. Aluminum Association Specifications for Aluminum Structures.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Complete fabrication and erection drawings of all work specified herein.
 - 2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for stair treads and nosings shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used for stair treads and nosings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 SAFETY STAIR NOSINGS

- A. Abrasive cast aluminum, safety stair nosings shall be provided on all concrete or concrete filled steel pan stairs, including the top stair of metal stairs that attach to concrete, and as shown on the Drawings unless noted otherwise.
- B. Nosing shall be 3 inches wide and shall extend the full width of the stairway minus 3 inches on either side. Nosing shall be cast into the concrete and held in place with butterfly type extruded anchors.
- C. The nosing shall be "Style 231-A", by Amstep Products, "Alumogrit Type 101", by Wooster Products, Inc., "Type AX", by Safe-T-Metal Company. For steel pan concrete filled stairs, nosing shall be "Type 101-SP", Wooster Products, Inc., or "Type AXPE", by Safe-T-Metal Company. For pan stairs, nosing shall be continuous over corner of stair treads to fully protect corner of treads from abrasion. All exposed fasteners shall be Type 304 stainless steel.

2.04 STAIR TREADS

- A. Stair treads shall be aluminum with an abrasive nosing as shown on the Drawings.
- B. Stair treads shall be designed for the live load specified in Section 05510, Metal Stairs.
- C. Stair treads shall be as manufactured by IKG Industries, or Safe-T-Metal Company.

2.05 FRP STAIR NOSINGS

- A. FRP stair nosings shall be provided on all concrete stairs in sodium hypochlorite areas and as indicated on the Drawings.
- B. FRP stair nosings shall conform to Section 06610, Glass Fiber and Resin Fabrications as indicated on the Drawings.

2.06 FRP STAIR TREADS

- A. FRP stair treads shall be provided for FRP stairs in sodium hypochlorite areas and as indicated on the Drawings.
- B. FRP stair treads shall conform to Section 06610, Glass Fiber and Resin Fabrications.

PART 3 -- EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- E. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

- A. Assembly and installation of stair treads and nosings shall be performed in strict accordance with manufacturer's recommendations.
- B. All stair treads and nosings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -

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SECTION 05830

BEARING DEVICES AND ANCHORING

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

- A. The Contractor shall furnish and install bearing plates, pads, expansion devices, anchor rods and bolts and/or other devices used in conjunction with bearings and anchoring of bearing devices and assemblies at supports in accordance with this item and in conformity with the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening
- D. Section 05120 - Structural Steel
- E. Section 05140 - Structural Aluminum
- F. Section 09900 - Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified hereunder shall conform to the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

- | | | |
|----|---------------------|---|
| 1. | RMA Rubber Handbook | A4-F3-T.063-B2, Grade 2, Method B |
| 2. | ASTM A240, | Standard Specification for Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plate and Sheet |
| 3. | ASTM A480 | Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip |
| 4. | ASTM D395, Method B | Standard Test for Rubber Property – Compression Set |
| 5. | ASTM D412 | Standard Test for Rubber Properties In Tension |

6.	ASTM D471	Standard Test for Rubber Property - Effect of Liquids
7.	ASTM D573	Standard Test for Rubber-Deterioration In Air Oven
8.	ASTM D575, Method A	Standard Test for Rubber Properties In Compression
9.	ASTM D624, Die C	Standard Test for Rubber Property - Tear Resistance
10.	ASTM D746	Standard Test for Brittleness Temperature of Plastics and Elastomers by Impact
11.	ASTM D792	Standard Test for Specific Gravity and Density of Plastics by Displacement
12.	ASTM D1149	Standard Test for Rubber Deterioration - Surface Ozone Cracking In a Chamber (Flat Specimens)
13.	ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40
14.	ASTM D2240	Standard Test for Rubber Property - Durometer Hardness
15.	ASTM D2256	Standard Test for Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method
16.	ASTM D4894	Standard Specification for PTFE Granular Molding and RPM Extension Materials
17.	ASTM D4895	Standard Specification for PTFE Resin Produced From Dispersion

1.04 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01300, Submittals:

1. Certification of compliance that the materials furnished under this section meet and conform to the property and physical requirements, including all testing, as stated herein and as referenced. Specifically, the certification shall state compliance with the applicable standards (ASTM, ANSI, etc.) for fabrication and testing.
2. Shop Drawings for all materials, including installation and adjustment instructions. Included with the Shop Drawings shall be all material certifications, mill test results, working drawings, etc., which are required by this and other applicable sections of the Specifications.

PART 2 -- PRODUCTS

2.01 ELASTOMERIC BEARING PADS

- A. The elastomer portion of pads shall be new neoprene compound. Pads shall be cast under heat and pressure and may be individually molded or cut from pressure-cast stock. Variations from the dimensions shown on the Drawings shall not be more than the following: thickness, $\pm 1/16$ inch; width, $-1/8$ to $+1/4$ inch; length, $-1/8$ to $+1/4$ inch. Tolerances, dimensions, finish and appearance, flash, and rubber-to-metal bonding shall conform to the requirements of A 4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be furnished in one piece and shall not be laminated unless otherwise specified. Pads shall be furnished in identifiable packages.
- B. Adhesive for use with elastomer pads shall be an epoxy-resin compound compatible with the elastomer having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20°F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikodur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.
- C. Laminated pads shall consist of alternate laminations of elastomer and hot-rolled steel sheets molded together as a unit. Outer metal laminations shall be $3/16$ inch, and inner laminations shall be 14 gage. Outer laminations of elastomer shall be $1/4$ inch, and inner laminations shall be of equal thickness (at least $3/8$ but not more than $1/2$ inch), depending on the number of laminations and thickness of the pad. Edges of metal laminations shall have a cover of approximately $1/8$ inch of elastomer. The top and bottom bearing surfaces shall each have an integral sealing rib approximately $1/8$ inch in depth, in addition to the specified total thickness, and $3/16$ inch in width around their peripheries. The bond between the elastomer and metal shall be such that failure shall occur in the elastomer and not between the elastomer and steel when tested for separation. Variations from specified dimensions for individual laminations shall not be more than those specified herein. The total thickness of the complete pad shall not vary more than $\pm 1/8$ inch.
- D. Material having a nominal durometer hardness of 70 and 50 shall be used for nonlaminated pads and laminated pads, respectively. Test samples will be prepared from finished pads. Samples of each thickness will be taken from 2 full-size pads from each shipment of 300 pads or less, with 1 additional pad for each additional increment of 300 pads or fraction thereof. When tested using the ASTM methods designated, samples shall comply with the following physical requirements.
1. **Original Physical Properties:** Test results for tear resistance, tensile strength, and ultimate elongation shall not be more than 10 percent below the following specified value:

	Nominal 50	Hardness 70
Min. tear resistance, ASTM D624, Die C (lb/in of thickness)	180	200
Hardness, ASTM D2240 (points)	50 \pm 5	70 \pm 5
Min. tensile strength, ASTM D412 (average psi of longitudinal and transverse)	2,500	2,500

Min. ultimate elongation (%)	400	300
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The compressive deflection tested in accordance with ASTM D575, Method A, shall be as follows:

- a. **Laminated Pads:** The maximum compression deflection shall be 5 and 7 percent of the total rubber thickness at loads of 500 and 800 pounds per square inch, respectively. The maximum shear resistance shall be 50 pounds per square inch of the plan area at 25 percent shear deformation at -20°F . Test pads shall be subjected to a compressive load of 1.5 times the maximum design load without visible damage to the bearing.
 - b. **Nonlaminated Pads:** When loaded within 300 to 800 pounds per square inch, material shall show a compressive deflection within 20 percent of that given in the charts of Method A, interpolating for actual measured hardness.
2. **Changes in Original Physical Properties:** When pads are oven aged 70 hours at 212°F in accordance with ASTM D573, changes shall not be more than the following:

Property	Value
Hardness (points change)	0 to +15
Tensile strength (% change)	± 15
Ultimate elongation (% change)	-40

3. **Extreme Temperature Characteristics:** Compression set under constant deflection, ASTM D395, Method B, 22 hours at 212°F , shall not be more than 35 percent. With the low-temperature brittleness test, ASTM D746, breaks shall not occur above -20°F .
4. **Ozone Cracking Resistance:** Upon exposure to 100 parts per million of ozone in air by volume at a strain of 20 percent and a temperature of $100 \pm 2^{\circ}\text{F}$ in a test otherwise in accordance with ASTM D1149, cracks shall not develop within 100 hours. Samples shall be wiped with solvent before the test to remove traces of surface impurities.
5. **Oil Swell:** The volume change shall not be more than +120 percent when tested in accordance with ASTM D471 with ASTM Oil No. 3, 70 hours at 212°F .

2.02 TFE BEARING SURFACES

- A. TFE resin shall be virgin material conforming to the requirements of ASTM D4894 or D4895. The specific gravity shall be 2.13 to 2.19. The melting point shall be $623 \pm 2^{\circ}\text{F}$.
- B. Filler material shall be milled glass fibers, carbon, or other approved inert filler materials.
- C. Adhesive material shall be an epoxy resin conforming to FS MMM-A-134, FEB film or equal, as approved by the Engineer.

- D. When tested in accordance with ASTM D4894 or D4895, finished unfilled TFE sheets shall have a tensile strength of at least 2,800 pounds per square inch and an elongation of at least 200 percent.
- E. Filled TFE sheets shall contain inert filler material uniformly blended with TFE resin. Finished filled TFE sheets containing glass fiber or carbon shall conform to the following:

	ASTM Method	15% Glass Fibers	25% Carbon
Min. tensile strength	D4894/D4895	2,000 psi	1,300 psi
Min. elongation	D4894/D4895	150%	75%
Min. specific gravity	D792	2.20	2.10
Melting point	D4894/D4895	327±10°C	317 ±10°C

- F. Fabric containing TFE fibers shall be manufactured from oriented multifilament TFE fluorocarbon fibers and other fibers as required by specific designs. When tested in accordance with ASTM D2256, the tensile strength of TFE fibers shall be at least 24,000 pounds per square inch and the elongation shall be at least 75 percent.
- G. Where TFE sheets are to be epoxy bonded, one surface of the sheet shall be factory treated by an approved manufacturer using the sodium naphthalene or sodium ammonia process.
- H. Stainless steel mating surfaces shall be at least 16 gage in thickness and shall conform to the requirements of ASTM A240, Type 304. The mating surface shall be a true plane surface with a Brinnell hardness of at least 125 and a surface finish of an at least No. 8 mirror finish in accordance with ASTM A480. Stainless steel mating surfaces shall be polished or rolled as necessary to conform to the friction requirements specified herein. The stainless steel shall be attached to the sole plate by means of a seal weld around the entire perimeter of the facing material.
- I. The coefficient of friction for the completed bearing assembly shall not be more than the following:

Material	Bearing Pressure		
	500 psi (3.447 MPa)	2,000 psi (13.790 Mpa)	3,500 psi (24.132 MPa)
Unfilled TFE, fabric			
Containing TFE fibers, TFE	.08	.06	.04
perforated metal composite			
Filled TFE	.12	.10	.08
Interlocked bronze and			
filled TFE structures	.10	.07	.05

2.03 PREFORMED FABRIC BEDDING MATERIAL

- A. Material shall be composed of multiple layers of 8-ounce cotton duck impregnated and bound with high-quality natural rubber or its equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plys shall be such as to produce the specified thickness after compression and vulcanizing. Finished pads shall withstand compression loads perpendicular to the plane of the laminations of at least 10,000 pounds per square inch without a detrimental reduction in thickness or extrusion.

2.04 ANCHOR RODS

- A. Anchor bolts shall be as specified in Section 05050, Metal Fastening.

2.05 PIPE SLEEVES AND COLLARS

- A. Pipe sleeves and collars shall be cut from schedule 40 PVC plastic pipe meeting the requirements of ASTM D1785 unless otherwise noted on the Drawings.

PART 3 -- EXECUTION

3.01 STEEL PLATES, SHAPES, AND BARS

- A. Unless galvanizing is indicated on the Drawings, items shall be painted in accordance with the Drawings and Section 09900, Painting.
- B. If galvanizing is indicated on the Drawings, steel bearing assemblies for both structural steel beams and girders and prestressed concrete members shall be galvanized as specified in Section 05035, Galvanizing. Except for attachments of bearing plates to beams, all fabrication and welding of bearing plate assemblies shall be performed before the steel is galvanized. All joints of welded parts shall be sealed with weld material. Welds made for attaching bearing plates to beams or girders shall be cleaned and given 2 coats of zinc rich paint having a minimum total coating thickness of 3 mils.

3.02 BRONZE PLATES

- A. Sliding surfaces of bronze plates shall be polished.

3.03 COPPER-ALLOY PLATES

- A. Finishing of rolled copper-alloy plates will not be required provided their surfaces are plane, true, and smooth.

3.04 SELF-LUBRICATING PLATES

- A. Plates shall be fabricated from cast bronze or rolled copper alloy.
- B. Sliding surfaces of plates shall be provided with annular grooves or cylindrical recesses or a combination thereof, which shall be filled with a lubricating compound. The lubricating compound shall be compressed into recesses under sufficient pressure to form a nonplastic lubricating inset. The inset shall comprise at least 25 percent of the total area of the plate. The frictional coefficient shall not be more than 0.10. The compound shall be free from

material that will cause abrasive or corrosive action on metal surfaces and able to withstand extremely high pressures and atmospheric elements over long periods of time.

- C. Items shall be the standard products of the manufacturer of such materials for the application.
- D. Prior to assembly, the steel surface that will bear on the self-lubricating bearing plate shall be thoroughly lubricated with additional antioxidant lubricant furnished by the manufacturer. Coatings shall be removed before application of antioxidant lubricant.

3.05 ELASTOMERIC PADS

- A. Care shall be taken in fabricating pads and related metal parts so that effects detrimental to their proper performance, such as uneven bearing and excessive bulging, will not occur.

3.06 PLACEMENT OF BEARING PLATES AND PADS

- A. Bearing areas shall be finished to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area.
- B. Bearing plates or pads shall be set level in exact position and shall have a uniform bearing over the entire area. Provision shall be made to keep plates or pads in the correct position during erection of beams or placement of concrete.
- C. Elastomeric pads and other flexible bearing materials shall be placed directly on masonry surfaces finished to a roughness equivalent to that of a No. 36 to No. 46 grit. Pads, bearing areas, or bridge seats and metal bearing plates shall be thoroughly cleaned and free from oil, grease, and other foreign materials. Metal bearing plates or bottoms of prefabricated beams that are to bear on elastomeric pads shall be coated with epoxy and then surfaced with a No. 36 to No. 46 silicon carbide or aluminum oxide grit. Bearing areas shall be finished to equivalent roughness.
- D. Metal bearing plates shall be bedded on seats as follows:
 - 1. The seat bearing areas shall be thoroughly swabbed with approved paint, and three layers of duck, 12 to 15 ounce per square yard, shall be placed on it, each layer being thoroughly swabbed with paint on its top surface.
 - 2. Superstructure shoes or pedestals shall be placed in position while paint is plastic. As an alternate to duct and paint, preformed fabric bedding material at least 1/8 inch in thickness may be used when called for on the Drawings or approved in writing by the Engineer.

3.07 PLACEMENT OF ANCHOR RODS

- A. All necessary anchor rods and bolts (anchors) shall be accurately set either in the concrete as they are being placed, in formed holes, or in holes cored after the concrete has set. If set in the concrete, the rods and bolts shall be accurately positioned by means of templates and rigidly held in position while the concrete is being placed. Holes may be formed by inserting or casting in the fresh concrete oiled wooden plugs, metal pipe or plastic sleeves, or other approved devices, and withdrawing them after the concrete has partially set or left in place as indicated on the Drawing's or approved by the Engineer. Holes so formed shall be at

least 3 inches in diameter or at least 2.5 times the diameter of the rod or bolt. If cored, holes shall be at least 2.5 times the diameter of the anchor used or as indicated on the Drawings. Equipment used for coring concrete shall have been approved by the Engineer. Impact tools will not be permitted. Reinforcing steel shall be placed to provide adequate space to core rod/bolt holes without cutting the reinforcing steel. For cored holes, anchor rods and bolts shall be adequately held in place at the centroid of the hole or as specified on the Drawings by using approved pre-fabricated equalizers designed to allow grout to penetrate and fill the hole completely and spaced as approved by the Engineer.

- B. During freezing conditions, anchor holes shall be protected from water accumulations at all times.
- C. Anchors which are to be placed in holes of sufficient and specified diameter after the concrete has set shall be bonded to the concrete with a non-shrink high-strength Portland cement grout in accordance with Section 03600 – Grout or shall be adhesive anchors in accordance with Section 05050 - Metal Fastening. The type anchoring system and grout shall be as indicated on the Drawings. The grout or adhesive shall completely fill the holes. Anchors shall be tested for sufficient pull-out capacity as indicated in applicable sections of the Specifications or as indicated on the Drawings.
- D. Anchors that are not designed to project through bearing plates shall be checked for proper projection above the masonry bearing area immediately prior to placement of bearing plates and beams. Nuts on anchor rods at expansion ends shall be adjusted to permit free movement of the span.
- E. Angles for anchor assemblies to be attached to sides of concrete beams shall not be installed until beams have received their full dead load and supporting falsework has been removed.

- END OF SECTION -

SECTION 09801

RAVEN 405 COATING SYSTEM

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

- A. Furnish and install special coating systems in accordance with the Contract Documents.
- B. Coating System
 - 1. Install Raven 405 coating system where shown on the drawings for the Thomas Island Regional Pump Station and Interceptor project.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03250 - Concrete Accessories
- B. Section 03350 - Concrete Finishes
- C. Section 09900 - Painting

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these Specifications the Work shall conform to the applicable requirements of the following documents:
 - 1. SSPC-SP13/NACE No. 6 Surface Preparation of Concrete
 - 2. NACE National Association of Corrosion Engineers
 - 3. SSPC The Society of Protective Coatings
 - 4. ASTM American Society of Testing and Materials

1.04 SUBMITTALS

- A. Shop Drawings including the following items shall be submitted in accordance with Section 01300.
 - 1. Manufacturer's product data and material safety data sheets for each coating product provided. Include manufacturer's color chart for each product supplied.
 - 2. Manufacturer's installation instructions and recommendations specific to environmental conditions, surface preparation, substrate conditions, and application procedures.

3. Complete shop drawings including location and details for all terminations and transitions.
4. Certifications:
 - a. Furnish affidavits from the manufacturer certifying that materials furnished conform to the requirements specified.
 - b. Certify concrete repair and coating products have been checked for compatibility.
 - c. Certification from manufacturer stating the applicator and applicator's assigned personnel are certified and have received specific training for the application of the Raven 405 coating system.
 - d. Certificate from applicator stating the assigned personnel have received specific training for the application of the Raven 405 coating system.
 - e. Submit manufacturer's representative or independent inspector's NACE or SSPC certification.
5. Submit manufacturer's representative name, address and telephone number who will inspect work.
6. Provide list of at least 10 applications in high H₂S environments in the Southeast including contact names, address, phone numbers and date of installation for both the coating system and the applicator.
7. Field Data Records and Installation Reports.
8. Product Warranty.
9. Closeout Submittals:
 - a. As-built drawings which include coating application limits, transitions, and terminations.
 - b. Photos
 - c. Quality assurance records, field data records and installation reports
 - d. Certificate of Surface Preparation
 - e. Test and evaluation reports including pull-off strength (adhesion) and spark testing.
 - f. Final Report
 - g. Final Certified Warranty

1.05 QUALIFICATIONS

- A. Products shall be manufactured by company specializing in manufacturing the products specified in this section with a minimum of five continuous years of experience for performance in similar applications in wastewater treatment plants and wastewater collection systems.
- B. The Contractor performing the work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be an approved installer of the coating system as certified and licensed by the manufacturer. The Contractor shall have successfully installed a minimum of 50,000 square feet of the proposed system and shall have a minimum of five (5) years service for applying the selected lining or coating system as documented by verifiable references. There shall be no exceptions to this experience requirement. The Contractor shall submit the following information to the Engineer for review and approval before any work is performed. The following information is required.
 - 1. The number of years of experience in performing this type of specialized work and in installing the specified coating system.
 - 2. Name of the manufacturer and supplier for this work and previous work listed below.
 - 3. A list of municipal clients that the Contractor has performed this type of work including names, phone numbers, and square feet of material installed.
 - 4. The Contractor shall submit a certified statement from the manufacturer that he/she is a certified and/or licensed installer of the coating.

1.06 QUALITY ASSURANCE

- A. The supplier shall be responsible for the provisions of all test requirements specified in the referenced ASTM Standards as applicable. The supplier shall also bear the cost of all tests specified in Paragraph 3.05, Field Testing and Acceptance of Raven 405 Coating System. In addition, all coating products to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of plant inspection of all products and materials approved for this Contract shall be borne by the Owner.
- B. Inspections of the coating products and materials may also be made by the Engineer or other representatives of the Owner after delivery. The products and materials shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though samples may have been accepted as satisfactory at the place of manufacture. Materials rejected after delivery shall be marked for identification and shall be removed from the job at once.
 - 1. Provide adequate time and access for inspections for the following major activities:
 - a. Pre-surface preparation
 - b. Monitoring of surface preparation
 - c. Post-surface preparation

- d. Monitoring of repair and resurfacing product application
- e. Post repair and resurfacing products
- f. Monitoring of coating application
- g. Post application inspection and testing
- h. Corrective actions and final inspection

C. Pre-installation Meeting

1. At least two weeks prior to beginning work, the Contractor shall conduct a Pre-installation Meeting to discuss coating procedures and submittals. Attendees shall include the Coating Applicator, Owner, Engineer, Manufacturer's Technical Representative, Testing and Inspection Agencies (if applicable), Concrete Repair subcontractor (if applicable) and the Contractor. The minimum agenda includes:
 - a. Environmental condition requirements
 - b. Surface temperature requirements
 - c. Surface pH requirements
 - d. Surface preparation procedures
 - e. Cleaning procedures
 - f. Testing procedures to determine moisture content of concrete
 - g. Proper procedures to fill substrate
 - h. Application equipment
 - i. Proper application of primer
 - j. Proper application of coating system
 - k. Proper termination and transition details
 - l. Inspection of coating during and after application
 - m. Testing of coating.
 - n. Repair methods
 - o. Documentation requirements
 - p. Approval Procedures

D. Field Data Records

1. Maintain daily Quality Assurance Records including the following:
 - a. Date
 - b. Atmospheric Temperature and Humidity
 - c. Substrate pH
 - d. Substrate Temperature
 - e. Dew Point

- f. Product Batch Numbers
- g. Mixing Time for Each Part and the Combined Parts of a Coating System
- h. Pot Life
- i. Curing Time of Primer and Finish Layers
- j. Holiday Test Results and Repair Data
- k. Foreman or Supervisor's Signature

1.07 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. Provide the services of a qualified manufacturer's technical representative who shall adequately supervise the surface preparation and application of the coating and lining products. The manufacturer's representative shall be available to evaluate the coating at each step through the process and shall supervise the lining or coating application until the installer has shown through the proper surface preparation and application of the lining or coating that the system will be installed in accordance with all manufacturer recommendations.
- B. Manufacturer's technical representative or authorized inspector shall be currently certified by NACE or SSPC.
- C. A manufacturer's technical representative shall observe the application of the complete system a minimum of two days at the beginning of the application at each structure specified to receive Raven 405 coating system. The manufacturer's technical representative shall provide guidance to ensure proper application of the system.
- D. The manufacturer's technical representative shall submit to the Engineer a final report, at the completion of the work, identifying the products used, verifying and certifying that surfaces and lining systems were properly applied, free of pinholes, blisters and other blemishes that will compromise the coating performance and that the coating systems were proper for the exposure and surface. Discrepancies that are found during the final inspection shall be repaired and reinspected until system is completely satisfactory.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in shipping, handling and placing to avoid damaging the products. Extra care may be necessary during cold weather construction. Any product or material damaged in shipment shall be replaced as directed by the Engineer.
- B. Products shall be delivered to the site in clearly labeled containers and packaging. While stored, the products shall be adequately packaged and protected. Products shall be stored in a manner as recommended by manufacturer.
- C. Any product showing deterioration, or which has been exposed to any other adverse storage condition that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work.

1.09 WARRANTY

- A. All lining and coatings installed shall be guaranteed by the Contractor for a period of two years from the date of final acceptance. During this period, all defects discovered in the coating, as

determined by the Owner or Owner's Engineer shall be repaired or replaced in a satisfactory manner by the Contractor at no cost to the Owner.

- B. The Contractor is responsible for properly preparing the structures for coating prior to the installation of the systems, including stopping all leaks, patching voids, protecting or removing and handling all mechanical equipment such as valves and valve assemblies and weirs, cleaning surfaces, removing rubble, etc.

PART 2 – PRODUCTS

2.01 PRIMER

- A. Primer shall be moisture tolerant, suitable for the environmental conditions, and compatible with the Raven 405 coating. Primer shall be as recommended and preferably manufactured by the manufacturer of the Raven Coating System. If approved by manufacturer, Raven Coating System can be self-priming.
- B. Primer shall be as recommended by the coating manufacturer to achieve a superior coating system performance. Manufacturer shall select primer based on substrate moisture, environmental conditions and humidity, substrate temperature, pH, and other properties.

2.02 RAVEN COATING SYSTEM

- A. Provide Raven Coating System on surfaces indicated to receive Raven Coatings in this specification and on drawings. Raven Coating System is to be applied only by Factory Trained and Certified Applicators.
- B. The coating shall be Raven 405 epoxy mortar system such as manufactured and applied by Raven Lining Systems.
- C. The Raven 405 Coating shall be applied in two (2) coats of 60 mils each for a total DFT of 120 mils. In addition to Raven Coating, fill bugholes, depressions, and irregularities in surfaces with any dimension greater than 0.0625 inch with epoxy filler recommended by manufacturer and apply primer at 10 mils recommended by manufacturer to achieve superior performance.
- D. Raven Coating System shall meet the following minimum characteristics:
 - 1. Total Film Thickness of System including primers shall not be less than 100 mils (unless otherwise noted).
 - 2. Chemical Resistance of 10% of sulfuric acid.
 - 3. Water Vapor Permeance of 0.002 perms per ASTM E96, Method E.
 - 4. Concrete Tensile Pull Strength 350 psi ASTM D4541.
 - 5. Tensile Strength of 2,750 psi ASTM D412.
 - 6. Abrasion Resistance, CS17 Wheel <120mg loss, ASTM D4060, 1000 gm load/1000 cycles.
 - 7. Minimum Shore Hardness D50, ASTM D2240.

8. Resistant to negative water infiltration.
9. 100% solids epoxy mortar system containing aggregate and/or fiber reinforcement.

PART 3 -- EXECUTION

3.01 PROTECTION OF IN-PLACE CONDITIONS

- A. Equipment, vehicles, buildings, and other finished items shall be protected from damage and overspray. Sensitive equipment shall be wrapped in plastic and tape.

3.02 SURFACE PREPARATION

- A. Surfaces to receive coating shall be clean and free of dirt, oil, grease, and other foreign materials.
- B. Concrete and masonry surfaces shall cure for 28 days minimum prior to coating. Moisture content of concrete and masonry surfaces shall conform to manufacturer's recommended limits, and as listed in SSPC-SP13/NACE 6 Section 6 Acceptance Criteria Table 1. Surfaces shall be tested in accordance with ASTM D4263 – Plastic Sheet Test, ASTM F1869 – Calcium Chloride and ASTM F2170 – Relative Humidity Gauge as recommended by the manufacturer.
- C. Test surfaces to ensure they are within requirements of the manufacturer. Do not begin coating work until moisture is within manufacturer's recommended range. Any leaks shall be repaired as all surfaces shall be free of visible moisture and floating water.
- D. Minimum surface preparation of concrete shall be per Section 09900, SSPC 13, and provide a surface profile as required by the coating manufacturer. Remove all laitance, weak concrete, dirt, and other contaminants. Remove all fins, protrusions, and similar imperfections to allow a uniform surface after surface preparation. Under no circumstance shall surface preparation be less than manufacturer's recommendation to provide the best possible installation. Moisture levels of concrete shall be tested and documented and within acceptable ranges prior to application of coating.
- E. Bugholes, depressions, and irregularities in surfaces with any dimension greater than 0.0625 inch shall be filled with epoxy filler recommended by manufacturer.
- F. Where the surface deterioration is less than or equal to 1/2 inch (as measured from the final finished surface to the prepared surface to be repaired) skim coats of epoxy modified cementitious mortar shall be applied to restore and smooth surface irregularities to the final finished surface. Epoxy modified mortar system shall be manufactured by same manufacturer of Raven Coating System.
- G. Where the surface deterioration is greater than 1/2 inch the surface shall be repaired to final finished surface using Spall Repair Patching Material. Surface material shall be applied in strict accordance with manufacturer's printed instructions and recommendations. Materials shall be cured a minimum of 10-days or as recommended by the repair material manufacturer for the site conditions. Manufacturer of Raven Coating System shall confirm proposed spall repair patching material is compatible with Raven Coating System.

- H. Where manufacturer requires additional surface preparation, to provide best possible installation, additional requirements shall be performed.
- I. Provided written certification on the coating manufacturer's letterhead, signed by an officer of the company that the surface preparation meets the requirements of the coating manufacturer.

3.03 PRIMER APPLICATION

- A. Apply tolerant primer at 10 mils or as recommended by manufacturer to achieve superior performance. Test moisture and pH levels of concrete and document. Apply primer when surface is within acceptable ranges prior to application of primer.

3.04 RAVEN 405 COATING APPLICATION

- A. All methods, procedures of mixing, application and curing of the coating material shall be accomplished in strict accordance with manufacturer's printed instructions and recommendations.
- B. Apply coating in a minimum of two coats in addition to primer and filler. Apply Raven coating in two (2) coats of 60 mils each for a total DFT of 120 mils in strict accordance with manufacturer's printed instructions and recommendations.
- C. Application shall be by certified and experienced personnel only. Application of coating systems shall take place when the temperature of the concrete is stable or falling to ensure a minimal amount of out gassing by concrete. Use dehumidification units, fans or other means to provide an adequate environment for application and cure when the environment is not adequate for application or cure.
- D. Application shall produce at a minimum a totally bonded coating, corrosion proof, free of blisters, pinholes and any and all blemishes that may be precursors to failure. Promptly correct or remove, and repair areas that fail visual inspection or testing. Recoat time between coats shall be documented and shall not exceed manufacturer's requirements. Where recoat times are exceeded the coating shall be prepared in strict accordance with manufacturer's recommendations including scarification to provide sufficient profile.
- E. Follow manufacturer's recommendations for terminating coating into a chase and providing 1" radius inside corners, and easing outside corners. Provide a 1-1/2 inch cant cove along the floor/wall transition.

3.05 FIELD TESTING AND ACCEPTANCE OF RAVEN COATING

- A. Field acceptance of the Raven coating system shall be based on the Engineer's evaluation of the appropriate installation of each coat per field inspections, on observation of the measurements of the wet film thickness, and on the observation of spark testing and adhesion testing conducted on the cured liner.
- B. Pre-application testing shall be conducted by applying the Raven Coating at 20 mil thickness over a 5 square foot area where directed to demonstrate the coating application to the inspector(s).

- C. During application of each layer of the Raven coating, the Contractor shall measure the thickness and uniformity of the coating by the use of a wet film thickness gage meeting the requirements of ASTM D4414. The wet film thickness shall be tested continuously for the Contractor's own use. At least three such tests will be observed by the Engineer or Owner for each coat in each 500 square feet.
- D. The Raven coating shall provide a continuous monolithic surfacing with uniform thickness throughout and be free of pinholes, slumps and drips.
- E. All surfaces shall be inspected via high voltage spark testing when all coating work is complete and the coating is hard to the touch.
 - 1. The structure environment shall be properly vented prior to testing to ensure hazardous conditions do not exist.
 - 2. High voltage spark testing shall be performed in accordance with ASTM D4787. The spark testing equipment shall be initially set at 100 volts per 1 mil of applied film thickness of the coating and then adjusted as necessary per ASTM D 4787.
 - 3. All detected holidays shall be marked and the area of the liner shall be repaired. The surface area around the coating shall first be abraded using an appropriate grit paper or other hand abrasion tool. After abrading and cleaning the area, the area shall be patched by hand application of the coating material. All repair procedures shall follow manufacturer's recommended procedures.
- F. The pull-off strength (adhesion) of the liner shall be tested using any one of the five Test Methods (A, B, C, D or E) described in ASTM D-4541. The Contractor shall propose the method and equipment to be used in the tests. The liner adhesion shall be tested in one area for each structure or each 1000 square feet of coated area. At least three replicate pull-off tests shall be performed for each area. The Contractor shall also submit his proposed method for reinstatement of the area of the coating affected by the test. Repair of test areas shall be made by the Contractor at no additional cost to the Owner.
- G. There shall be no groundwater infiltration or other leakage through the structure walls after coating. If leakage is found, it shall be eliminated with an appropriate method as recommended by the coating manufacturer and approved by the Engineer at no additional cost to the Owner.
- H. All pipe connections shall be open and clear.
- I. There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, delaminations or other type defects in the lining.
- J. If any defective coating is discovered after it has been installed, it shall be repaired or replaced in a satisfactory manner within 72 hours and at no additional cost to the Owner. This requirement shall apply for the entire guarantee period.

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SECTION 09900

PAINTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein.
- B. Section Includes:
 - 1. Paint Materials
 - 2. Shop Painting
 - 3. Field Painting
 - a. Surface Preparation
 - b. Piping and Equipment Identification
 - c. Schedule of Colors
 - d. Work in Confined Spaces
 - e. OSHA Safety Colors

1.02 RELATED SECTIONS

- A. Section 15030 - Piping and Equipment Identification Systems

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications the Work shall conform to the applicable requirements of the following documents:
 - 1. SSPC - Steel Structures Painting Council
 - a. SSPC-Vis 1 Pictorial Surface Preparation Standards for Painting Steel Structures
 - b. SSPC-SP2 Hand Tool Cleaning
 - c. SSPC-SP3 Power Tool Cleaning
 - d. SSPC-SP5 White Metal Blast Cleaning

- e. SSPC-SP6 Commercial Blast Cleaning
- f. SSPC-SP10 Near-White Metal Blast
- 2. NACE - National Association of Corrosion Engineers
- 3. ASTM D1737 - Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus
- 4. ASTM B117 - Method of Salt Spray (Fog) Testing
- 5. ASTM D4060 - Test Method for Abrasion Resistance of Organic Coating by the Taber Abraser
- 6. ASTM D3359 - Method for Measuring Adhesion by Tape Test

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
 - 1. Manufacturer's literature and Material Safety Data Sheets for each product.
 - 2. Painting schedule identifying surface preparation and paint systems proposed. Cross-reference with Tables 9-1 and 9-2. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items.

1.05 SYSTEM DESCRIPTION

- A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenance.
- B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.
- C. Paint surfaces which are customarily painted, whether indicated to be painted or not, with painting system applied to similar surfaces, areas and environments, and as approved by Engineer.
- D. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

1.06 QUALITY ASSURANCE

- A. Painting operations shall be accomplished by skilled craftsman and licensed by the state to perform painting work.
- B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.

1.07 STORAGE AND DELIVERY

- A. Bring materials to the job site in the original sealed and labeled containers.
- B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

PART 2 -- MATERIALS

2.01 GENERAL INFORMATION

- A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.
- B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared, products were properly applied, and the paint systems were proper for the exposure and service.
- C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.
- D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.
- E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.
- F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of

regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.

2.02 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:
 - 1. Tnemec Company Inc.
- B. Exterior exposed steel:
 - 1. Surface Preparation - SSPC-SP6/NACE 3 Commercial Blast Cleaning. The surface shall be free of all foreign matter and dry prior to painting.
 - 2. 1st coat - Series 1 Omnithane applied at 2.5 - 3.5 dry mils.
 - 3. 2nd coat - Series N-69 (Color: 110GN Clover) Hi-Build Epoxoline II applied at 4.0-6.0 dry mils.
 - 4. 3rd Coat - Series 73-U (Color: 112GN Foliage) Endurashield applied at 3.0 - 5.0 dry mils.
- C. Steel (Immersion):
 - 1. Surface Preparation - SSPC-SP10/NACE 2 Near White Blast Cleaning. The surface shall be free of all foreign matter and dry prior to painting
 - 2. 1st coat - Series 1 Omnithane applied at 2.5 - 3.5 dry mils.
 - 3. 2nd coat - Series N-69 (Color: 110GN Clover) Hi-Build Epoxoline II applied at 4.0-6.0 dry mils.
 - 4. 3rd Coat - Series 104 (Color: 112GN Foliage) H.S. Epoxy applied at 3.0 - 5.0 dry mils.
- D. All field applications shall be inspected and approved by a Tnemec authorized factory representative and Charleston Water System approved representative. Subject to compliance with the Specifications, provide products from one of the following manufacturers
- E. Approval shall be in the form of a written acceptance letter to be supplied by the Tnemec representative stating that all areas of application have been cleaned, primed and coated in accordance with the factory's approval for warranty acceptance.

PART 3 -- EXECUTION

3.01 SHOP PAINTING

- A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.
- B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints. Shop Drawings indicating shop painting will not be approved until project paint system has been submitted to and approved by the Engineer.

3.02 SURFACE PREPARATION

A. General

- 1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.
- 2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted prior to cleaning and painting. Reposition items removed upon completion of painting operations.
- 3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.
- 4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.
- 5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch-up coats are in addition to the specified applied systems, and not considered a field coat.
- 6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.

7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

B. Metal Surface Preparation

1. Conform to current Steel Structures Painting Council (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.
2. Perform blast cleaning operations for metal when following conditions exist:
 - a. Moisture is not present on the surface.
 - b. Relative humidity is below 80%.
 - c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.
 - d. Painting or drying of paint is not being performed in the area.
 - e. Equipment is in good operating condition.
 - f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.
3. Sandblast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.
4. Sandblast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service.
5. Sandblast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment.
6. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system.
7. Prime cleaned metals immediately after cleaning to prevent rusting.
8. Clean rusted metals down to bright metal by sandblasting and immediately field primed.

C. Concrete Surface Preparation

1. Cure concrete a minimum of 30 days before surface preparation, and painting begins.

2. Test concrete for moisture content using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.
3. Brush-off blast (Reference ASTM D 4259) concrete to remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall be similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.
4. Acid etch (Reference ASTM D 260) concrete floors to receive paint. Following method is a minimum requirement. Remove residual dust and dirt. Wet surface of concrete until surface is damp. Etch surface with 15% to 20% muriatic acid solution to produce a "medium sandpaper" texture. Do not allow acid solution to dry on concrete. Rinse concrete when bubbling action of the acid begins to subside. Continue rinsing process until pH is 7 or higher. Remove excess water and allow concrete to thoroughly dry before coating. Other methods may be used, if approved by Engineer.
5. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric filler compatible with painting system. Complete fill coats may be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.
6. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.
7. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.

E. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.
2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

F. Masonry

1. Cure for a minimum of 30 days prior to paint application.
2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.
3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

3.03 APPLICATION OF PAINT

- A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.
- B. Apply paint without runs, sags, thin spots, or unacceptable marks.
- C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.
- D. Special attention shall be given to nuts, bolts, edges, angles, flanges, etc., where insufficient film thicknesses are likely. Stripe paint prior to applying prime coat. Stripe painting shall be in addition to coats specified.
- E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.
- F. Allow paint to dry a minimum of twenty-four hours between applications of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.
- G. Suspend painting when any of the following conditions exist:
 - 1. Rainy or excessively damp weather.
 - 2. Relative humidity exceeds 85%.
 - 3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.
 - 4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.
 - 5. Surface temperature of item is within 5 degrees of dewpoint.
 - 6. Dew or moisture condensation are anticipated.
 - 7. Surface temperature exceeds the manufacturer's recommendations.

3.04 INSPECTION

- A. Each field coat of paint will be inspected and approved by the Engineer or his authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.
- B. Use magnetic dry film thickness gauges and wet film thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.

- C. Coatings shall pass a holiday detector test.
- D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.
- E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.
 - 1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Razor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.
 - 2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Razor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.
- F. Paint manufacturer or his representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES

- A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.
- B. Take all necessary precautions to contain dispersion of sandblasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the sandblasting debris and paint. Suspend painting operations when sanding debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

3.06 PIPING AND EQUIPMENT IDENTIFICATION

- A. Piping and equipment identification shall be in accordance with Section 15030, Piping and Equipment Identification Systems.

3.07 SCHEDULE OF COLORS

- A. Match colors indicated. Piping and equipment colors are indicated in Section 15030. Colors which are not indicated shall be selected from the manufacturer's full range of colors by the Engineer. No variation shall be made in colors without the Engineer's approval. Color names and numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

3.08 WORK IN CONFINED SPACES

- A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or direct air supply to individual workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosion-proof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state and local regulations at all times.

TABLE 9-1
PAINTING SCHEDULE

SURFACE	APPLICATION	PAINTING SYSTEM & NO. OF COATS	PRODUCT REFERENCE (TABLE 9.2)	TOTAL MIN. DRY FILM THICKNESS (MILS)
<u>Structure</u> Submerged Wastewater in enclosed structures	Water retaining side of new wall surfaces where opposite side of wall is dry.	See Section 09800	N/A	N/A
<u>Metals</u> Interior and exterior nonsubmerged (gloss)	All new, pumps, motors and mechanical equipment, piping, vents, etc.	1 coat epoxy polyamide primer 1 coat epoxy polyamide 1 coat aliphatic polyurethane	104 102 115	4-6 4-6 3-5
Wet well (Submerged)	All new piping, supports, etc. not stainless steel or aluminum	2 coats high solids epoxy	119	8-10/coat
Structural steel and misc. metals	Non-submerged misc. supports, etc.	1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4
Aluminum surfaces in contact with concrete		2 coats coal tar	107	26
Shop Primed Structural Steel		1 barrier coat 1 coat epoxy 1 coat epoxy	113 114 120	2-3 3-4 3-4
Interior: Tar-dipped piping where color is required		2 coats epoxy resin sealer 2 coats epoxy polyamide	112 102	5-8/coat 5-8/coat
PVC Piping		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4

TABLE 9-2
PRODUCT LISTING

<u>REF.</u>	<u>SYSTEM</u>	<u>PURPOSE</u>	<u>PRODUCT</u> <u>Tnemec Series</u>
101	Epoxy filler	Primer-sealer	130-6601
102	Epoxy polyamide	Finish coat semi-gloss or gloss	66
103	Acrylic latex	Sealer	6
104	Epoxy Polyamide – metal	Primer	66
107	Coal tar	Sealer	46-465
112	Epoxy polyamide	Sealer	66-1211
113	Urethane	Barrier coat	530
114	Polyamine Epoxy	Intermediate coat	27
115	Aliphatic Polyurethane	Finish coat	1074 or 1075
116	Acrylic epoxy	Finish coat	113 or 114
119	High solids epoxy	Finish coat	104
120	Epoxy ¹	Primer/Finish	435

¹ Provide primer as required or recommended by manufacturer. Equal products are Raven 405 or Sauereisen No. 210.

- END OF SECTION -

SECTION 10535

CANOPIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Work in this section includes furnishing and installation of extruded aluminum, post supported canopies and hanger rod canopies with perimeter gutter.
- B. Coordination Items and Considerations
 - 1. Concrete for canopy footings. Footing block outs for post-supported units provided by manufacturer to be installed as part of concrete work.
 - 2. Flashing.
 - 3. Water drainage away from canopy where necessary.
 - 4. Coordination of all electrical fixtures and conduits or other items that are planned to be attached to the canopy.

1.02 QUALITY ASSURANCE

- A. Products meeting these specifications established standard of quality required as manufactured by a manufacturer with a minimum of 10 years of experience manufacturing and designing canopy systems.

1.03 SHOP DRAWINGS

- A. Confirm dimensions prior to preparation of shop drawings when possible.
- B. Supply manufacturer's standard literature and specifications for canopies.
- C. Submit shop drawings and calculations showing structural component locations/positions, material dimensions and details of construction and assembly. Shop drawings and calculations shall be sealed by a Registered Engineer in the State of South Carolina.
- D. Coordinate and show location and approved attachment methods for electrical fixtures, lightning protection, and conduits and other items that require attachment to the canopy on the Shop Drawings.

1.04 PERFORMANCE REQUIREMENTS

- A. Canopy must be designed for wind, snow and live load requirements of the local building code.

- B. Canopy must be designed to support additional accessories attached to canopy system (columns, beams, ceiling, fascia, electrical conduits and fixtures, etc.).
- C. Electrical accessories including but not be limited to lighting, switches and associated electrical conduits shall be coordinated with the canopy manufacturer. Attachments points shall not penetrate roof system or water conveying systems (wet columns and beams).
- D. Process control panels, electrical panels, etc. and associated conduits shall be provided with a support system independent of the canopy system.

1.05 DELIVER, STORAGE, HANDLING

- A. Deliver and store all canopy components in protected areas.

PART 2 -- PRODUCTS

2.01 MANUFACTURER

- A. Mapes Industries, Inc.
- B. Peachtree Protective Covers
- C. Or approved equal.

2.02 MATERIALS

- A. Decking, beams, posts and fascia shall be extruded aluminum, alloy 6063-T6, in profile and thickness indicated.
- B. Decking shall be 2¾" extruded, .078 decking.
- C. Posts shall be 0.125" minimum. Beams shall be 0.188" minimum.
- D. Fascia shall be standard 6" extruded "J" style (minimum .125 aluminum).
- E. Galvanized steel hanger rods shall be ¾" diameter. Provide required accessories for complete installation.

2.03 FINISHES

- A. Finish shall be standard two-coat Kynar. Color shall be selected by the Owner from manufacturer's standard range of colors. Steel hanger rods and accessories shall match color of canopy.

2.04 FABRICATION

- A. Support columns and gutter beams shall be designed such that the columns will be notched to create a "saddle" that will receive and secure the gutter beams.

- B. Post and beams connection shall be designed to resist a minimum shear stress of 350 lb. Pre-welded or factory-welded connections are not acceptable.
- C. Decking shall be designed with interlocking extruded aluminum members with mechanical fasteners field applied to provide structural integrity for the completed assembly.
- D. Concealed drainage. Water shall drain from covered surfaces into integral gutter beam and be directed to ground level discharge via one or more designated support posts or downspout for cantilevered canopies.

PART 3 -- EXECUTION

3.01 INSPECTION

- A. Confirm that surrounding area is ready for the canopy installation.
- B. Installer shall confirm dimensions and elevations to be as shown on drawings provided by manufacturer.
- C. Erection shall be performed by an approved installer and scheduled after all concrete, masonry and roofing in the area is completed.

3.02 INSTALLATION

- A. Installation shall be in strict accordance with manufacturer's shop drawings. Particular attention should be given to protecting the finish during handling and erection.
- B. Do not install items to the canopy system which have not been coordinated and approved by the canopy manufacturer.
- C. After installation, entire system shall be left in a clean condition.

- END OF SECTION -

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SECTION 11000

EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in acceptable operation all mechanical equipment and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system.
- B. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, and other appurtenances as specified, and as may be required for a complete and operating installation.
- C. It is the intent of these Specifications that the Contractor shall provide the Owner complete and operational equipment/systems. To this end, it is the responsibility of the Contractor to provide necessary ancillary items such as controls, wiring, etc., to make each piece of equipment operational as intended by the Specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 1 - General Requirements
- B. Division 5 - Metals
- C. Division 9 - Finishes
- D. Division 15 - Mechanical Construction
- E. Division 16 - Electrical
- F. Division 17 - Control and Information Systems

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01090, Reference Standards.

1.04 PERFORMANCE AFFIDAVITS

- A. When required in the appropriate equipment Specifications, the Contractor shall submit manufacturer's Performance Affidavits for equipment to be furnished.

- B. By these affidavits, each manufacturer must certify to the Contractor and the Owner, jointly, that he has examined the Contract Documents and that the equipment, apparatus, or process he offers to furnish will meet in every way the performance requirements set forth or implied in the Contract Documents.
- C. The Contractor must transmit to the Engineer three (3) copies of the affidavit given him by the manufacturer or supplier along with the initial Shop Drawing submittals.
- D. The Performance Affidavit must be signed by an officer of the basic corporation, partnership, or company manufacturing the equipment and witnessed by a notary public.
- E. Shop Drawings, if required, will not be reviewed prior to receipt of an acceptable Performance Affidavit.
- F. The Performance Affidavit shall have the following format:

Addressed to: Charleston Water Systems

Reference: Thomas Island Regional Pump Station and Interceptor

Text: (Manufacturer's Name) has examined the Contract Documents and hereby state that the (Product) meets in every way the performance requirements set forth or implied in Section ____ of the Contract Documents.

Signature: Corporate Officers shall be Vice President, or higher. (Unless statement authorizing signature is attached.)

1.05 SHOP DRAWINGS

- A. Shop Drawings, descriptive data, dimensions, parts, performance characteristics, material Specifications, construction details, piping and wiring diagrams, and associated items, as appropriate, showing conformance of all equipment to the Contract Documents, shall be submitted to the Engineer for review in accordance with Section 01300, Submittals. Additional required information shall include: the horsepower, voltage, and rotative speed of the motor along with other pertinent motor data, and the total weight of the equipment plus the approximate weight of the shipped materials. Shop Drawings shall also include complete erection, installation, and adjustment instructions, and recommendations.
- B. SHOP DRAWINGS ON ITEMS REQUIRING PERFORMANCE AFFIDAVITS WILL NOT BE REVIEWED UNTIL ACCEPTABLE PERFORMANCE AFFIDAVITS ARE RECEIVED.

1.06 OPERATION AND MAINTENANCE INSTRUCTION/MANUALS

- A. The Contractor, through manufacturer's representatives or other qualified individuals, shall provide instruction to designated employees of the Owner in the operation and care of all equipment installed hereunder. A written report by the representative covering instructions given shall be sent to the Owner, Engineer, and Contractor.
- B. The Contractor shall furnish and deliver to the Engineer, prior to the 80% completion point of construction, five (5) complete sets of instructions, technical bulletins, and any other printed matter such as wiring diagrams and schematics, prints or drawings, containing full

information required for the proper operation, maintenance, and repair of the equipment. Included in this submission shall be a spare parts diagram and complete spare parts list. These requirements are a prerequisite to the operation and acceptance of equipment.

- C. Each set of instructions shall be bound together in appropriate three-ring binders.
- D. A detailed Table of Contents shall be provided for each set of instructions.
- E. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item.
- F. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission.
- G. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.
- H. Extensive pictorial cuts of equipment are required for operator reference in servicing.
- I. When written instructions include Shop Drawings and other information previously reviewed by the Engineer, only those editions thereof which were approved by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the instructions.

1.07 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall coordinate all details, locations, and other conditions with various equipment suppliers, so that the equipment supplied functions as part of a complete system.
- B. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Owner's operating personnel in its maintenance and operation as outlined in Division 1, General Requirements and below. The Contract prices for equipment shall include the cost of furnishing the manufacturer's technical representative for the number of days specified. The manufacturer's technical representative shall provide the following services.
 - 1. Provide necessary assistance and instruction for installation, adjustment, and field testing of equipment.
 - 2. Submit written certification jointly to the Owner, the Engineer, and the General Contractor, that the equipment supplied or manufactured by their organization has been installed and tested to their satisfaction, and that all final adjustments thereto have been made. Certification shall include date of final acceptance field test, as well as a listing of all persons present during tests.
- C. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

- D. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.
- E. The times specified for services by the manufacturer's technical representative in the equipment Specifications are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.
- F. The Contractor shall notify manufacturers or suppliers that they will be required to state and guarantee a firm delivery date for all equipment which they offer to furnish. Delivery dates shall be as required by the Contractor to meet the approved progress schedule.

1.08 GENERAL INFORMATION AND DESCRIPTION

- A. All parts of the mechanism furnished shall, be amply designed and constructed for the maximum stresses occurring during fabrication, erection, and continuous operation. All materials shall be new, and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.
- B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.
- C. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards and shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation, and all conditions of operation.
- D. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provision shall be made for adequate lubrication by readily accessible devices.
- E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.
- F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.
- G. All machinery and equipment shall be safeguarded in accordance with the safety codes of the USA and the State of South Carolina.
- H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with suitable protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.
- I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.

PART 2 -- PRODUCTS

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11000-4

Charleston Water System
Thomas Island Regional PS and Interceptor

2.01 ACCEPTABLE MANUFACTURERS

- A. The materials covered by these Specifications are intended to be standard equipment of proven reliability, and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

2.02 ANCHORS AND SUPPORTS

- A. The Contractor shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and suitable templates shall be used by the Contractor when required in the detailed equipment Specifications.
- B. Anchor bolts and fasteners shall be of size, strength, and material required for the purpose intended and shall be in accordance with Section 05050, Metal Fastening, and with the detailed equipment Specifications. The Contractor shall provide all concrete pedestals required for equipment furnished. All equipment pedestals shall be doweled.
- C. Pipe sleeves or other means of adjusting anchor bolts shall be provided where indicated or required. Equipment shall be leveled by first using sitting nuts on the anchor bolts, and then filling the space between the equipment base and concrete pedestal with non-shrink grout, unless alternate methods are recommended by the manufacturer and are acceptable to the Engineer (such as shim leveling pumps). Non-shrink grout shall be as specified in Section 03600, Grout.

2.03 STANDARDIZATION OF GREASE FITTINGS

- A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be hydraulic type, Alemite, or approved equal.

2.04 GENERAL INFORMATION AND DESCRIPTION

- A. All parts of the equipment furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection, and continuous operation. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the unit is to be subjected and shall conform to all applicable sections of these Specifications. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.
- B. All structural steel shall have a minimum thickness of 1/4" and shall be coated as described in Division 9 and as specified herein.
- C. Structural steel used in fabricated parts shall conform to requirements of "Standard Specifications for Structural Steel" ASTM Designation A36. All shop welding shall conform to the latest standards of the American Welding Society.

- D. All anchor bolts, handrail bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel. All anchor bolts shall be a minimum of 1/2-inch diameter.

2.05 STRUCTURAL STEEL

- A. All materials used in fabricating structural steel shall be new and undamaged.
- B. All materials shall conform to applicable provisions of the AISC Specifications for the design and fabrication of structural steel, AWS Welding Specification, and to pertinent ASTM Standard Specifications, including the following:

Material	ASTM Standard Specifications for	Designation
Structural steel not welded	Steel for bridges	A-36
Welded structural steel	Structural steel for welding	A-36
Cast Iron	Gray iron castings	A-48
Machine bolts	Low carbon steel standard fasteners	A-325 High Strength

PART 3 -- EXECUTION

3.01 SHOP TESTING

- A. All equipment so noted in the detailed equipment Specifications, shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.
- B. Testing shall be as specified in Section 01650, Equipment Testing and Plant Start-up.
- C. Where multiple units of an identical design are specified to be tested, unless otherwise noted, only one of each group shall require testing.
- D. No such equipment shall be shipped to the project until the Engineer has been furnished a certified copy of test results and has notified the Contractor, in writing, that the results of such tests are acceptable.
- E. When called for in the detailed equipment Specifications, arrangements shall be made for the Engineer to witness performance tests in the manufacturer's shop. The Engineer shall be notified ten working days before shop testing commences. Expenses are to be paid by Owner.
- F. Five (5) certified copies of the manufacturer's actual test data and interpreted results thereof, shall be forwarded to the Engineer for review.

3.02 STORAGE OF EQUIPMENT AND MATERIALS

- A. Contractor shall store his equipment and materials at the job site in accordance with the manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations, and rulings of the public authority having jurisdiction.

- B. Material or equipment stored on the job site is stored at the Contractor's risk. Any damage sustained of whatever nature shall be repaired to the Engineer's satisfaction at no expense to the Owner.
- C. Contractor shall not store unnecessary materials or equipment on the job site and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.
- D. Contractor shall enforce the instructions of the Owner and Engineer regarding the posting of regulatory signs for loadings on structures, fire safety, and smoking areas.
- E. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

3.03 FIELD TESTING

- A. All equipment shall be set, aligned, and assembled in conformance with the manufacturer's drawings and instructions, and as specified in Section 01400, Quality Control and Section 01650, Equipment Testing and Plant Start-up.
- B. Field tests shall be performed by the Contractor and shall consist of the following:
 - 1. Check equipment for alignment. Direct coupled shafts with flexible or rigid couplings shall be checked for parallel and angular misalignment using dial indicators. Maximum allowable misalignment in either direction shall be 0.002-inch unless otherwise indicated by the Engineer.
 - 2. All bearings, gear housing, etc., shall be flushed in accordance with the manufacturer's recommendations to remove any foreign matter accumulated during shipment, storage, or installation. Lubricants shall be added in strict conformance with the manufacturer's recommendation.
 - 3. Check equipment for proper rotation and check motor for no-load current draw.
- C. Upon completion of the above, and at a time approved by the Engineer, the equipment will be tested by operating it as a unit with all related piping, controls, and other ancillary facilities. Operating field tests shall consist of the following:
 - 1. Check equipment for excessive vibration and noise.
 - 2. Check motor current draw under load conditions. The rated motor nameplate current shall not be exceeded.
 - 3. Check all pumps at maximum speed for at least four points on the pump curve for capacity, head, and electric current draw.
 - 4. Recheck alignment with dial indicators where applicable, after unit has run under load for a minimum of 24 hours.
- D. When the field tests have been completed and are acceptable, the Engineer will issue an Equipment Checkout Form with all pertinent data from the tests.

- E. In addition to the above described field tests, any other tests specifically required by the individual equipment Specifications or by the manufacturer shall be performed by the Contractor.
- F. All costs in connection with field testing of equipment such as light, lubricants, instruments, labor, equipment, etc., shall be borne by the Contractor. Energy, fuel, chemicals, water, etc. normally consumed by specific equipment shall be supplied to the Owner.
- G. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.
- H. Upon completion of thirty (30) consecutive days of successful operation, the manufacturer's field representative shall return and ensure the equipment is operating correctly and in acceptable working condition. Manufacturer shall provide to the Owner in writing of the equipments condition formally before the Owner takes over operation of the equipment.

3.04 INSTALLATION

- A. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation. Equipment shall be installed strictly in accordance with recommendations of the manufacturer. A copy of all installation instructions shall be furnished the Engineer's field representative one week prior to installation.
- B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.
- C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.
- D. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the manufacturer's qualified mechanic, millwright, or machinist, to align the pump and motor prior to making piping connections or anchoring the pump base.
- E. Workmanship shall be of first-class quality.
- F. All equipment sections and loose items shall be match-marked prior to shipping.

3.05 FAILURE OF EQUIPMENT TO PERFORM

- A. Any defects in the equipment, or failure to meet the guarantees or performance requirements of the Specifications shall be promptly corrected by the Contractor by replacements or otherwise.
- B. If the Contractor fails to make these corrections, or if the improved equipment shall fail again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacture of

said equipment, may reject said equipment and order the Contractor to remove it from the premises at the Contractor's expense.

- C. The Contractor shall then obtain specified equipment to meet the contract requirements or upon mutual agreement with the Owner, adjust the contract price to reflect not supplying the specific equipment item.
- D. In case the Owner rejects said equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him for said rejected equipment on progress certificates or otherwise on account of the lump sum prices herein specified.
- E. Upon receipt of said sums of money, the Owner will execute and deliver to the Contractor a bill of sale of all his rights, title, and interest in and to said rejected equipment; provided, however, that said equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected.
- F. Said bill of sale shall not abrogate Owner's right to recover damages for delays, losses, or other conditions arising out of the basic contract.

3.06 ACCESSORIES, SPARE PARTS, AND SPECIAL TOOLS

- A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications or where recommended by the equipment manufacturer.
- B. Spare parts shall be identical and interchangeable with original parts.
- C. Parts shall be supplied in clearly identified containers, except that large or bulky items may be wrapped in polyethylene.
- D. Painting requirements for spare parts shall be identical to those for original, installed parts.
- E. Spare parts shall be stored separately in a locked area, maintained by the Contractor, and shall be turned over to the Owner in a group prior to substantial completion. All of these materials shall be properly packed, labeled, and stored where directed by the Owner and Engineer.
- F. Contractor shall submit, for approval by the Engineer, a complete list of the special tools and appliances to be furnished. Such tools and appliances shall be furnished in approved painted steel cases, properly labeled and equipped with good grade cylinder locks and duplicate keys.
- G. The Contractor shall furnish all special tools and appliances necessary to operate, disassemble, service, repair, and adjust the equipment and shall furnish a one year supply of all recommended lubricating oils and greases. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required. All of these materials shall be properly packed, labeled and stored where directed by the Engineer.

3.07 PAINTING

- A. All surface preparation, shop painting, field repairs, finish painting, and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900, Painting.
- B. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.
- C. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.08 WELDING

- A. The Equipment Manufacturer's shop welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirement of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.
- B. The Equipment Manufacturer's shop drawings shall clearly show complete information regarding location, type, size, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.
- C. The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.
- D. The Contractor shall perform all field welding in conformance with the information shown on the Equipment Manufacturer's drawings regarding location, type, size, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society, and special conditions, as shown by notes and details.

3.09 EQUIPMENT IDENTIFICATION

- A. All mechanical equipment shall be provided with a substantial brass or stainless steel nameplate, securely fastened in a conspicuous place, and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

- B. Each pump and other piece of mechanical equipment shall also be identified as to name and number by a suitable laminated plastic or metal nameplate attached to the unit; for example, "Raw Water Pump #1". Coordinate name and number with same on remotely located controls, control panel, etc.
- C. Nameplates shall not be painted over.

3.10 WARRANTY

- A. All equipment shall be warranted in accordance with the General Conditions and Section 01300.
- B. Warranty requirements may be added to or modified in the detailed equipment Specifications of other Sections.

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SECTION 11100
PUMPS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, paint, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.
- B. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.
- C. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Engineer.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 1 - General Requirements
- B. Division 5 - Metals
- C. Division 9 - Painting
- D. Section 11000 - Equipment General Provisions
- E. Division 15 - Mechanical Construction
- F. Division 16 - Electrical
- G. Division 17 - Control and Information Systems

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All pumping equipment, materials, accessories, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01090, Reference Standards.

1.04 SHOP DRAWINGS

- A. The Contractor shall submit Shop Drawings in accordance with Section 01300 and Section 11000.

- B. Additional required information in pumping equipment Shop Drawings shall include: the horsepower, voltage and rotative speed of the motor, and the total weight of the equipment, plus the approximate weight of the shipped materials.
- C. Shop Drawings shall also include complete erection, installation, and adjustment instructions, and recommendations.

1.05 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall coordinate the efforts of all pump suppliers such that all variable frequency drives provided under this Contract are of the same manufacture, as specified in Section 16495, Variable Frequency Drive Systems. The Contractor shall also retain overall responsibility for coordination between the pump suppliers and the variable frequency drive manufacturer.
- B. For each series of pumps of the same model, a qualified pump manufacturer's technical representative shall supervise and check the installation for not less than one (1) day and supervise its initial operation, instruct the operators in operation, proper maintenance, and repairs for not less than one (1) day, except for sump pumps of less than 5 horsepower, unless otherwise specified in the individual pump specification.
- C. The Contractor shall be responsible for coordinating all interfaces with related mechanical, structural, electrical, and instrumentation and control work.
- D. The Contractor shall be responsible for providing all accessory equipment, and all work associated with installation of the pumps for the pumps furnished.

PART 2 -- PRODUCTS

2.01 MOTOR STARTERS AND CONTROLS

- A. Motor starters and controls shall be furnished and installed as specified in Division 16 and Division 17.

2.02 GAUGES

- A. Gauges shall be furnished and installed under this Section. All gauges shall be the Bourdon tube type with a black phenolic case conforming to NEMA 4 requirements and a 4-1/2-inch diameter dial face.
- B. Gauge windows shall be constructed of a shatterproof glass.
- C. The gauge dial shall have black scale markings on a white background evenly spaced over a 270 degrees arc.
- D. Gauges shall be provided on the suction and discharge of each pump, except wet-pit vertical submersible pumps. Gauges shall be provided on the discharge of the vertical submersible pumps in a location as indicated by the Engineer.

- E. Suction gauges shall be of the single scale compound type to indicate both pressure and vacuum. Each suction gauge shall be graduated in feet of water over the span of 34 feet below and above zero.
- F. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head. Graduation shall be in feet of water.
- G. The Contractor shall coordinate with the various pump manufacturers so that all gauges are supplied by one gauge manufacturer. Gauges shall be as manufactured by Ashcroft Gauge, Division of Dresser Industries, U.S. Gauge Division of Ametek, or equal.

2.03 DIAPHRAGM SEALS

- A. Pressure instruments (gauges, switches, transmitters, etc.) used for primary sludge service shall be provided with in-line, full line size isolating ring seals. The Contractor shall provide for the inclusion of the in-line seals in the process piping.
- B. Pressure instruments used for service in all solids bearing fluids except for primary sludge service shall be provided with one-half inch diameter isolating ring-seals mounted in 316 stainless steel pipe nipples tapped 90 degrees into the associated piping. The suction and discharge pressure gauges for the effluent pumps shall be installed with these isolating rings.
- C. Pressure instruments used for chemical or other hazardous service shall be provided with standard chemical diaphragm seals.
- D. Refer to Division 17, Controls and Information Systems, and the instrumentation details in the Drawings for further details.

PART 3 -- EXECUTION

3.01 SHOP TESTING

- A. Shop tests shall be performed in accordance with Section 01650, Equipment Testing and Plant Start-up, Section 11000, Equipment General Provisions, and except where stated otherwise herein, the Hydraulic Institute Standards.
- B. Pump testing shall be witnessed by the Engineer. The testing procedure shall be submitted to the Engineer for review before scheduling the testing. The Engineer shall be given at least 2 weeks advanced notice of the scheduled testing date.
- C. Certified test curves for each series of pumps are required, unless otherwise stated in the individual pump specification.
- D. Tolerances shall be within those specified by the Hydraulic Institute Standards.

3.02 FIELD TESTING

- A. Field tests shall be made in accordance with in Section 01650, Equipment Testing and Plant Start-up, and Section 11000, Equipment General Provisions.

- B. Preliminary field tests shall be made as soon as possible after installation of the pumps. Final acceptance tests shall demonstrate the following:
1. That the pumps have been properly installed and are in proper alignment.
 2. That the pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.
 3. That there are no mechanical defects in any of the parts.
 4. That the pumps can meet the specified operating conditions.
 5. That the pumps can pass the size of solids specified and the type of liquid for which the pumps are to be used.
- C. Upon completion of thirty (30) consecutive days of successful operation, the manufacturer's field representative shall return and ensure the equipment is operating correctly and in acceptable working condition. Manufacturer shall provide to the Owner in writing of the equipments condition formally before the Owner takes over operation of the equipment.

3.03 INSTALLATION

- A. The equipment shall be installed by the Contractor in accordance with the Drawings, the instructions and drawings of the manufacturer, and Section 11000, Equipment General Provisions.
- B. The Contractor shall furnish oil and grease for initial operation. The manufacturer and grades of oil and grease shall be in accordance with the recommendations of the equipment manufacturer.

3.04 EQUIPMENT IDENTIFICATION

- A. All pumps shall be supplied with nameplates as specified in Section 11000, Equipment General Provisions.
- B. Nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency.

- END OF SECTION -

SECTION 11130

SUBMERSIBLE NON-CLOG PUMPS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in acceptable operation submersible non-clog pumps and all necessary accessories as specified herein at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

Pumps No. 1 – No. 3			
Tag Numbers	P-101, 102, 103 (<i>future</i>)		
Number of Units	2		
Design Capacity (gpm)	275	410	640
Total Dynamic Head (feet)	110	97	78
Maximum Brake Horsepower	12.7	16.7	21.0
Maximum Pump Speed (rpm)	1755		
Temperature of Liquid Pumped	Ambient		
Suction Condition	Flooded		
Minimum Size of Solids (Spherical Diameter, Inches)	3.5		
Discharge Diameter (In.)	4		

1.03 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals:

1. Performance Affidavit

- a. By these affidavits, each manufacturer must certify to the Contractor and the Owner, jointly, that he has examined the Contract Documents and that the equipment, apparatus, or process he offers to furnish will meet in every way the performance requirements set forth or implied in the Contract Documents.
- b. The Contractor must transmit to the Engineer three (3) original copies of the affidavit given him by the manufacturer or supplier along with the initial Shop Drawing submittals.

- c. The Performance Affidavit must be signed by an officer of the basic corporation, partnership, or company manufacturing the equipment and witnessed by a notary public.

- d. The Performance Affidavit shall have the following format:

Addressed to: (Contractor) and Charleston Water System

Reference: Charleston Water System – Thomas Island Regional Pump Station

Text: (Manufacturer's Name) has examined the Contract Documents and hereby state that the (Product) meets in every way the performance requirements set forth or implied in Section ____ of the Contract Documents.
Signature: Corporate Officers shall be Vice President, or higher.
(Unless statement authorizing signature is attached.)

- B. Submit Operation and Maintenance manuals in accordance with Section 01300, Submittals.

1.04 WARRANTY AND GUARANTEE

- A. Warranty and Guarantee shall be as specified in Section 01700, Project Closeout.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Each influent pump shall be a submersible, non-clog, centrifugal pump, as manufactured by Model XFP 100G-CB1 as manufactured by ABS, or Model NP3153 MT3~642 as manufactured by Flygt.

2.02 GENERAL

- A. The pump and all related equipment shall be designed for the wastewater applications specified herein and shall be suitable for continuous or intermittent operation. The pump shall be bottom suction, side discharge construction and shall be supplied with a foot mounted discharge connection elbow and integral sliding rail removal system of the pump manufacturer's design matched to the pumps being supplied.
- B. The pumps are to be installed outside and exposed to the weather and shall be specifically designed for continuous operation in air at ambient temperature conditions. Design for the following ambient conditions:
 - 1. Maximum Temperature: 103°F.
 - 2. Minimum Temperature: 27°F.

3. Relative Humidity: 30 to 100% (condensing conditions).
- C. The pumps shall also be designed to reliably operate in a continuously submerged condition.
- D. The pumps shall not overload the motors at any point on its entire pump curve.

2.03 MATERIALS

- A. The lifting cover, stator housing, and volute casing shall be close grained cast iron conforming to ASTM A48-Class 30, 35, or 40. Ductile iron pump volute shall be furnished if recommended by pump manufacturer for specified pressure rating. All exposed nuts, bolts, washers, and other fastening devices shall be AISI type 316 stainless steel.
- B. Casing shall be a smooth surface devoid of blowholes, pits, burrs, or other irregularities. The casing shall have a suction cover, which can be easily removed for easy access to the impeller. All non-stainless steel metal surfaces coming in contact with the pumped media shall be protected by a factory applied spray coating of Supplier's modified acrylic primer and finish. The volute shall be single piece, non-concentric design and shall have smooth fluid passages large enough at all points to pass any size solids which can pass through the impeller. Pump volute shall be provided with a cleanout port to allow for removal of any foreign material blocking or impeding performance of the pump.
- C. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile or Viton rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without the requirement of a specific torque limit. Secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall not be acceptable.
- D. The impeller shall be hard alloy gray cast iron conforming to ASTM A-48 Class 30, 35, or 40. Impellers shall be dynamically balanced, closed non-clogging design with multiple vanes. The impeller shall be capable of handling solids of specified sphere size, fibrous materials, heavy sludge, and other matter found in normal wastewater applications. The impeller shall be mechanically secured to the motor shaft per manufacturer's recommendations utilizing machined stainless steel components. Adhesive or friction-type fits are not acceptable. Impeller shall be coated with the same system applied to the interior of the casing.
- E. A wear ring system shall provide efficient sealing between the volute and impeller. Casing and impeller wear ring shall be of stainless steel construction. Supplier shall submit AISI grades of stainless steel proposed for the wear rings. Rings shall be drive fitted to the volute inlet and heat-shrink fitted to the impeller.
- F. Shafting shall be constructed of AISI 329 stainless steel or 400 Series stainless steel for the pump and motor, sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such a design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be suitably heat-treated, turned, ground, and polished over its entire length.

G. Shaft Seals

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies of high-pressure design. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. Seal lubricant shall be FDA Approved, nontoxic.
 2. The lower, primary seal unit, located between the pump and the lubricant chamber shall contain one stationary and one positively driven rotating, industrial duty, corrosion resistant, seal rings (Tungsten carbide/Tungsten carbide or Tungsten carbide/silicon carbide). The lower seal shall be independent of the impeller hub.
 3. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, chamber shall contain one stationary and one positively driven rotating, industrial duty, corrosion resistant, seal rings (ceramic/carbon or carbo/Ni-resist).
 4. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. The seal system shall not be damaged when run dry. No external source of seal cooling or lubrication water shall be required.
 5. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. Cartridge type systems will not be acceptable. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.
- H. The pump shaft shall rotate on at least two (2) heavy duty permanently lubricated bearings. Bearings shall be designed to carry all radial and axial thrust loads and shall have a minimum AFBMA B-10 life of 100,000 hours at all points along the usable portion of the pump curve at maximum pump speed.
- I. Each pump, as recommended by the manufacturer, shall be provided with an integral, self-supplying cooling system that is adequately designed to cool the motor without an external cooling source. The cooling jacket shall be of cast-iron construction and shall surround the stator housing. The cooling jacket shall provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. The impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the pumpage, through the cooling system. The cooling liquid shall pass through a classifying labyrinth prior to entering the cooling jacket. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall direct the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about

the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4" diameter located 180° apart. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104°F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.

- J. Gauge taps shall be provided on the discharge piping of the vertical submersible pumps in a location as directed by the Engineer. Gauges shall be provided with an appropriate range with an upper range beyond pump shut off head and in accordance with the following:
1. Provide on the discharge side of each pump.
 2. Provided rounded type, stainless steel case, 4 ½" nominal diameter with phosphor-bronze bourdon tubes, glycerin filled 3" NPT bottom male threaded connections, stainless steel rack and pinion movement, black micro-adjusted corners and black figures with white plastic dials and a threaded ring.
 3. Gauge shall be capable of meeting an accuracy range within 1% of the total scale range.
 4. Provide diaphragm isolators on all gauges. Provide diaphragm materials intended for uses in municipal wastewater applications.
 5. Gauge connections shall consist of the following:
 - a. ¼-inch Type 316 stainless steel shutoff valve with Viton seals as manufactured by Whitey ball valve.
 - b. ¼-inch stainless steel piping connections.
- K. The Slide Rail Mounting System shall be as shown on the Contract Drawings and as specified herein.
1. A rail system shall be provided and installed for each pump and included dual rails per pump. The pump shall be easily removed from the wetpit for inspection or service without entering the pit or disconnecting piping.
 2. The pump shall be provided with a foot mounted discharge connection elbow constructed of cast iron conforming to ASTM A48-Class 30 or 35, permanently installed in the wet well along with the discharge piping. The discharge connection elbow shall be constructed with a 125 lb. ANSI standard flat faced flange. The pump shall be automatically connected to the discharge connection elbow when lowered into place, and shall be easily removed for inspection or service. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple downward motion of the pump.

3. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by the guide bar(s) and pressed tightly against the discharge connection elbow to provide positive sealing under all conditions.
 4. The entire sliding rail system shall be designed to safely withstand all stresses imposed thereon by vibration, torque, shock and all possible direct and eccentric loads. No portion of the pump shall bear directly on the floor of the sump.
 5. Lower guide bar holders shall be integral with the discharge connection. Guide bars shall be of at least standard weight 316 stainless steel pipe of a conservative size adequate for its intended use. The guide bars shall not support any portion of the weight of the pump.
 6. All anchor bolts, lifting bolts, eye lugs and lifting cable, etc. necessary for a complete installation and maintenance of the pump shall be constructed of Type 316 stainless steel and shall be adequately designed for its intended use.
 7. All metal to metal interfaces where movement might occur shall be non-sparking. The slide mounting system for the influent pumps shall meet or exceed Underwriters Laboratory requirements for operation in a Class I, Division 1, Group D hazardous location.
- L. All anchor bolts, lifting bolts, eye lugs, etc. necessary for complete installation and maintenance of the pump shall be furnished by Supplier and constructed of Type 316 stainless steel and shall be adequately designed for its intended use.

2.04 ELECTRICAL AND CONTROL REQUIREMENTS

- A. The pump manufacturer shall provide the power and control cables between the pump and the local disconnect switch, junction box, or control panel (see Drawings) and shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All pumps for the same pumping application shall be provided with the same length of cable. No splices shall be allowed unless specifically indicated on the Drawings. Cables shall be PVC or oil resistant chloroprene rubber jacketed type SPC cable suitable for submersible pump applications, shall be sized according to NEC and ICEA standards, and shall meet with MSHA approval. Stainless steel strain relief connectors shall be furnished for all cables.
- B. Cable Entry Water Seal
1. The cable entry water seal design shall insure a watertight and submersible seal without specific torque requirements. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate gaining access through the pump top. The junction chamber containing the terminal board shall be sealed from the motor by an elastomer compression seal O-ring. Connection between the cable conductors and stator leads shall be made

with threaded compressed type binding post permanently affixed to the terminal board and thus perfectly leak proof. Each pump shall be equipped with separate terminal board that totally isolates the incoming power supply from the pump motor.

2. An acceptable alternate cable entry seal shall include cable leads that enter at the top of the motor and shall allow the cable-to-motor connection to be accomplished in the field without soldering. All power and control lead wires shall be double sealed as they enter the motor in such a manner that cable-wicking will not occur. This sealing system shall consist of a rubber grommet followed by epoxy that is high in adhesive qualities and has a low coefficient of expansion. Each conductor shall have a small section of insulation removed to establish a window area of bare wire and each wire shall be untwisted and surrounded by epoxy potting material. A cable strain relief mechanism shall be an integral part of the sealing system. The cable sealing system shall be capable of withstanding an external pressure test of 1,200 psi as well as a cable assembly pull test as required by Underwriters Laboratories. Power and control leads shall be terminated on a sealed terminal board. The terminal board and its bronze lugs shall be O-ring sealed.

C. Electrical Requirements

	Influent
Motors	
Rating	460V, 3 ph, 60 Hz
Horsepower	45
Speed, rpm	1800
Insulation	Class F
Explosion Proof	Yes
Inverter Duty	No
Service Factor	1.15
Motor Winding Temperature Switches	Yes
RTDs	No
Cooling Jacket	No

- D. The pump motor shall be a squirrel-cage induction type, housed in a watertight chamber. The stator winding and stator leads shall be moisture resistant. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.
- E. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of ten (10) starts per hour without overheating.
- F. The motor shall be provided with pre-lubricated radial and thrust bearings which are designed to carry the entire load which may be imposed upon it under all operating conditions.

- G. Moisture detector probes shall be provided in the oil-seal chamber. The pump manufacturer shall provide a moisture detection relay compatible with the probes. The relay shall be installed in the pump station control panel.

2.05 PUMP STATION CONTROL PANEL

- A. Control panel shall be provided in a NEMA 4X, 316 stainless steel, UL-508A listed, free-standing enclosure with minimum 12" legs. All components of the control panel shall be NEMA rated and U.L. listed or recognized. IEC rated devices are not acceptable. Short circuit ratings for all equipment located within the control panel shall be 42kAIC rms, minimum. All controls, auxiliary contacts, relays, panels, transformers, motor starters, overload alarms, and other ancillary control panel equipment shall be provided. Control panel shall meet the applicable requirements of Division 16, Specification 16902. The control panel shall include, but not be limited to, the following:
 - 1. A single, main circuit breaker, operable from outside the control panel. Main circuit breaker shall also be provided with a pad-lockable disconnecting means. Control panel shall only require a single, 480VAC, 3-phase power supply. Ratings for the main circuit breaker shall be as indicated on the Drawings.
 - 2. Branch circuit breakers shall be provided for each of three (3) motor starters, one (1) control power transformer, one (1) hoist, one (1) future odor control panel, and one (1) combination power unit, minimum. Branch circuit breaker ratings shall be as indicated on the Drawings.
 - 3. Two (2) reduced voltage solid state starters shall be provided as specified in Section 16481.
 - 4. Control power shall be 120 VAC from an integral control power transformer(s) via branch circuit breaker(s).
 - 5. PLC-based pump controls shall be provided as specified herein.
 - 6. SCADA radio shall be provided as specified herein.
 - 7. Intrinsically safe barriers and surge protection, as required.
 - 8. A 12 VDC power supply shall be provided inside the control panel for the SCADA radio system. The system shall accept 120 VAC input and consist of a DC power supply.
 - 9. All other items indicated on the Standard Pump Station Control Panel schematic drawings shall be provided to create a complete and operable system, even if items are not specifically indicated herein.
- B. Control panel shall be capable of providing all available status and alarm conditions via the radio to the Owner's SCADA system. Registers shall be consolidated into blocks to minimize independent read/writes. Panel manufacturer shall coordinate with the Owner for remote communication requirements. Status and alarms shall include at a minimum (but not be limited to) the following:

1. LOW LEVEL alarm (transmitter initiated).
2. HIGH LEVEL alarm (transmitter initiated).
3. LOW-LOW LEVEL alarm (float activated).
4. HIGH-HIGH LEVEL alarm (float activated).
5. Pump RUN (all pumps)
6. Moisture failure or motor over temperature (all pumps).
7. Motor Overload (all pumps).
8. HOA position (all pumps).
9. Phase Fail.

C. Reduced Voltage Solid State Starters (RVSS)

1. The RVSS shall be provided by the Pump Station Control Panel supplier, in accordance with Specification Section 16481 – Individual Motor Controllers.

D. SCADA Communication Equipment

1. A spread spectrum radio shall be provided in the control panel enclosure. Radio shall be DIN rail mounted, 900 MHz, spread spectrum with associated din rail mounted power supply. Radio shall be 4RF Aprisa SRi model APSI-N915-SSC-SO-22-C1AA.

E. Pump Controller and associated pump control equipment

1. Pump station control logic shall be PLC based. PLC shall be Allen-Bradley CompactLogix 5324ER and capable of transmitting remote monitoring indications as well as receiving owner setpoints, call to run signals, etc.
2. Wetwell level shall monitored by a HydroRanger Plus ultrasonic level transmitter as manufactured by Siemens. Transmitter shall be panel mounted in subpanel.
3. Level transducer shall be Echomax XPS-15 transducer as manufactured by Siemens.
4. A backup float system shall be provided in the event of a level transmitter or PLC failure. Level switches of the direct acting float-operated design shall be comprised of a hermetically sealed, approximately 5-inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene or PVC jacket, with three conductor cable a minimum of 20 feet in length. Unless otherwise specified, media specific gravity is 0.95 to 1.05. Microswitches shall be one normally open and one normally closed, 5A-115V AC capacity. Float hangers and supports shall be provided as shown on the installation detail drawings. Float switches shall be Model ENM as manufactured

by Flygt, or equal.

F. Pump Control logic shall be able to accept the following writes remotely from Owner SCADA system:

1. Level operation elevations.
2. Manual start/stop of all pumps.
3. Lead/lag pump selection.

G. The panel shall have the ability to receive the following digital status signals from remote equipment for transmission via the radio to the Owner's SCADA system. The panel shall also be provided with a minimum of 8 spare digital inputs for remote monitoring of future equipment.

1. Standby generator RUN.
2. Standby generator FAULT.
3. ATS in UTILITY.
4. ATS on GENERATOR.
5. ATS FAIL.

H. Functional Control Description

1. Process Overview

- a. Two (2) submersible pumps shall be provided under Division 11 in the Pump Station wet well as shown on Drawings with a third pump to be provided in the future. These pumps shall be provided with a RVSS reduced voltage soft start (RVSS) starter in the Pump Station Control Panel (PSCP).
- b. Each pump shall be controlled locally via their respective RVSS in HAND control mode or via the pump control in AUTOMATIC control mode.
- c. The third (future) pump shall have all controls, motor starters, logic, etc. provided in the PSCP and ready to accept that pump with minimal to no modifications required to the panel.

2. Control Equipment

- a. A RVSS shall be provided under Division 11 for each pump. Reference Division 16 for RVSS details. The motor controls shall include the following:
 - i. HAND-OFF-AUTO (H-O-A) selector switch
 - ii. START/STOP pushbuttons

- iii. POWER ON indicating light
- iv. RUN indicating light
- v. MOTOR WINDING OVERTEMP indication light
- vi. MOISTURE DETECTION indication light
- vii. RVSS FAULT indicating light
- viii. PHASE MONITOR FAULT indicating light
- ix. RESET pushbutton
- x. Elapsed Run Time meter

3. PLC Control Operations:

- a. When the H-O-A switch for a pump is in HAND, the pump shall be started/stopped using the START/STOP pushbutton at the PSCP. When the H-O-A switch is in OFF, the pump shall not run under any condition. When the H-O-A switch is in AUTO, the corresponding pump shall be controlled by the PLC as described below.
- b. The pumps shall operate in a lead/lag sequence. The lead pump shall start upon the level reaching the LEAD PUMP ON level and continue to run until reaching the PUMPS OFF level. If the wetwell level continues to rise with the lead pump running, the lag pump shall start upon reaching the LAG PUMP ON level and both pumps shall run until reaching the PUMPS OFF level. Wetwell operation levels shall be as follows:

LEVEL OPERATION		
Wet Well Level	Action	Elevation
HIGH LEVEL	High Level Alarm	-10.50
LAG PUMP ON	Start Lag Pump	-10.75
LEAD PUMP ON	Start Lead Pump	-11.25
PUMPS OFF	Stop All Pumps	-12.50
LOW LEVEL	Low Level Alarm	-12.75

- 4. The in-service pumps shall auto-rotate the lead/lag order after each pumping cycle.
- 5. Pumps that are out of service, in manual (HAND) control, or failed shall not be considered for automatic control. The future third pump shall be considered out of service with HOA and circuit breaker both in the OFF position.
- 6. Backup Float Operation:
 - a. Backup floats shall activate upon a HIGH-HIGH level condition and call both pumps to run until reaching the LOW-LOW level condition at which time both pumps shall stop.

I. SCADA Communication Equipment by Others

1. All SCADA communication equipment located outside of the control panel shall be provided by the Contractor for installation in the field. This includes, but is not limited to, antenna, antenna pole, feed-line coaxial cable, lightning protection, conduit, supporting straps, cable bonding/grounding kit, etc. Approximate locations of equipment are shown on the Drawings. Coordinate exact location with Owner prior to installation.

J. Enclosure

1. Enclosure shall be NEMA 4X, 316 stainless steel with subpanel and interior swing open, dead front door. Enclosure shall be equipped with a 3-point, 90 degree turn, pad-lockable latch kit and a hinged interior door for mounting of level transmitter display, pilot lights, switches, labels, and other required components.
2. Control components within the control panel shall be separated from power components based on the most recent edition of IEEE 518-1982.
3. Control panel shall be free-standing and secured firmly to an aluminum equipment platform. Accessory feet kits of minimum 12" height shall be provided for adequate clearance to install conduit stub-ups and their associated sealing fittings, hardware, and hubs, from below.
4. Enclosure shall be sized to meet project requirements. Ensure adequate space is required for all wiring, and that proper space is provided for adequate air flow within the enclosure.
5. Provide a fully gasketed, dead-front enclosure with 3-point, quarter-turn latching, lockable door handle with concealed hinge. Hinges shall be completely rust-free under all circumstances. Enclosures, hinges, or hardware that rusts, including "surface" rust where pitting is evident, shall cause the entire panel to be replaced and any and all associated repair work and materials shall be at the Contractor's expense and at no additional cost to CWS.

2.06 SPARE PARTS

- A. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following for each series of pumps

One (1) - set of lower and upper wearing rings
One (1) - set of motor and pump bearings
One (1) - complete mechanical seal assembly (upper and lower)
Two (2) - complete set of gaskets and O-ring seals

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with this Section. For each series of pumps, field services shall include the following site visits:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1
Services after Startup	1	1

3.02 SHOP TESTING

- A. Shop testing shall be in accordance with the following additional requirements:
1. Impeller, motor rating and electrical connections shall be checked.
 2. A motor and cable insulation test for moisture content or defective insulation shall be made.
 3. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
 4. The pump shall be run for 30 minutes submerged, a minimum of six (6) ft. under water.
 5. After the run-dry test, the insulation test shall be performed again.
 6. After the run-dry test, the pump shall be run continuously unsubmerged for 2 hours under full load with no damage to the motor. During this test, the pump shall demonstrate compliance with the specified performance for flow, head, and horsepower and shall experience a heat rise of not greater than 45°C (80°F) above ambient temperature.

3.03 FIELD TESTING

- A. Final acceptance tests shall demonstrate the following:
1. The pumps have been properly installed and are in proper alignment.
 2. The pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.

3. The pumps can meet the specified operating conditions. All pumps shall be checked at maximum speed for a minimum of four points on the pump curve for capacity, head, and amperage. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing.

- END OF SECTION -

SECTION 14605
MONORAIL SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install and make fully operational the electric monorail system(s) which shall be complete with all necessary accessories, in compliance with the Specifications and as shown on the Drawings.
 - 1. These Specifications shall be considered as minimum requirements. The Contractor shall add such additional features as are necessary for a satisfactory and complete operation.
 - 2. All materials supplied under this Specification shall comply in all respects with the provisions of the Occupational Safety and Health Act of 1970, including all standards promulgated under the authority of such Act, and shall also meet all applicable industrial codes in the State in which the equipment is installed.
 - 3. All parts furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials specified herein shall be designed for a Class A service in accordance with the Crane Manufacturer's Association of America.
- B. It shall be the Contractor's responsibility to insure that the monorails furnished shall be compatible and have the necessary clearances with the hoisting equipment for normal operation.
 - 1. If the Contractor elects to utilize the monorail in any way during the erection of buildings and installation of equipment, he shall notify the Owner in writing and shall provide for an inspection by the monorail manufacturer and take any steps necessary to return the material to "as new" condition. He shall also obtain recertification by the manufacturer and reinstate all warranties and guarantees.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals
- B. Section 11000 – Equipment General Provisions
- C. Section 14620 – Trolley Hoists

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes and standards refer to the most current issue available at the time of Bid.

1. CMAA - Crane Manufacturers Association of America.
2. AISC – “Manual of Steel Construction”
3. ASTM A48 - Standard Specifications for Gray Iron Castings
4. ANSI B30.11 Safety Code for Underhung Cranes and Monorail Systems
5. ANSI B30.16 Safety Code for Overhead Hoists

1.04 SUBMITTALS

- A. The Contractor shall submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions. Additional required information shall include the total weight of the material. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.05 QUALITY ASSURANCE

- A. The materials covered by these Specifications are intended to be standard, of proven reliability and as manufactured by reputable manufacturers having experience in the production of such materials. The materials furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall provide satisfactorily operation when installed as shown on the Drawings and per manufacturers recommendations.
- B. The warrantee shall be per Section 01300.

1.06 CONTRACTOR'S RESPONSIBILITIES

- A. The manufacturer and ultimately the Contractor shall be totally responsible for structural design of the monorail system(s) proposed. The Contractor shall submit certification that the system(s) have been designed to resist all loads implied herein and loadings stipulated in the South Carolina Building Code. The Certification shall also state that the design has been performed and sealed by a registered Professional Engineer in the State of South Carolina.
- B. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Owner's operating personnel in its maintenance and operation as outlined in Division 1. The services of the manufacturer's representative shall be provided for a period of not less than two (2) days as follows:

1. At least one trip of one (1) day to supervise and approve the installation of the equipment.
 2. One trip of one (1) day after acceptance of the equipment to supervise initial start-up and operation and instruct the Owner's personnel in proper operation and maintenance of the equipment.
- C. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

PART 2 -- PRODUCTS

2.01 MONORAIL

- A. Unless otherwise indicated on the Drawings, monorail shall be patented line consisting of a top flange, web and hardened 3.25" or 3.33" bottom operation flange. All rails shall be furnished with splices and end stops and shall be designed for spans, thermal expansion and contraction and turning radii as shown on the Drawings. Provisions shall be made for connection of monorail to support locations designated on Drawings. Monorail shall be manufactured by Louden, Twin City Monorail, American Monorail or equal.
- B. The monorail system(s) shall be designed for lifting and moving parts of process equipment during servicing and/or replacement in the locations and conditions of service as specified in the Hoist Schedule located at the end of Section 14620 - Trolley Hoists.

2.02 ELECTRICAL SYSTEM

- A. Electrical equipment and wiring shall comply with the latest National Electric Code.
- B. Electrical power wiring and connection to the electrical system integral to the equipment shall be provided under Division 16. All other power wiring associated with and integral to the hoist systems shall be furnished and installed under Division 16.
- C. An insulated channel conductor shall be supplied along the monorail. The conductor shall be capable of carrying 100 amperes per pole, 3-phase, 460V. The conductor shall be supported as recommended by the manufacturer. The conductor shall be "Saf-T-Bar" enclosed electrification as manufactured by Howell Corporation, Midland Ross, SAFPOWER as manufactured by Cleveland Tramrail, or equal. The conductor channels shall be of stainless steel, flame retardant, amply double insulated. The system shall permit longitudinal movement of the housing and busways only to the extent to allow for expansion and contraction. An expansion joint section shall be provided as required for expansion and contraction and still maintain true alignment. Collectors shall be of the type required by the conductor manufacturer.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Monorail and electrification shall be installed in accordance with Section 05120 - Structural Steel, Division 16, and manufacturer's instructions and recommendations.
- B. Monorail and electrification installation shall be as approved by the manufacturer.

3.02 FIELD TESTS

- A. Field tests shall be conducted in accordance with manufacturer's instructions and recommendations. Prior to initial use, monorail shall be proof-tested at 125% of rated load in accordance with all OSHA requirements. Certification shall be submitted in accordance with Section 01300 - Submittals.

3.03 PAINTING

- A. All equipment shall have manufacturer's standard finishes. Field painting shall be as specified in Section 09900, Painting.

- END OF SECTION -

SECTION 14620

TROLLEY HOISTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install and make fully operational the trolley hoist(s), which shall be complete with all necessary accessories, in compliance with the Specifications and as shown on the Drawings.
 - 1. These Specifications shall be considered as minimum requirements. The Contractor shall add such additional features as are necessary for satisfactory operation of the specified equipment.
 - 2. All equipment supplied under this Specification shall comply in all respects with the provisions of the Occupational Safety and Health Act of 1970, including all standards promulgated under the authority of such Act, and shall also meet all applicable industrial codes in the State of South Carolina.
 - 3. All parts of the mechanism furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All equipment specified herein shall be designed for a Class A service in accordance with the Crane Manufacturer's Association of America.
- B. It shall be the Contractor's responsibility to insure that the hoisting equipment furnished shall be compatible and have the necessary operating clearances with the monorail beam(s), or bridge crane(s) specified or shown on the Drawings.
 - 1. If the Contractor elects to utilize the hoisting equipment in any way during the erection of buildings and installation of equipment, he shall notify the Owner in writing and shall provide for an inspection by the hoisting equipment manufacturer and take any steps necessary to return the equipment to "as new" condition. He shall also obtain recertification by the manufacturer and reinstate all warranties and guarantees.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals
- B. Section 11000 – Equipment General Provisions
- C. Section 14605 – Monorail Systems

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes and standards refer to the most current issue available at the time of Bid.

1. CMAA - Crane Manufacturers Association of America
2. AISC – “Manual of Steel Construction”
3. ASTM A48 - Standard Specifications for Gray Iron Castings
4. ANSI B30.11 - Safety Code for Underhung Cranes and Monorail Systems.
5. ANSI B30.16 - Safety Code for Overhead Hoists.
6. International Building Code with SC Modifications

1.04 SUBMITTALS

- A. The Contractor shall submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions. Additional required information shall include: the horsepower, voltage, and rotative speed of the motor and the total weight of the equipment plus the approximate weight of the shipped materials. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.05 QUALITY ASSURANCE

- A. The equipment covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per manufacturers recommendations.
- B. The warrantee shall be per Section 01300.

1.06 CONTRACTOR'S RESPONSIBILITIES

- A. The manufacturer and ultimately the Contractor shall be totally responsible for structural design of the hoist systems proposed. The Contractor shall submit certification that the systems have been designed to resist all loads implied herein and loadings stipulated in the South Carolina Building Code. The Certification shall also state that the design has been performed and sealed by a registered Professional Engineer in the State of South Carolina.
- B. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Owner's operating personnel in its maintenance and operation as outlined in Division 1. The services of the manufacturer's representative shall be provided for a period of not less than two (2) days as follows:
 1. At least one trip of one (1) days to supervise and approve the installation of the equipment.
 2. One trip of one (1) day after acceptance of the equipment to supervise initial start-up and operation and instruct the Owner's personnel in proper operation and maintenance of the equipment.

- C. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.
- D. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.
- E. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products manufactured by one of the following: No exceptions.
 - 1. ACCO Industries, Inc.
 - 2. Electrolift, Inc.
 - 3. Yale

2.02 GENERAL

- A. The Contractor shall furnish and install hoist system(s) as shown on the Drawings and as specified in the Hoist Schedule, complete with all necessary accessories required for a complete and fully operational installation.
- B. All equipment specified in this Section shall be designed and furnished by the hoist manufacturer who shall be responsible for the suitability and compatibility of all included equipment.
- C. The trolley(s) and hoist system(s) shall be designed for lifting and moving parts of process equipment during servicing and/or replacement in the locations and conditions of service as specified in the Hoist Schedule located at the end of this Section.

2.03 TROLLEY DRIVE

- A. The motor driven trolley shall include a 460V, 3-phase gear-motor with fluid drive couplings or solid-state soft start with adjustable time and torque, and electric brake. All load carrying parts shall be of steel. The wheels shall have hardened treads. Wheels and axles shall be equipped with antifriction bearings which are permanently sealed and lubricated. The gear head of the motor shall have an alloy steel, heat-treated gear train operating in a fully enclosed oil bath. The gear shaft shall have precision, oil lubricated ball bearings. Where monorail track as specified or shown on the Drawings is curved, trolleys shall be designed to negotiate curved sections

2.04 HOIST DRIVE

- A. Hoist drive shall be of the two (2) speed, close-headroom, cross-mounted type and shall include a direct coupled motor, solenoid brake, geared train with inherent load brake, hook, drum and electrical controls. Rated capacity shall be stamped on the hoist frame. The frame shall be oil-tight,

of cast steel construction, with no part of the load carried by assembly bolts. Gearing shall be machine cut and heat-treated, and shall operate in an oil bath. Except for the drum pinion, no gears shall be cantilever mounted. Shafting shall be ground and polished and all bearings shall be of the antifriction type. Grease fittings and oil reservoir shall be readily accessible. The drum shall be of the large diameter, guarded, flanged type with machine cut grooves to accommodate the hoist cable without overwrapping. The wire ropes shall be of the preformed extra flexible type, have a safety factor of at least five, and be anchored to the hoist drum. The load block shall be of the safety type with guarded sheaves and forged swiveled hooks. Hooks shall open slowly when subjected to heavy overloads.

- B. The solenoid brake shall be spring set with magnetic release operated by and interlocked with the electrical control equipment. A worm gear drive with an inherent load brake designed in accordance with the Hoist Manufacturer's Institute standards shall be provided for controlling the speed when lowering, and for holding maximum hook load for any load up to capacity. Stressed parts shall be of cast or forged steel. In the event of a power failure the braking system shall automatically lock the piece of equipment being lifted to prevent further movement.

2.05 CONTROLS

- A. Starting equipment shall be integral with the hoist unit and shall be of the full voltage, magnetic-reversing type with three overload elements. Equipment shall be housed in a NEMA 4X enclosure.
- B. Pendant controls for lift and travel shall be provided complete with heavy-duty push-button station of constant pressure type with silver-to-silver contact elements, and sufficient control cable and chain for support of the control station at a point 4 feet above the lowest operating floor where multiple levels are to be accessed. A retracting cord reel shall be provided which will allow the control pushbutton station to be retracted to a maximum of four feet above the upper operating level. Two speed control of the hoist drive shall be effected by a two-step pushbutton.
- C. Control power shall be 120 volt, provided by a control power transformer within the starter units. One side of this transformer shall be grounded, the other side shall be connected via a fuse of adequate rating.

2.06 ELECTRICAL EQUIPMENT

- A. Electrical equipment and wiring shall comply with the latest National Electric Code and all motor operated equipment shall be wired by the hoist manufacturer. All electric motors shall conform to the applicable parts of Section 15170, Electric Motors. The system shall be designed for a single 460V, 3-phase, 60 Hz power connection. Hoisting motors shall be a two-speed squirrel cage induction motors with ball or roller bearings, and serviceable on 460V, 3-phase. The trolley motors shall be a single speed squirrel cage induction motors NEMA Design "D". Motors shall be of the totally enclosed type designed for hoist service. The motor rating shall be on a 30-minute 55°C, duty cycle basis. Motors shall be provided with 120V space heaters.
- B. All wiring between motor, limit switches and starters shall be short, compact and protected by rigid galvanized steel conduit or flexible steel neoprene jacketed cable. Service power to the crane, hoist and trolley shall be by means of an insulated channel conductor type power feed system. Power source connections shall be furnished with strain relief devices, where applicable. Wiring between the power feed system and hoisting equipment shall be by the hoisting equipment manufacturer.

- C. Limit switches shall be approved geared typed, positive in action, compact, oil proof and readily accessible. Solenoid brakes shall be disk type, spring set with magnetic release. Solenoids shall be totally enclosed, protected from oil and moisture, readily accessible for adjustment and maintenance and shall develop the required forces without overheating.

2.07 SCHEDULE FOR TROLLEY HOIST SYSTEM(S)

- A. Locations, dimensions, design criteria, number required, etc. for hoist system(s) are indicated in the Trolley and Hoist Schedule located at the end of this Section.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. All hoist equipment shall be installed in accordance with manufacturer's instructions and recommendations.

3.02 FIELD TESTS

- A. Field tests shall be conducted in accordance with Section 01650, and manufacturer's instructions and recommendations. Prior to initial use, all hoists shall be proof-tested at 125% of their rated load in accordance with all OSHA requirements. Certification that the equipment has been tested and passed shall be submitted in accordance with Section 01300, Submittals.

3.03 TOOLS, SUPPLIES, AND SPARE PARTS

- A. The Contractor shall furnish all special tools necessary to disassemble, service, repair and adjust the equipment, and any spare parts as recommended by the equipment manufacturer.
- B. All of these materials shall be properly packed, labeled and stored where directed by the Engineer.

3.04 PAINTING

- A. All equipment shall have manufacturer's standard finishes. Field painting shall be as specified in Section 09900, Painting.

TROLLEY AND HOIST SCHEDULE

The trolley and hoist units shall be designated for the following conditions:

Location:	Thomas Island Regional Pump Station
Capacity (tons)	1
Minimum Lift (feet)	35
Operating Floor Elevation	8.00
Hook Elevation	
High Point	17.62
Low Point	-13.00
Trolley Type	Motorized (Electrically Operated)
Hoist Type	Wire Rope (Electrically Operated)
Trolley Speed (fpm)	60
Trolley Motor HP (minimum)	1/4
Hoist Speed (fpm)	18 and 6
Hoist Motor HP (minimum)	2 and 0.66

All elevations are approximate and all equipment shall be installed as shown on the Contract Drawings.

- END OF SECTION -

SECTION 15000

BASIC MECHANICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.
- B. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent Contracts for a complete installation.
- C. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, wall sleeves, wall pipes, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.
- D. Piping assemblies under 4-inch size shall be generally supported on walls and ceilings, unless otherwise shown on the Drawings or ordered by the Engineer, being kept clear of openings and positioned above "headroom" space. Where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.
- E. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.
- F. The work shall include, but not be limited to, the following:
 - 1. Connections to existing pipelines.
 - 2. Test excavations necessary to locate or verify existing pipe and appurtenances.
 - 3. Installation of all new pipe and materials required for a complete installation.
 - 4. Cleaning, testing and disinfecting as required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 1, General Requirements

- B. Division 2, Sitework
- C. Division 9, Finishes
- D. Division 11, Equipment
- E. Division 16, Electrical

1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

- A. The Contractor shall furnish to the OWNER (through the Engineer) a Performance Affidavit stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing. The requirements for Certifications shall be as specified in Section 01300 – Submittals.
- B. Shop Drawings for major piping (2-inches in diameter and greater) shall be prepared and submitted in accordance with Section 01300 – Submittals. In addition to the requirements of Section 01300 – Submittals, the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.
- C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

1.04 WARRANTY

- A. Warranty shall be per Section 01300.

PART 2 -- PRODUCTS

2.01 GENERAL

- A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.
- B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified in Section 3.09.
- C. Joints in piping shall be of the type as specified in the appropriate Piping System Schedule in Section 15390, Schedules.

- D. ALL BURIED EXTERIOR PIPING SHALL HAVE RESTRAINED JOINTS FOR THRUST PROTECTION UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS. ALL EXPOSED EXTERIOR PIPING SHALL HAVE FLANGED JOINTS, UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS.
- E. The Drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

2.02 WALL PIPES

- A. Where wall sleeves or wall pipes occur in walls that are continuously wet on one or both sides, they shall have water stop flanges at the center of the casting or as shown on the Drawings. Ends of wall pipes shall be flange, mechanical joint, plain end, or bell as shown on the Drawings, or as required for connection to the piping. Wall pipes shall be of the same material as the piping that they are connected to. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange. Unless otherwise shown on the Drawings, waterstop flanges shall conform to the minimum dimensions shown below:

<u>Pipe Size</u>	<u>Waterstop Flange Diameter</u>	<u>Waterstop Flange Thickness</u>
4" - 12"	OD + 3.10"	0.50"
14" - 24"	OD + 4.15"	0.75"
30" - 36"	OD + 4.50"	1.00"
42" - 48"	OD + 5.00"	1.25"
54"	OD + 5.90"	1.50"

2.03 SLEEVES

- A. Unless shown otherwise, all piping passing through walls and floors shall be installed in sleeves or wall castings accurately located before concrete is poured, or placed in position during construction of masonry walls. Sleeves passing through floors shall extend from the bottom of the floor to a point 3 inches above the finished floor, unless shown otherwise. Water stop flanges are required on all sleeves located in floors or walls which are continually wet or under hydrostatic pressure on one or both sides of the floor or wall.
- B. Sleeves shall be cast iron, black steel pipe, or fabricated steel in accordance with details shown on the Drawings. If not shown on the Drawings, the Contractor shall submit to the Engineer the details of sleeves he proposes to install; and no fabrication or installation thereof shall take place until the Engineer's approval is obtained. Steel sleeves shall be fabricated of structural steel plate in accordance with the standards and procedures of AISC and AWS. Steel sleeve surfaces shall receive a commercial sandblast cleaning and then be shop painted in accordance with Section 09900 – Painting.
- C. When shown on the Drawings or otherwise required, the annular space between the installed piping and sleeve shall be completely sealed against a maximum hydrostatic

pressure of 20 psig. Seals shall be mechanically interlocked, solid rubber links, trade name "Link-Seal", as manufactured by the Thunderline Corp., Wayne, Michigan, or approved equal. Rubber link, seal-type, size, and installation thereof, shall be in strict accordance with the manufacturer's recommendations. For non-fire rated walls and floors, pressure plate shall be glass reinforced nylon plastic with EPDM rubber seal and 304 stainless steel bolts and nuts. For fire rated walls and floors, two independent seals shall be provided consisting of low carbon steel, zinc galvanized pressure plates, silicon rubber seals and low carbon steel, zinc galvanized bolts and nuts.

2.04 SOLID SLEEVE COUPLINGS

- A. Solid sleeve couplings shall be used to connect buried service piping where shown on the Drawings. Solid sleeves shall be full-length mechanical joint ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Where installing fittings in an existing line, provide cut-in sleeve, ductile iron, with mechanical joint. Unless otherwise shown or specified, the acceptable products are Tyler Union, Star Pipe Products, and Sigma Corporation.

2.05 TAPPING SLEEVES AND TAPPING SADDLES

- A. Tapping sleeves shall be made of ductile iron MJ type tapping split-type with flanged outlet. All bolts, follower rings and gaskets on each end of the sleeve. Sleeves shall be Mueller H-615 and American Flow Control Series 2800. All sleeves shall have a minimum working pressure of 150 psi. provide square or hexagonal head bolts with hexagonal nuts. All square and hexagonal head bolts and hexagonal nuts shall be Cor-Ten steel, 304 stainless steel, or 316 stainless steel. Provide ¾-inch NPT test plug on top of the outlet. All taps shall be machine drilled; no burned taps will be allowed.
- B. Tapping saddles may be used on mains sixteen (16) inches and larger where the required tap size does not exceed one-half the size of the main (i.e. 8-inch tapping saddle for use on a 16-inch main). Tapping saddles shall be manufactured of ductile iron providing a factor of safety of at least 2.5 at a working pressure of 250 psi. Saddles shall be equipped with a standard AWWA C-110-77 flange connection on the branch. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddles. Straps shall be of alloy steel. The tapping saddle shall be the American tapping saddle, U.S. Pipe tapping saddle, or approved equal. All taps shall be machine cut, no burned taps will be allowed.
- C.

2.06 UNIONS

- A. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.
- B. For copper piping, unions shall have ground joints and conform to ANSI B16.18.
- C. For PVC and CPVC piping, unions shall be socket weld type with Viton O-ring.

2.07 THERMOPLASTIC TUBING AND FITTINGS

- A. Thermoplastic tubing shall be manufactured from polyallomer tubing. Tubing shall be protected from ultraviolet radiation degradation with a black coating or integral color conforming to ASTM D-1248, Type 1, Class C, Category 3. Fittings and connectors used with thermoplastic tubing shall be the flareless tube type constructed of brass conforming to SAE CA377, SAE CA360 or approved equal. Brass sleeves shall be used.
- B. Assembly of the thermoplastic tubing shall consist of pushing the tubing into the fitting and hand tightening the nut with final tightening with a wrench. Care shall be taken not to overtighten the nut. Plastic tube racks and bend holders shall be provided for holding the tubing in position. Needle valves used with thermoplastic tubing shall be the globe type constructed with a brass body, stem and seat and Buna-N "O"-ring seals. Installation shall be in accordance with the manufacturer's recommendations. Thermoplastic tubing, shall be the Impolene (polyallomer) system and needle valves, fittings and connectors shall be the Poly-Flo with 261 UB Universal Nut and Sleeve system as manufactured by Imperial Eastman, or approved equal.

2.8 HEAT TRACED PIPING

- A. Exposed pipes to be insulated shall also be protected from freezing by heat tracing. Freeze protection heat tracing shall consist of twin 16 AWG copper brass wires with a semiconductor polymer core where electrical resistance varies with temperature. The heat tracing shall have a fluoropolymer outer jacket for corrosion resistance. The heat tracing shall be rated for three (3) watts per foot output, self-regulating with a maximum temperature of 150°F, equal to a Chromalox No. SRL3-1CT383400. Maximum length for tape shall be 300 feet for each circuit. Temperature controller shall be provided to sense pipe temperature to determine on or off condition of the heat tracing. Temperature control shall be equal to a Chromalox No. RTBC-2-384729. The heat tracing system shall operate on 120 VAC. See Drawings for installation detail. Heat tracing of piping shall be provided as specified in Section 15390 – Schedules.

2.9 PIPE INSULATION

- A. Materials (Outdoor Piping Exposed to Weather)
 - 1. Premolded cellular glass thermal insulation in accordance with ASTM C 552 and C 585 fabricated for standard pipe sizes, fittings and valves.
 - 2. Maximum thermal conductivity of 0.38 BTU \times in/h \times ft² \times F at 70 °F in accordance with ASTM C 177 and C 518.
 - 3. Maximum water vapor permeability of 0.00 perm-in when tested in accordance with ASTM E 96.
 - 4. Average density of 8.0 lb/ft³.
 - 5. Maximum Flame spread rating of 5 and smoke-developed rating of 0 when tested in accordance with NFPA 255.

6. Utilize installation adhesives and joint sealants as recommended by the insulation manufacturer
 7. Install 0.10 inch thickness smooth T-316 stainless steel jacketing over insulation retained by T-316 stainless steel bands of the same or thicker gauge.
 8. Insulation products shall be equal to Pittsburgh Corning Foamglass.
- B. Piping insulation thickness shall be 1-inch for pipes up to 2-inches, 1-1/2 inches for pipes over 2-inches and up to 4-inches, and 2-inches for pipes over 4-inches.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping connections to equipment shall be provided with unions or coupling flanges located so that piping may be readily dismantled from the equipment. At certain applications, Dresser, Victaulic, or approved equal, couplings may also be used. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Unless otherwise shown or approved, provided a minimum headroom clearance under all piping of 7 feet 6 inches.
- B. Unless otherwise shown or specified, all waste and vent piping shall pitch uniformly at a 1/4-inch per foot grade and accessible cleanouts shall be furnished and installed as shown and as required by local building codes. Installed length of waste and vent piping shall be determined from field measurements in lieu of the Drawings.
- C. No pressure testing shall be performed until the pipe has been properly backfilled in place. All pipe passing through walls and/or floors shall be provided with wall pipes or sleeves in accordance with the specifications and the details shown on the Drawings. All wall pipes shall be of ductile iron and shall have a water stop located in the center of the wall. Each wall pipe shall be of the same class, thickness, and interior coating as the piping to which it is joined. All buried wall pipes shall have a coal tar outside coating on exposed surfaces.
- D. JOINT DEFLECTION SHALL NOT EXCEED 75 PERCENT OF THE MANUFACTURERS RECOMMENDED DEFLECTION. Excavation and backfilling shall conform to the

requirements of Section 02200 - Earthwork, and as specified herein. Maximum trench widths shall conform to the Trench Width Excavation Limits shown on the Drawings or as indicated in Section 02200, Earthwork. All exposed, submerged, and buried piping shall be adequately supported and braced by means of hangers, concrete piers, pipe supports, or otherwise as may be required by the location.

- E. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. UNDER NO CIRCUMSTANCES SHALL ANY OF THE MATERIALS BE DROPPED OR DUMPED INTO THE TRENCH.
- F. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.
- G. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.
- H. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.
- I. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.
- J. AT THE CLOSE OF EACH WORK DAY THE END OF THE PIPELINE SHALL BE TIGHTLY SEALED WITH A CAP SO THAT NO WATER, DIRT, OR OTHER FOREIGN SUBSTANCE MAY ENTER THE PIPELINE, AND THIS PLUG SHALL BE KEPT IN PLACE UNTIL PIPE LAYING IS RESUMED.
- K. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.
- L. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used. Exceptions: (closure pieces at manholes and areas where joint deflection is required).
- M. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe

alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each manhole and any adjustments will be coordinated and approved by the Engineer.

- N. ALL PIPING SHALL HAVE TYPE "B" BEDDING AS SHOWN ON THE DRAWINGS, UNLESS OTHERWISE SPECIFIED HEREIN, SECTION 15390, OR INDICATED ON THE DRAWINGS.
- O. Detector tape shall be installed 12 inches below final grade and directly above all buried sewer and force main piping. Provide 2" wide metallic detection tape. Provide 5.0 mil overall thickness with no less than 50 gauge solid aluminum foil core. Foil to be visible from both side. No inks or printing extended to the edges of the tape. Encase printing to avoid rub-off. Tensile strength - 28 psi. Use heat-set Mylar inks. The tape shall be green and shall be clearly and permanently labeled "CAUTION SEWER LINE BURIED BELOW" at no greater than 24" on center. Detector tape shall be Lineguard III as manufactured by Lineguard, Inc., or approved equal.
- P. AT THE CLOSE OF WORK EACH DAY PIPELINE TRENCHES SHALL BE COMPLETELY BACKFILLED. IN PAVED AREAS THE SURFACE SHALL BE RESTORED AS SPECIFIED IN SECTION 02510, PAVING AND SURFACING, TO ALLOW FOR TRAFFIC OVER THE TRENCH DURING NON-WORKING HOURS. UNDER NO CONDITIONS SHALL ANY PIPELINE TRENCH BE LEFT OPEN DURING NON-WORKING HOURS.
- Q. Each section of sewer pipe shall be laid to the appropriate line and grade, as designed, working in the upstream direction with the bell end laid upgrade.

3.02 REINFORCED CONCRETE PIPE, CONCRETE CULVERT, AND DRAIN PIPE

- A. The laying of reinforced concrete pipe shall conform to the applicable sections of the Concrete Pipe Handbook as published by the American Concrete Pipe Association.

3.03 DUCTILE IRON PIPE

- A. Ductile iron pipe (DIP) shall be installed in accordance with the requirements of the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association, and AWWA C600. DIP shall be furnished as specified in Section 15006, Ductile Iron Pipe.
- B. Where it is necessary to cut ductile iron pipe in the field, such cuts shall be made carefully in a neat workmanlike manner using approved methods to produce a clean square cut. The outside of the cut end shall be conditioned for use by filing or grinding a small taper, at an angle of approximately 30 degrees.
- C. UNLESS OTHERWISE APPROVED BY THE ENGINEER, FIELD WELDING OF DUCTILE IRON WILL NOT BE PERMITTED.

3.04 PVC/CPVC AND HDPE PIPE

- A. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC) and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC shall be furnished as specified in Section 15008,

PVC/CPVC Pipe. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.

- B. Plastic piping shall not be installed when the temperature is less than 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

3.05 CARBON AND STAINLESS STEEL PIPE

- A. Installation of steel pipe shall be by skilled workmen and shall conform to the applicable sections of AWWA Manual M-11. Joints for steel piping shall be either screwed, welded, or flanged as shown on the Drawings or as specified.
- B. Welding in the field shall be performed only when requested on the shop drawings and permitted by the Engineer for carbon steel pipe. No welding of stainless steel pipe shall be allowed in the field. All field welds shall be radiographically inspected.
- C. Installation of the steel casing pipe shall be by skilled workmen and in accordance with the best standard practice for steel pipe installation. Joints for steel casing pipe shall be butt welded.
 - 1. The boring equipment to be used for installing the jacked casing shall be of such size and capacity to allow the boring to proceed in a safe and expeditious manner. The installation of the casing and boring of the hole shall be done simultaneously to avoid cave-ins or settlement and for safety of traffic above.
 - 2. The Contractor shall check the vertical and horizontal alignment of the casing by survey instrument at least once during each four feet of advance, or as directed by the Engineer. Pits shall be well sheeted and braced as necessary for safe and adequate access for workmen, inspectors and materials and shall be of a size suitable to equipment and material handling requirements.
 - 3. Under no conditions shall jetting or wet boring of encasement under pavement be allowed.
 - 4. After installation of the carrier pipe, each end of the casing pipe shall be made watertight with a brick masonry bulkhead. In addition, a Class B concrete cradle shall be provided from each end of the bulkhead to the first pipe joint outside of the bulkhead.

3.06 COPPER PIPE

- A. Installation of copper pipe shall be by skilled workman in accordance with the manufacturer's recommendations. Use teflon tape at all fittings unless otherwise required for intended service. Install unions at the connections to each piece of equipment to allow removal of equipment without dismantling connecting piping.
- B. Wall sleeves shall be provided for all piping passing through exterior walls and shall be of the same material as the piping to which it is joined. All wall sleeves shall be provided with an acceptable waterstop.

- C. The Contractor shall provide hot and cold water mains with branches and risers complete from point indicated on the Drawings running to all fixtures and other outlets indicated. Mains and branches shall be run generally as shown on the Drawings. The Contractor shall provide all interior water piping, branches, and risers as shown on the Drawing and shall make connections to all plumbing fixtures, hose bibs, wall hydrants, and other points requiring water under this and other Divisions of the Specifications.
- D. All water mains and branches shall be pitched at least one (1) inch in twenty-five (25) feet toward fixtures. The piping installation shall be arranged so that the entire system can be drained through fixture supply connections.
- E. Unions shall be installed at the connections to each piece of equipment to allow for removal of equipment without dismantling connecting piping.
- F. Joints 1-1/4 inches and larger shall be made with silver solder. For joints less than 1-1/4 inches and all valves (regardless of size) use 95/5 solder. Soldered joints shall be prepared with a non-corrosive paste flux in accordance with manufacturer's instructions. All joints shall be thoroughly cleaned with emery cloth and reamed out before assembly. Acid core solder will not be permitted.

3.07 JOINTS IN PIPING

- A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.
- B. Piping joints shall be as specified in individual pipe sections and shall conform to the requirements on the Drawings. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed and the condition corrected.
- C. Flanged joints shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places. Bolts or studs shall be uniformly tightened around the joints. Where stud bolts are used, the bolts shall be uniformly centered in the connections and equal pressure applied to each nut on the stud. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.
- D. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution or mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be

inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.

- E. Threaded and/or screwed joints shall have long tapered full depth threads to be made with the appropriate paste or jointing compound, depending on the type of fluid to be processed through the pipe. All pipe up to, and including 1-1/2-inches, shall be reamed to remove burr and stood on end and well pounded to remove scale and dirt. Wrenches on valves and fittings shall be applied directly over the joint being tightened. Not more than three pipe threads shall be exposed at each connection. Pipe, in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot. Joints in all piping used for chlorine gas lines shall be made up with a glycerine and litharge cement. Joints in plastic piping (PVC/CPVC) shall be laid and joints made with compounds recommended by the manufacturer. Installation shall conform to the requirements of ASTM D2774 and ASTM D2855. Unions required adjacent to valves and equipment.
- F. Soldered joints shall have the burrs removed and both the outside of pipe and the inside of fittings shall be thoroughly cleaned by proper tools recommended for that purpose. Flux shall be applied to both pipe and inside of fittings and the pipe placed into fittings and rotated to insure equal distribution of flux. Joints shall be heated and solder applied until it shows uniformly around the end of joints between fitting and pipe. All joints shall be allowed to self-cool to prevent the chilling of solder. Combination flux and solder paste manufactured by a reputable manufacturer is acceptable. Unions required adjacent to valves and equipment.
- G. Welded joints shall be made by competent operators in a first class workmanlike manner, in complete accordance with ANSI B31.1 and AWWA C206. Welding electrodes shall conform to ASTM A233, and welding rod shall conform to ASTM A251. Only skilled welders capable of meeting the qualification tests for the type of welding which they are performing shall be employed. Tests, if so required, shall be made at the expense of the Contractor, if so ordered by the Engineer. Unions shall be required adjacent to valves and equipment.
- H. Copper joints shall be thoroughly cleaned and the end of pipes uniformly flared by a suitable tool to the bevels of the fittings used. Wrenches shall be applied to the bodies of fittings where the joint is being made and in no case to a joint previously made. Dimensions of tubing and copper piping shall be in complete accordance with the fittings used. No flare joints shall be made on piping not suited for flare joints. Installations for propane gas shall be in accordance with NFPA 54 and/or 58.
- I. Solvent or adhesive welded joints in plastic piping shall be accomplished in strict accordance with the pipe manufacturer's recommendations, including necessary field cuttings, sanding of pipe ends, joint support during setting period, etc. Care shall be taken that no droppings or deposits of adhesive or material remain inside the assembled piping. Solvent or adhesive material shall be compatible with the pipe itself, being a product approved by the pipe manufacturer. Unions are required adjacent to valves and equipment. Sleeve-type expansion joints shall be supplied in exposed piping to permit 1-inch minimum of expansion per 100 feet of pipe length.

- J. Dielectric unions shall be installed wherever dissimilar metals are connected except for bronze or brass valves in ferrous piping. Unions shall be provided downstream of each valve with screwed connections. The Contractor shall provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.
- K. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

3.08 FLUSHING AND TESTING

- A. All piping shall be properly flushed and tested unless specifically exempted elsewhere in the Specifications or otherwise approved by the Engineer. All liquid conveying pipelines shall be flushed and tested with water. The Contractor shall furnish and install all means and apparatus necessary for getting the air or water into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be flushed and tested in such lengths or sections as agreed upon among the Owner, Engineer, and Contractor. Test pressures shall be as specified in Section 15390 – Schedules, and shall be measured at the lowest point of the pipe segment being tested. The Contractor shall give the Owner and Engineer at least one (1) week's notice of the time when he intends to test portions of the pipelines. The Engineer reserves the right, within reason, to request flushing and testing or any section or portion of a pipeline.
- B. The Contractor shall provide water for all flushing and testing of liquid conveying pipelines. Raw water or non-potable water may be used for flushing and testing liquid pipelines not connected to the potable water system. Only potable water shall be used for flushing and testing the potable water system.
- C. The Contractor shall furnish and install all means and apparatus necessary for getting the water into the pipe and flushing and testing; including pumps, gauges, and meters, any necessary plugs and caps, and any temporary piping required to discharge water, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be filled slowly either through an existing valve or through taps. Special care shall be exercised in loading lines to prevent damage. The Contractor shall coordinate with the Owner the operation of all existing valves. **All valve operations shall be done by Owner personnel only.**
- D. The Contractor shall provide the Engineer with a detailed flushing, pressure testing, and disinfection plan for approval. **The Engineer reserves the right to adjust, modify, and/or alter the proposed plan to serve the best interests of the Owner at no additional cost to the Owner.**
- E. At the conclusion of the installation work, the Contractor shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period. If after this cleaning any obstructions remain, they shall be corrected by the Contractor, at his own expense, to the satisfaction of the Engineer. Liquid conveying pipelines shall be flushed at the rate of at least 2.5 feet per second for a duration suitable to the Engineer or shall be flushed by other methods approved by the Engineer.

- F. The Contractor shall flush all facilities described herein in accordance with Section 4 of these Specifications. The times for flushing shall be limited to nights/mornings between the hours of 11:00 p.m. and 2:00 a.m. and shall be coordinated, through the Engineer, with the Owner for their ability to provide adequate water. The Contractor shall have no claim for monetary compensation from the Owner for the inability of the Owner to provide adequate water at the proposed time of flushing. Compensation to the Contractor is limited to an extension of time to the Contract only.
- G. The Contractor may be required to use pipe extensions to direct discharge flows to the nearest storm drain to prevent excessive water from flowing on private property. Care shall be exercised to prevent the water from entering the trench or wetting the backfill material. All materials shall be furnished by the Contractor.
- H. During testing the piping shall show no leakage. Any leaks or defective piping disclosed by the leakage test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.
- I. After flushing, all liquid conveying pipelines shall be hydrostatically tested at the test pressure specified in the appropriate Piping System Schedule in Section 15390 – Schedules. The procedure used for the hydrostatic test shall be in accordance with the requirements of AWWA C600. Each pipeline shall be filled with water for a period of no less than 24 hours and then subjected to the specified test pressure for 2 hours. During this test, exposed piping shall show no leakage. Allowable leakage in buried piping shall be in accordance with AWWA C600 (see Part 3.09).
- J. Any leaks or defective pipe disclosed by the hydrostatic test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

3.09 HYDROSTATIC TESTING

- A. Conduct hydrostatic testing in accordance with AWWA C600.
 - 1. Conduct tests on each line or valved section of line.
 - 2. Clean and flush line of dirt and foreign material.
 - 3. Slowly fill main in order to expel air from the main through the air release valves or other appurtenance.
 - 4. Tests are to be conducted in the presence of the Engineer or his representative and witnessed by a Charleston Water System representative.
- B. Pressure tests:
 - 1. Pressure leakage test shall be conducted in accordance with AWWA C600. Each section of the pipeline shall be subjected to and successfully meet a pressure test of 150% of its working pressure, but not less than 100 psi. The line shall be slowly filled with water and all air expelled through the air valves or other means.

2. A suitable test pump, furnished by the Contractor, shall be connected to the line by means of a tap in the line, or other suitable method, and the proper test pressure slowly applied to the line. The test pressure, +/- 5 psi, shall be maintained for at least two (2) hours. Leaks, if found, shall be immediately repaired. The Engineer or his representative shall be present on site and confirm the test results.
3. Replace defective pipe, joints, fittings and valves with new material and repeat the test until results are satisfactory.

C. Leakage test:

1. Conduct leakage test in conjunction with pressure test.
2. Testing allowance shall be defined as the maximum quantity of makeup water that is added into a pipeline undergoing hydrostatic pressure testing, or any valved section thereof, in order to maintain pressure within +/- 5 psi of the specified test pressure (after the pipeline has been filled with water and the air has been expelled). No pipe installation will be accepted if the quantity of makeup water is greater than that determined by the following formula:

$$L = \frac{S \times D \times \sqrt{P}}{148,000}$$

Where:

L = Allowable Leakage, in gallons per hour

S = Length of Pipe tested, in feet

D = Nominal Diameter, in inches

P = Average test pressure, in psig

3. Should test disclose leakage greater than that specified above, repair, or if necessary, remove and replace the defective joint or valve until the leakage is within the specified allowance

3.10 LOW PRESSURE AIR TESTING FOR GRAVITY SEWER PIPE LINES

- A. The Contractor shall conduct low-pressure air tests on all completed sections of gravity sewer in accordance with UNI-B-6-98 (or latest revision). The air test results will be used to evaluate materials and construction methods on the sewer line sections.

The Contractor shall furnish an air compressor which will provide at least 300 cubic feet of air per minute at 100 psi, pressure gauges, air hoses, air hose connections and other equipment necessary to conduct the air test. Plugs in sewers 18" in size and larger shall be connected by cable for thrust reaction. The following provisions will be adhered to when conducting low pressure air tests:

- B. Equipment:

1. Plug Design

Either mechanical or pneumatic plugs may be used. All plugs shall be designed to resist internal testing pressures without the aid of external bracing or blocking. However, the Contractor should internally restrain or externally brace the plugs to the manhole wall as an added safety precaution throughout the test.

2. Singular Control

To facilitate test verification, all air used shall pass through a single, above ground control panel.

3. Air Control

The above ground air control equipment shall include a shutoff valve, pressure regulating valve, input pressure gauge, and a continuous monitoring, calibrated pressure gauge having a pressure range from 0 to at least 10 psi. Gauge shall display a NIST traceable calibration sticker with calibration date. The continuous monitoring gauge shall be no less than 4" in diameter with minimum divisions of 0.10 psi and an accuracy of plus or minus ± 0.04 psi.

Acceptable Air Test Control Units:

1. SEALCO Model 5012-100 Portable Low Pressure Air Test Control Unit
2. Cherne Air-Loc Low Pressure Air-Testing System
3. Approved equal.
4. Separate Hoses

Two separate hoses shall be used to: (1) connect the control panel to the sealed line for introducing low-pressure air, and (2) a separate hose connection for constant monitoring of air pressure build-up in the line.

5. Pneumatic Plugs

If pneumatic plugs are utilized, a separate hose shall also be required to inflate the pneumatic plugs from the above ground control panel.

C. Test Procedure:

1. Plug Installation and Testing After a manhole-to-manhole reach of pipe has been backfilled to final grade, prepared for testing, and the specified waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.

2. Line Pressurization

Low pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psi greater than the average back pressure of any groundwater above the pipe, but not greater than 9.0 psi. Immediately before

testing, if groundwater is present, the groundwater elevation must be determined by appropriate means.

3. Pressure Stabilization

After achieving the required internal pressure, the air supply shall be throttled to maintain the pressure for at least 2 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe walls.

4. Timing Pressure Loss

When temperatures have been equalized and the pressure stabilized, the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 5.0 psi. At a reading of 4.0 psi, or any convenient observed pressure reading between 4.0 psi and 4.5 psi, timing shall commence with a stopwatch or other timing device that is at least 99.8% accurate.

A predetermined required time for a specified pressure drop shall be used to determine the lines acceptability. Traditionally, a pressure drop of 1.0 psi has been specified. However, other pressure drop values may be specified, provided the required holding times are adjusted accordingly.

If the specified pressure drop is 0.5 psi rather than the more traditional 1.0 psi, then the required test times for a 1.0 psi pressure must be halved. Specifying a 0.5 psi pressure drop is desirable in that it can reduce the time needed to accomplish the air test without sacrificing test integrity. Therefore, the following subsections contain provisions for both the traditional 1.0 psi pressure drop and the more efficient 0.5 psi pressure drop. All requirements for a specified 0.5 psi drop are given in parentheses.

5. Determination of Line Failure

If the time shown in Table I (or Table II), for the designated pipe size and length, elapses before the air pressure drops 1.0 psi (or 0.5 psi); the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even though the 1.0 psi (or 0.5 psi) drop has not occurred.

6. Determination of Line Failure

If the pressure drops 1.0 psi (or 0.5 psi) before the appropriate time shown in Table I (or Table II) has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

7. Line Repair or Replacement

If the section fails to meet these requirements, the Contractor shall determine at his own expense the source, or sources of leakage, and he shall repair or replace all defective materials and/or workmanship to the satisfaction of the Charleston Water System. The extent and type of repair, which may be allowed, shall be subject to the

approval of Charleston Water System. The completed pipe installation shall then be retested and required to meet the requirements of the test.

8. Pressure Test Table

The following table is provided to assist in determining required test pressure where groundwater is present. Table is based on average groundwater depth above the pipe invert for the section of pipe to be tested. It is the responsibility of the Engineer to calculate proposed test pressure and submit to the Charleston Water System inspector for approval. In the absence of groundwater, minimum test pressure shall be 4.0 psi. Under no circumstances shall maximum test pressure exceed 9.0 psi.

Groundwater Above Pipe Invert (ft)	Pressure (psi)
1	4.5
2	5.0
3	5.5
4	6.0
5	6.5
6	7.0
7	7.0
8	7.5
9	8.0
10	8.5
11	9.0

9. Specified Time Tables

To facilitate the proper use of this recommended practice for air testing, the following tables are provided. Table I contains the specified minimum times required for a 1.0 psi pressure drop from a starting pressure of at least 4.0 psi greater than the average back pressure of any groundwater above the pipe's invert. Table II contains specified minimum times required for a 0.5 psi pressure drop from a starting pressure of at least 4.0 psi greater than the average back pressure of any groundwater above the pipe's invert. Both Tables also include easy to use formulas for calculating required test times for various pipe sizes and odd lengths

Table I

Specification time required for a 1.0 psig pressure drop for size and length of pipe indicated for Q=0.0015

1 Pipe Diameter (in)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	4:00	597	0.380L	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674L	22:47	34:11	45:34	56:58	68:32	79:46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

Mandrel Test - After backfilling trenches, Contractor shall test PVC sewer pipe for initial diametric deflections by the use of a 5% mandrel which is acceptable to Charleston Water System. mandrel shall be proof tested in the presence of the Engineer or his representative. The initial diametric deflection shall not exceed 5%. The mandrel pull shall be as described in the Ten State Standards. The Contractor shall not use any mechanical device in the mandrel pull.

3.12 CLOSED CIRCUIT TELEVISION (CCTV) INSPECTION FOR GRAVITY SEWER MAINS

A. General:

1. This specification section provides inspection criteria for all sanitary sewer pipelines.
2. Pipelines must be inspected utilizing the Pipeline Assessment Certification Program (PACP) inspection standards and closed-circuit television techniques. This process has been developed to identify and locate any sewer line defects, determine corrective action and perform/document post-correction inspection.
3. It is the responsibility of the Contractor to ensure that these CCTV inspection procedures are performed

B. Scope of work:

1. The CCTV Contractor shall video inspect all mainline sections from manhole to manhole, and all service laterals from the right-of-way boundary to the mainline connection or manhole connection.
2. Perform video inspection immediately following construction and prior to the low-air pressure and deflection testing
3. Prior to performing CCTV inspection activities, thoroughly clean all sewer lines and service laterals designated to be televised.
4. After cleaning, remove all equipment from the sewer line(s).

5. Immediately prior to performing the video inspection procedure, water must be introduced into the nearest upstream manhole, and all cleanouts for laterals, until observed at the nearest downstream manhole.

C. CCTV and associated equipment:

1. Television inspection equipment shall have an accurate footage counter that will display on the monitor and record the camera distance from the centerline of the starting manhole.
 - a. Distance measurements within the sewer line are to be accurate within 0.5% of the above ground measurement.
 - b. Line segment inspections shall be made manhole to manhole.
2. Prior to the beginning of each CCTV inspection, manhole identification numbers, as indicated on Drawings, will be displayed in the title and shall become a part of the video record.
3. Camera:
 - a. Provide remotely operated pan and tilt type.
 - b. The rotating camera and light head configuration shall have the capability of 360 degree rotating view angle and a minimum 270 degree pan angle with the capability to pan and tilt simultaneously while the transporter moves to view defects and voids around the entire diameter of the pipe wall, ensuring complete inspection of the mainline pipe, service laterals and any deficiencies.
4. Quality:
 - a. The camera, television monitor, and other components shall be color.
 - b. Geometrical distortion of the image shall not exceed one percent.
 - c. To ensure peak picture quality throughout all conditions encountered, the color camera shall be equipped with the necessary circuitry to allow for the remote adjustment of the optical focus iris from the power control unit at the viewing station.
 - d. A variable intensity control of the camera lights shall also be located at the viewing station.
5. All fog shall be evacuated from the pipeline and the pipeline kept clear of any fog during the CCTV inspection process.
6. Lighting and camera quality shall be suitable to allow a clear, in-focus picture for the entire inside periphery of pipelines extending at least ten (10) feet in front of the camera.

- a. In High Density Polyethylene (HDPE) or ductile iron poly-lined pipe, lighting should be sufficient enough to provide a clear view at least two (2) feet in front of the camera.
7. The replay of the recorded video information shall be free of electrical interference and shall provide a clear stable image.

D. Execution:

1. It is the responsibility of the Engineer to provide the CCTV Contractor with a set of Construction Plans prior to CCTV inspection activities. Line segment inspections shall be made manhole to manhole.
2. Internal inspection of pipelines shall be performed by PACP certified personnel, trained in the identification of pipe deficiencies and condition assessment utilizing closed-circuit television inspection equipment.
 - a. A full 360 degree view of the pipe is required during inspection.
 - b. The pipe must be clear and free of any dirt and/or debris. The CCTV Inspection Technician shall have full control of the movement of the television camera unit at all times.
 - c. The travel speed of the camera shall be variable but uniform and shall not exceed 20 feet per minute (fpm).
 - d. Any means of propelling the camera through the sewer line which would produce non-uniform or jerky movement of the camera, will not be acceptable.
 - e. The television system shall be capable of performing line segment inspection in increments of 400 feet with one setup.
3. Service laterals shall be inspected utilizing a CCTV inspection push system, capable of inspecting up to one hundred (100) feet of pipe.
 - a. All sanitary service lateral segments must be CCTV inspected from the top of the riser located at the property line, to the sewer mainline, noting type of cleanout installed, on the same disk for a continuous run.
 - b. Continuous footage readings for identifying the location of defects must be accurate to within 3 percent tolerance.
 - c. Deficiency identifications are to be called out and recorded to the nearest full foot.
 - d. Any inaccuracy in the continuous footage meter, identified deficiencies, or lateral location descriptions which cause doubt as to the accuracy of the locations or total length shall render the line segment recording as unacceptable.

4. As directed by the Owner or the Engineer, the camera shall be stopped to view and analyze conditions that appear unusual or uncommon. The CCTV Inspection Technician shall, at all times, be able to move the camera through the lines in either direction without the loss of quality in the video presentation.
5. The interior of the pipe shall be carefully inspected to determine the location and extent of all deficiencies. Pipe conditions that result in a question of proper installation procedures shall be noted so that these conditions can be reviewed and, if necessary, corrected before actual acceptance of the sewer system.
6. CCTV inspections will take place immediately after construction and prior to, or concurrent with, the low pressure air and mandrel testing. This will allow the correction of deficiencies found during the CCTV inspection process.
7. Access for CCTV inspection purposes shall be made via existing line segment manholes and lateral cleanouts.
 - a. Should access to a particular sewer segment be difficult, and where adjacent segments require television inspection, the CCTV Contractor may be allowed to complete the inspection of multiple sewer line segments with one setup.
 - b. When multiple sewer line segments are inspected utilizing one setup, the CCTV Contractor shall zero the footage counter at each subsequent sewer manhole to establish a uniform starting point, Station 0+00, for each line segment televised.
8. At all defects and service connections, the camera shall be stopped and the pan and tilt features shall be used to obtain a clear picture.
9. At each service lateral, the camera shall be panned to view up each lateral or point of connection. Make note of any deficiencies through the use of Data Collection Software.
10. CCTV Contractor shall record inspections in a PACP format and the video shall be recorded in a high quality CD/DVD format. The title block shall include the following information:
 - a. Date and time of day.
 - b. PACP certified television operator's identification (Name, ID number, etc.).
 - c. Sewer segment number.
 - 1) Segment numbers shall be designated by the ENGINEER.
 - d. Upstream manhole number.
 - e. Downstream manhole number.
 - f. Size of sewer pipe.
 - g. Pipe material.
 - h. Closest cross street or address where the line segment is located.

- i. Direction of movement of camera and direction of normal flow.
- j. Location of service connections indicated by clock position and with counter distance in feet from beginning manhole's centerline.
- k. Location (start and end counter distances in feet from the beginning manhole's centerline) and description of obstructions, structural defects, longitudinal and/or circumferential cracking, joints including open and/or offset joints, ovality, leakage or evidence thereof, break in connections, protruding connections, mineral deposits, roots, previous repairs, deposits on pipe walls, sags, and other abnormalities with respect to the sewer's condition with counter distance in feet from the beginning manhole's centerline.
- l. CCTV Contractor's log shall contain the same information.

11. CD/DVD shall visually display, at a minimum, the following:

- a. CCTV Contractor's name.
- b. Project name.
- c. Charleston Water System Job Number and Extension.
- d. Date of Inspection.
- e. Pipe segment number.

3.11 PAINTING AND COLOR CODING SYSTEM

- A. All exposed piping specified shall be color coded in accordance with the Owner's standard color designation system for pipe recognition and in accordance with Section 15030 – Piping and Equipment Identification Systems. In the absence of a standard color designation system, the Engineer will establish a standard color designation for each piping service category from color charts submitted by the Contractor in compliance with Section 09900 – Painting.
- B. All piping specified in this Section shall be painted in accordance with Section 09900 – Painting, except as follows:
 - 1. Copper pipe
 - 2. Stainless steel pipe. Flanges and supports or hangers shall be painted.

- END OF SECTION -

SECTION 15006

DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included

1. This section covers the work necessary to furnish and install, complete, ductile iron pipe (DIP) and fittings for wastewater mains.

B. Related Work Specified Elsewhere

1. Section 01031 – Grade, lines and Levels
2. Section 0221 – Trench Excavation and Backfill
3. Section 09900 – Painting
4. Section 15000 – Basic Mechanical Requirements

C. Contractor Furnished and Installed

1. All ductile iron pipe, fittings and accessories, which become part of the finished product.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. The following specifications apply to the Work in this section. Use the most recent edition of each.

ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile-Iron Pipe Systems
ANSI/AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch for Water and Other Liquids
ANSI/AWWA C111/A21.11	Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C115/A21.15	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

ANSI/AWWA C150/A21.50	Thickness Design of Ductile-Iron Pipe
ANSI/AWWA C151/A21.51	Ductile-Iron Pipe, Centrifugally Cast for Water
ANSI/AWWA C153/A21.53	Ductile-Iron Compact Fittings
ANSI/AWWA C600	Installation of Ductile-Iron Water Mains and their Appurtenances
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWWA D11.2	Guide for Welding Iron Casting
ASTM A746	Standard Specification for Ductile-Iron Gravity Sewer Pipe

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Require submitted evidence that the ductile iron pipe and fitting manufacturer has a minimum of ten years of experience in material production of diameters noted on the plans and specifications.
2. All pipe material suppliers shall be ISO registered or provide the services of an independent inspection agency.
3. Prior to the start of manufacturing, any manufacturer not meeting the ISO registration requirements shall submit to the owner and owners' engineer the names of an independent inspection agency for approval.
 - a. The independent inspection agency shall be responsible for sample monitoring of chemical and mechanical test, sample visual inspection of quality assurance tests performed on in-process pipe and fittings, and a sample visual and dimensional inspection or finished product for this project.
 - b. A certified inspection report from the independent inspection agency of all witnessed tests shall be supplied to the owner or owner's engineers within ten (10) days of completion of pipe manufacturing.

- c. Chemical samples shall be taken from each ladle of iron and the manufacturers' chemical control limits shall be maintained for at least the following elements: carbon, sulfur, phosphorus, silicon, magnesium, chromium, manganese, tin, aluminum, cerium, copper, and lead.
 - 1) When chemical values fall outside the manufacturer's control limits, additional mechanical property tests shall be performed to assure minimum mechanical properties are met.

B. Supply only new and unused pipe.

C. Acceptance of Pipe

- 1. Acceptance will be on the basis of design, material tests, and inspection of the complete product.
- 2. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to inspection by the Owner.
 - a. Inspection may be made at the place of manufacture, or on the job site after delivery, or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specifications requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture.
 - b. All pipe which is rejected must be immediately removed from the project site by the Contractor.

D. Protection of Materials

- 1. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition.
- 2. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings.
- 3. Store rubber gaskets and polyethylene film under cover out of direct sunlight.
- 4. Do not store nuts, bolts, glands, and other accessories directly on the ground.

5. Keep insides of pipe and fittings free of dirt and debris.
6. Pipe and fittings in which the lining has been damaged shall be replaced by the Contractor at no additional cost to the Owner.
 - a. With the approval of the Engineer and Owner, small and readily accessible damaged areas may be repaired.
7. Any damage to pipe coatings must be repaired before the pipe is installed at no additional cost to the Owner.

1.4 SUBMITTALS

- A. Comply with pertinent provisions of Section 01300.
- B. For information only, submit manufacturer's certificate indicating that the pipe and fittings have been inspected and tested at the place of manufacture and meet the requirements of the referenced Standards and these Specifications. Submit manufacturer's certification that joints of the type have been hydrostatically tested and the results of the test.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE

- A. Ductile iron pipe shall be in accordance with ANSI A21.50/AWWA C150 and conform to the requirements of A21.51/AWWA C151, latest standards.
 1. Push-on and restrained joint pipe shall have a minimum rated working pressure of 150 psi.

- B. All buried pipe shall be pressure class as follows:

Pipe Sizes (<u>inch</u>)	Pressure Class (<u>psi</u>)
4-12	350

- C. Pipe wall thickness shall be in accordance to bury depth as shown on Drawings.
- D. Polyethylene Encasement:
 1. NOT required for gravity sewers.
 2. Provide for wastewater force mains and fittings.

- E. Flange pipe or Victaulic grooved pipe shall be class 53.
- F. Acceptable products:
 - 1. American Cast Iron Pipe Company.
 - 2. Griffin Pipe Company.
 - 3. U.S. Pipe Company.
 - 4. McWane Cast Iron Pipe Company.

2.2 DUCTILE IRON PIPE JOINTS

A. General

- 1. Ductile Iron Pipe and fittings shall be furnished with push-on joints, push-on restrained joints, mechanical joints, flanged joints, and grooved joints as required.
- 2. Pipe ends (spigot end, bell, and socket) for all pipe shall be gauged with suitable gauges at sufficiently frequent intervals to ensure compliance to the standard dimensions of ANSI/AWWA C151/A21.5, latest addition.

B. Joints

- 1. Push-on Joints
 - a. Push-on joints shall conform to ANSI A21.11/AWWA C111.
 - b. Acceptable products: Fastite, Tyton, or Bell-tite.
- 2. Flanged Joints
 - a. Flanged joints shall conform to ANSI A21.15/AWWA C115.
- 3. Mechanical Joints:
 - a. Provide mechanical joints complying with complying with ANSI 21.11 (AWWA C111) as modified by ANSI/AWWA C151/A21.51.

4. Restrained Joints

- a. Provide restrained joint pipe and fittings on wastewater force main piping at each fitting, valve, and as indicated on the Drawings for pipe joints.
- b. Acceptable products:
 - 1) American Cast Iron Pipe:
 - a) Fast Grip Gaskets
 - b) Flex-Ring
 - c) Field Flex-Ring
 - d) Lock-Ring
 - 2) US Pipe:
 - a) TR Flex
 - b) Field Lok 350 Gaskets
 - 3) Griffin Pipe:
 - a) Snap-Lok Restrained Joint
 - 4) EBBA Iron:
 - a) Megalug Restraint Gland
 - 5) Ford:
 - a) Series 1400 Restraint Gland
 - 6) Sigma:
 - a) One-Lok Series SLD Restraint Gland
 - 7) Cap Fear Industries:
 - a) EZ Restraint Gland.

C. Bolts, Nuts, and All-Thread Rod

1. Tee bolts and nuts shall be made from high strength low alloy steel and comply with ASTM A307.
 - a. Nuts and bolts used for flange connections shall be Type 316 stainless steel.
 - b. All fasteners shall have a minimum yield strength of 45,000 psi.
2. Material type shall be marked on the fasteners. Hex head bolts and nuts shall be a high strength Type 316 stainless steel and comply with the dimensions outlined in ANSI/AWWA C111/A.21.11.
 - a. The steel shall have a minimum yield strength of 45,000 psi.
3. Externally threaded standard fasteners shall be Type 316 stainless steel having a minimum yield strength of 45,000 psi.

2.3 DUCTILE IRON FITTINGS

A. General:

1. Provide all fittings with gaskets, glands, nuts, and bolts unless otherwise specified or indicated on the Drawings
2. Nuts and bolts shall be Cor-Ten steel, Type 304 stainless steel, or Type 316 stainless steel.
 - a. Tee bolts and nuts shall be high strength low alloy steel and comply with ASTM 307.
 - b. Material shall be marked on the nuts and bolts.
3. Compact fittings for pipe 3" – 48" diameter in diameter may be provided in accordance with ANSI/AWWA C153/A21.53.88.
4. No metric size fittings shall be permitted.
5. Fittings to be installed in the construction of wastewater systems shall conform to those of standard design and in current inventory of Charleston Water System. No special manufactured fittings will be allowed without prior approval of Charleston Water System.

B. Mechanical Joint Fittings:

1. Mechanical Fittings shall conform to ANSI A21.53/AWWA C153 or A21.10/AWWA C110.

C. Flanged Fittings

1. Flanged Fittings shall conform to ANSI A21.10/AWWA C110.
2. The AWWA C110 fitting flanges shall have facing and drilling which match AWWA C115 threaded-on flanges which also match ANSI B16.1 class 125 flanges except where class 250 are specifically noted.

D. Restrained Joint Fittings:

1. Provide at each fitting, valve, and transitions from PVC, FPVC, or HDPE to ductile iron pipe for wastewater force mains.
 - a. Provide on pipe joints as indicated on the Drawings.
2. Restrained joints to be in accordance with DIPRA, "Thrust Restraint Designed for Ductile Iron Pipe".
3. Acceptable products as specified above Part 2.2 – Ductile Iron Pipe Joints.

E. Acceptable products:

1. American Cast Iron Pipe Company
2. Griffin Pipe Company
3. U.S. Pipe Company
4. McWane Cast Iron Pipe Company
5. Sigma Corporation

2.4 DUCTILE IRON – PVC TRANSITION ADAPTER

- A. Provide ductile iron adapter for transitions between PVC and Ductile Iron Pipe.
- B. Provide Protecto 401 lining.

- C. Provide Model 501 Transition Coupling by Romac Industries or approved equal.

2.5 LININGS AND COATINGS

A. Linings

- 1. Provide ductile iron pipe and fittings with an interior lining of 40-mil nominal Protecto 401 ceramic epoxy.

B. Coatings

1. Direct Bury

- a. Ductile iron pipe and fittings for buried service shall receive a 1 mil exterior asphaltic coating in accordance with ANSI A21.50.

2. Exposed

- a. All exposed piping shall be primed at manufacturer's plant with Wasser FerroClad, Tnemec 37H-77, Tnemec 140-1211 or equal.
- b. All primed material to receive a field coating as specified the Engineer.
- c. Contact ductile iron manufacturer for additional recommended primers.

2.6 POLYETHYLENE ENCASEMENT

- A. Provide polyethylene encasement for all buried ductile iron pipe and fittings for wastewater force mains.

- 1. Do NOT provide polyethylene encasement for gravity wastewater mains.
- 2. Conform to: ANSI 21.5 (AWWA C105) 8 Mil Polyethylene Tube
- 3. Color: Green

2.7 METALLIC DETECTION TAPE

- A. Provide metallic detection tape on all buried piping.

1. Width: 2".
 2. Provide 5.0 mil overall thickness with no less than a 50 gauge solid aluminum foil core.
 - a. Foil to be visible from both sides.
 3. No inks or printing extended to the edges of the tape.
 4. Encase printing to avoid ink rub-off.
 5. Tensile strength: 28 lbs/inch.
 6. Use heat set Mylar inks.
- B. Color: Green.
- C. Wording on tape to indicate "CAUTION SEWER LINE BURIED BELOW" a minimum of every 24" as measured on center of wording.

2.8 TRACER WIRE

- A. Provide tracer wire for all wastewater force main installations.
- B. The locator wire shall be taped to the top of the pipe with polyethylene tape during the pipe laying operation.
- C. For force mains, which are installed by the open-trench method, the locator wire shall be stranded 12-gauge copper with insulation rated UF or USE by Underwriter's Laboratories.
- D. For force mains, which are installed by a trenchless method, horizontal directional drilling or other, the locator wire shall be stranded 10-gauge stainless steel with insulation rated UF or USE by Underwriter's Laboratories. Underground splice connections shall be minimized and shall be rated for direct burial service.

PART 3 - EXECUTION

3.1 GENERAL

- A. Order of Work:

1. The Owner reserves the right to direct the Contractor as to which portion of work should be constructed first, and where applicable, to use any completed portion, on order from the Engineer that the work is as specified and is acceptable for service.

B. Operation of Charleston Water System Valves and Hydrants:

1. Only Charleston Water System personnel shall operate Charleston Water System valves or hydrants unless otherwise directed or approved by Charleston Water System.
2. Approval for non-Charleston Water System personnel to operate Charleston Water System valves or hydrants shall be determined on a case-by-case basis.

3.2 RIGHTS-OF-WAY, EASEMENTS, AND PERMITS

- A. Prior to the beginning of the Work, consult with the Engineer to determine that all rights-of-way, easements, permits or other legalities are in order and become familiar with the requirements thereof. Confine the Work as required to comply with such requirements. Any encroachment beyond such limits shall be the Contractor's responsibility.

3.3 ALIGNMENT AND GRADE

A. Gravity Sewer:

1. Establish grade and alignment by means of a laser or other method approved by the Engineer.
 - a. Pipe installed at incorrect grade because of un-calibrated laser or other cause shall be removed and re-laid at the Contractor's expense.
2. Gravity sewer pipe installation must comply with ANSI/ASTM D2321 as the minimum acceptable standard as well as any additional requirements as stated herein.
3. Before sewer pipe is placed in position in the trench the bottom and sides to the trench shall be carefully prepared as per manufacturer's specifications.
4. Each pipe shall be accurately placed to the exact line and grade called for on the approved drawings. Laser equipment shall be used in setting pipe.

5. Lay in a full bed of No. 57 stone.
6. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade.
7. Pipe shall be straight when placed in the trench.
8. Trench bottoms found to be at incorrect grade after pipe laying operations having begun shall be corrected and brought to exact line and grade.
9. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior.
10. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden deflections.
11. All jointing of pipe and fittings shall be in accordance with the pipe manufacturer's recommendations.
12. Any leaks or defects discovered after completion of the work shall be repaired immediately. All pipes in place shall be carefully protected from damage until the backfilling operations have been completed.
13. Water shall not be allowed to run through the pipe or stand in the trench.

B. Wastewater Force Main:

1. Fittings, valves and other appurtenances shall be located where shown on the approved plans, with the pipe being cut if necessary to assure accurate placement.
2. Install the pipe, valves, and appurtenances to the alignment and profile shown on the approved drawings.
 - a. Maintain a positive or negative grade as shown.
 - b. Unauthorized high points shall be corrected at the Contractor's expense.
3. Pipe lines intended to be straight shall be so laid.

4. Where vertical or horizontal alignment requires deflection from straight lines or grade, do not exceed 75% of maximum deflection recommended by the pipe manufacturer or AWWA Standard 600.
5. If alignment requires deflection exceeding recommended limits, furnish bends to provide angular deflections within the allowable limits.

3.4 SEPARATION OF WASTEWATER MAINS AND WATER MAINS

A. General:

1. Sewer lines in relation to water lines must conform to South Carolina Standards for Wastewater Facility Construction R.61-67 Section 67-300, Paragraph A.14.
2. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which may permit the passage of any sewage or polluted water into the potable supply.
3. No potable water pipe shall pass through or come into contact with any part of a sewer system.
4. The term "wastewater main" shall include both "gravity sewer main" and "wastewater force main".

B. Sanitary Sewer Mains:

1. Horizontal:
 - a. Wastewater mains shall be laid at least ten (10) feet horizontally from any existing or proposed water main. The distance shall be measured edge to edge.
 - b. In cases where it is not practical to maintain a ten (10) foot separation, the wastewater main may be constructed closer with South Carolina Department of Health and Environmental Control (SCDHEC) approval provided:
 - 1) It is laid in a separate trench.
 - 2) It is laid in the same trench with the water main located at one side on a bench of undisturbed earth.

- 3) In either of the above cases, crown elevation of the sanitary sewer main shall be at least eighteen (18) inches below the invert elevation of the water line.

2. Vertical:

- a. Crown elevation of the wastewater main shall be at least eighteen (18) inches below the invert elevation of the water main at a minimum diagonal of forty-five (45) degrees.
- b. If eighteen (18) inches of vertical separation is not practical, the wastewater main may be located closer provided:
 - 1) It is located below the water main.
 - 2) A full length of pipe is installed in the wastewater main centered so that each joint is equidistant from the water main. Sanitary sewer pipe shall be PVC C900 or ductile iron.
 - a) Provide restrained joint fittings when transitioning from Ductile Iron to PVC.
 - 3) Flowable fill is placed between the water main and sanitary sewer main.
- c. Requests to place a wastewater main over a water main will be reviewed on a case-by-case basis and requires Owner approval prior to installation.

3. Special Conditions

- a. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the water main should be constructed of ductile iron pipe, and the wastewater main constructed of ductile iron pipe.
- b. Pressure test both lines to assure water tightness.
- c. Approval from the Owner must be obtained prior to installation.

3.5 SEPARATION OF WASTEWATER MAINS AND STORM DRAINS

- A. No wastewater piping shall pass through or come in contact with any part of a storm drainage pipe or structure.

- B. Provide minimum 18" vertical separation between wastewater piping and storm drainage pipe or structure.
 - 1. Request for vertical separation less than 18" will be reviewed on a case-by-case basis.
- C. Where wastewater piping crosses beneath a storm drainage pipe or structure with less than 3' vertical separation, use PVC C900 or Ductile Iron Pipe.
- D. Where wastewater piping crosses above a storm drainage pipe or structure with less than 2' vertical separation, use PVC C900 or Ductile Iron Pipe.

3.6 TRENCH EXCAVATION

- A. Excavate pipe trench in accordance with Section 02221 - Trench Excavation and Backfill.

3.7 PREPARATION OF BEDDING

- A. Excavate trench bottom to provide a level cross section with vertical walls extending to the top of the pipe zone.
- B. Excavate evenly to provide smooth profile grade without holes and ridges. Keep trench dewatered.

3.8 BACKFILL

- A. Backfill pipe trench in accordance with Section 02221 - Trench Excavation and Backfill.
- B. All trenches suspected of not meeting the compaction requirements shall be tested for conformance by a testing lab approved by the Owner and at the locations and depths requested by the Engineer.

3.9 PIPE HANDLING

- A. Distribution, Delivery, and Storage:
 - 1. Deliver the pipe to the job site in a safe manner.
 - 2. Keep inside of pipe and fittings clean and free of dirt, debris, and foreign materials.
 - 3. Store materials at the site so as not to block access to driveways, sidewalks, or any other traveled way.

4. Store rubber gaskets and polyethylene film under cover in a cool place and out of direct sunlight.
5. Do not store nuts, bolts, glands, and other accessories directly on the ground.

B. Handling and Placing:

1. Handle pipe to ensure delivery to the trench in sound, undamaged condition.
2. Provide and use proper implements, tools, and facilities for the safe and proper prosecution of the work.
3. Carry pipe into position – do not drag.
4. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of a derrick, ropes, belt slings, or other equipment approved by the manufacturer, in such a manner as to prevent damage to the pipeline materials and protective coatings and linings.
 - a. Thoroughly clean interior of pipe, fittings, and accessories before lowering into trench.
 - b. Keep clean during laying operations by plugging or other method approved by Engineer.
5. Do not drop or dump pipeline materials into the trench.
6. Use pinch bars, slings, or tongs for aligning or turning pipe.
7. Use care not to damage pipe linings. Replace pipe where any part of coating or lining is damaged at no additional cost to the Owner.
8. Except where necessary in making connections to other lines, lay pipe with the bells facing in the direction of laying.
9. Rest the full length of each section of pipe solidly on the pipe bed with recesses excavated to accommodate bells, couplings, and joints.
10. Do not lay pipe in water or when trench conditions are unsuitable for the work. Keep water out of the trench until jointing is completed.
11. Take up and re-lay pipe that has the grade or joint disturbed after laying.

C. Pipe Condition

1. Inspect each piece of pipe and each fitting for damage and defects immediately before installation; examine pipe ends with particular care
 - a. Remove damaged and unacceptable pipe.
 - b. Replace pipe where any part of the coating or lining is damaged at no additional cost to the Owner.
2. Keep interior and joint surfaces clean and free of foreign materials.
3. Securely close open ends of pipe, fittings, and valves when work is not in process.

3.10 CLEANING PIPE AND FITTINGS

- A. Remove all lumps, blisters, and excess coal-tar coating from the bell-and spigot ends of each pipe. Wire brush the outside of the spigot and the inside of the bell and wipe clean, dry, and free from oil and grease before the pipe is laid.
- B. Wipe the ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of all dirt, grease, and foreign matter.

3.11 CUTTING PIPE

- A. Cut pipe neatly and without damage to the pipe or lining.
- B. Unless otherwise recommended by the pipe manufacturer, and authorized by the Engineer, cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter.
 1. Do not flame cut.
 2. Use wheel cutters when practical.
- C. Cuts must be even and perpendicular with length of pipe.
- D. Dress cut ends of pipe in accordance with manufacturer's directives for the type of joint to be made.
 1. Grind smooth cut ends and rough edges.
 2. For push-on type connection: cut end must be beveled slightly.

3.12 DRESSING CUT ENDS

- A. Dress cut ends of pipe in accordance with the type of joint to be made.
- B. Dress cut ends of mechanical joint pipe to remove sharp edges or projections, which may damage the rubber gasket.
- C. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.
- D. Dress cut ends of pipe for flexible couplings, flanged coupling adapters, and grooved end pipe couplings as recommended by the coupling or adapter manufacturer.

3.13 JOINTING PIPE

- A. General
 - 1. Lay pipe on bedding such that it is continuously supported along the barrel, and is not bearing on the bell.
 - 2. After joint construction, place bedding material under bell.
 - 3. Bell pipe using manufacturer's approved leverage bar.
 - a. Do not use machinery to bell pipe.
 - 4. Home line is to be clearly visible when pipe is joined.
- B. Flanged
 - 1. Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material.
 - 2. The rubber gaskets shall be checked for proper fit and thoroughly cleaned.
 - 3. Care shall be taken to assure proper seating of the flange gasket is uniform.
 - 4. Bolts shall be tightened so that the pressure on the gasket is uniform.
 - a. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible.
 - b. Alternately tighten bolts 180 degree apart until full gasket flow and seal are secured.

5. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.
 6. Bias cut or unusual re-facing of any flange will not be acceptable.
- C. Mechanical, Push-On, and Restrained Joint
1. Join pipe with mechanical or push-on type joints in accordance with the manufacturer's recommendations.
 2. Provide all special tools and devices required for proper installation.
 3. Lubricant for the pipe gaskets shall be manufacturer's standard.
- D. Restraining Glands:
1. Adjoining surfaces shall be clean, lubricated, and meet the requirements of ANSI/AWWA C111/A21.11.
 2. Install using assembly recommendations established in ANSI/AWWA C111/A21.11 as well as installation instructions provided by the manufacturer.
 3. If twist-off nuts are provided, tighten screws until nuts break loose.

3.14 CLEANING

- A. After each joint is complete, clean pipe interior to the next joint.

3.15 DEFLECTION

- A. The maximum permissible deflection at joints shall be 75% of the maximum allowed by AWWA Standard C600, Tables 5 and 6.

3.16 POLYETHYLENE ENCASEMENT

- A. All ductile buried piping and fittings shall be wrapped in a polyethylene film in accordance with ANSI Standard A21.5 (AWWA C105).
- B. Install in accordance with ANSI/AWWA C105/A21.5.
- C. Close all open ends and damaged areas securely with polyethylene tape to the satisfaction of the Engineer.

- D. Prepare pipe prior to installation by removing lumps of clay, mud, cinders, dirt, etc.
- E. If damaged polyethylene film cannot be repaired, replace with new film.
- F. Polyethylene tape to the satisfaction of Engineer. If damaged polyethylene film cannot be repaired, replace with new film.
- G. Do NOT provide polyethylene encasement for gravity sewer mains.

3.17 CONNECTIONS TO EXISTING GRAVITY SEWER

A. Gravity Sewer:

- 1. Connection of gravity sewer main to an existing system shall be made at an existing manhole or by constructing a cut-in Manhole.
 - a. Existing manhole:
 - 1) Connection to an existing manhole shall be made in the presence of the Charleston Water System inspector.
 - 2) New holes in manholes shall be core drilled.
 - 3) When connecting to an existing manhole, temporarily block and/or divert sewage flows. Use high early strength cement to form proper channels with minimum interruption of service.
 - 4) Seal around new pipe as specified in details on the Drawings.
 - b. Cut-in manhole:
 - 1) Temporarily block and/or divert sewage flows.
 - 2) Cut out length of existing pipe to accept new pipe in manhole.
 - 3) If benches are pre-formed:
 - a) Insert short section of PVC pipe in the existing holes and seal.

- b) Lower bottom section of manhole into hole and sleeve to existing piping.
 - c) See Drawings for additional details.
- 4) If benches are not pre-formed:
 - a) Cut the PVC pipe to form the channel and insert the required length of pipe through the holes in the bottom section of the manhole, set to match existing slope, and seal.
 - b) Lower the assembly into the hole, sleeve to existing piping, and unblock sewage flows.
 - c) Using high early strength cement, form benches as in typical manholes.
 - d) See Drawings for additional details.

B. Wastewater Force Main:

- 1. Connection of new force main to an existing gravity system shall be made at an existing manhole or by constructing a cut-in manhole.
 - a. Existing manhole:
 - 1) Connection to an existing manhole shall be made in the presence of the Charleston Water System inspector.
 - 2) Connection shall be made at existing flow line. See Details.
 - 3) New holes in manholes shall be core drilled.
 - 4) When connecting to an existing manhole, temporarily block and/or divert sewage flows. Use high early strength cement to form proper channels with minimum interruption of service.
 - 5) Seal around new pipe.
 - 6) See Drawings for additional details.
 - b. Cut-in manhole:

- 1) If benches are pre-formed:
 - a) Insert short section of PVC pipe in the existing holes and seal.
 - b) Lower bottom section of manhole into hole and sleeve to existing piping.
 - c) See Details.
- 2) If benches are not pre-formed:
 - a) Cut the PVC pipe to form the channel and insert the required length of pipe through the holes in the bottom section of the manhole, set to match existing slope, and seal.
 - b) Lower the assembly into the hole, sleeve to existing piping, and unblock sewage flows.
 - c) Using high early strength cement, form benches as in typical manholes.
 - d) See Drawings for additional details.

c. Coatings:

- 1) Coat force main receiving manhole and the next manhole downstream.
- 2) Coating shall be Raven 405 Epoxy System, 120 mil nominal thickness, and shall be applied by a Raven Certified Applicator.
- 3) Coating shall be tested for pinholes using approved spark test method. Applicator shall be responsible for correcting any defects found during testing.

3.18 CONNECTION TO AN EXISTING FORCE MAIN

- A. Connection to an existing force main shall be made by installation of a tee or wye.

1. NOTE: Under certain conditions, Charleston Water System will review submittals for direct taps. When approved by Charleston Water System, force mains less than 4" in diameter; use Type 316 stainless steel tapping saddles. Force mains 4" in diameter and larger; use Type 316 stainless steel tapping sleeves.
- B. Provide cushioned swing check valve with isolating plug valve on each side of check valve. See details on Drawings for additional information.

3.19 ANCHORAGE

A. General

1. Retainer glands shall be used on all mechanical joint fittings.
2. All tees, plugs, caps, and bends equal to or exceeding 11-1/4 degrees, as shown, and at other locations where unbalanced forces exist, must have acceptable thrust restraint.

B. Thrust Blocking

1. Provide thrust blocking only at wet taps, as shown, or as directed by the Engineer.
2. The concrete mix shall have 28-day compressive strength of not less than 3,000 pounds per square inch.
3. The bearing surface shall be as shown or as directed by the Engineer.
4. Place the block so that the pipe and fitting joints will be accessible to repairs, unless otherwise shown.
5. Size of the blocking will be determined by the Engineer, based on soil bearing capacity.
6. Thrust blocking is not required where restrained joints are indicated.
7. Installation:
 - a. Locate thrust blocking between solid ground and the fitting to be anchored.
 - b. Unless otherwise shown or directed by the Engineer, place the base and thrust bearing sides of thrust blocking against undisturbed earth.

- c. Sides of thrust blocking not subject to thrust may be placed against forms.
- d. Protect steel rods and clamps by hot dipped galvanizing.

C. Restrained Joints

- 1. Provide restrained joint pipe and fittings on all piping as specified above and indicated on plans.
- 2. Provide for use with mechanical joint pipe and fittings where applicable.

3.20 METALLIC DETECTION TAPE

- A. All wastewater mains which are installed by the open-trench method shall also include the installation of a metallic detection tape buried directly over the pipe twelve (12) inches below the ground surface continuously.

3.21 TRACER WIRE

- A. Install tracer wire on all wastewater force main installations, regardless of piping material.
- B. Tape to the top of the pipe with polyethylene tape during the pipe laying operation.
- C. Underground splice connections shall be minimized and shall be rated for direct burial service.
- D. The tracer wire shall be looped into "dummy" cast-iron water valve boxes (with caps labeled "SEWER" and painted white) installed at grade level, one being installed adjacent to the valve vault at the source pump station.
 - 1. Additional valve boxes shall be installed at intervals of no greater than every one thousand (1000') feet along the length of the force main (unless the main was installed by a trenchless method).
 - 2. A final valve box shall be installed at the discharge point of the force main, whether that be at a manhole or at a "tee" into another force main.
 - 3. The looped termination shall allow for the connection of an electronic locator transmitter.
- E. If interference is encountered from adjacent utilities or if the depth of bury or line length interferes with the signal, install a dummy valve box with access to

the tracer wire at no additional cost to the Owner.

- F. Prior to acceptance of the main, the Contractor shall demonstrate to the Engineer or the Engineer's representative that the locator wire functions properly.
 - 1. Provide notice of at least seven (7) calendar days in advance of testing.
 - 2. The Contractor shall use one of several commercially available utility locating instruments to energize and trace the locator wire.
 - 3. When the wastewater force main is installed in the road shoulder, green-marking flags (pin flags) shall be installed along the length of the main at intervals of no greater than twenty (20') feet.
 - 4. Where the main is installed under concrete or asphalt, green marking paint shall be used.
 - 5. Testing of the locator wire and installation of the marking flags shall be done prior to scheduling a final inspection of the wastewater system.

3.22 TESTING GRAVITY SEWER MAINS

- A. Air Testing – See Section 15000 Part 3.09.
- B. Mandrel - See Section 15000 Part 3.10.

3.23 HYDROSTATIC TESTING OF WASTEWATER FORCE MAINS

- A. See Section 15000 Part 3.08.

3.24 CLOSED CIRCUIT TELEVISION (CCTV) INSPECTION GRAVITY WASTEWATER MAINS

- A. See Section 15000 Part 3.11.

- END OF SECTION -

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SECTION 15008

PVC/CPVC PIPE

PART 1 -- GENERAL

1.01 DESCRIPTIPON

A. Work included

1. This Section covers the work necessary to furnish and install, complete, polyvinyl chloride (PVC) pipe and fittings for wastewater mains.

B. Relater Work Specified Elsewhere

1. Section 01030 – Grade Lines and Levels
2. Section 02220 – Casing Installation
3. Section 02221 – Trench Excavation and Backfill

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. The following specifications apply to the Work in this section. Use the most recent edition of each.

ASTM A746	Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C33	Standard Specification for Concrete Aggregates
ASTM D1784	Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds

ASTM D2241	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR)
ASTM D2321	Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM D2412	External Loading Properties of Plastic Pipe by Parallel-Plate Loading
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Polyvinyl Chloride (PVC) Pipe Joints
ASTM DS837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
ASTM F477	Standard Specification for Gaskets for Polyvinyl Chloride (PVC) Pipe Gaskets
ASTM F679	Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile-Iron Pipe Systems
ANSI/AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings, 3-in through 48-in for Water and Other Liquids
ANSI/AWWA C111/A21.	11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C151/A21.51	Ductile-Iron Pipe, Centrifugally Cast for Water
ANSI/AWWA C153/A21.53	Ductile-Iron Compact Fittings
ANSI/AWWA C900	American National Standard for Polyvinyl Chloride (PVC) Pressure Pipe

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Acquire all pipe from one established manufacturer.
2. The pipe shall be of a type designed and manufactured for wastewater systems.

B. Supply only new and unused pipe.

C. Acceptance of Pipe

1. Acceptance will be on the basis of design, material tests, and inspection of the complete product.
2. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to inspection by the Owner.
 - a. Inspection may be made at the place of manufacture, or on the job site after delivery, or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specifications' requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture.
 - b. All pipe which is rejected must be immediately removed from the project site by the Contractor.

D. Protection of Materials

1. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition.
2. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings.
3. Store in unit packages as received from manufacturer until just prior to installation.
4. Store pipe and rubber gaskets under cover out of direct sunlight.
5. Do not store nuts, bolts, glands, and other accessories directly on the ground.
6. Keep insides of pipe and fittings free of dirt and debris.

PART 2 -- PRODUCTS

2.1 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. PVC pipe and fittings shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.
- B. Fittings used with this pipe shall be socket type or flanged type as specified herein, in Section 15390 - Schedules, or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.
- C. PVC pipe shall be Type 1 Grade 1 conforming to ASTM D 1784 and D 1785. Fittings shall conform to the following standard specifications:
 - Socket Type (Schedule 40); ASTM D 2466
 - Socket Type (Schedule 80); ASTM D 2467
- D. Provide flanged fittings of the same material as the specified pipe and material conforming to ANSI B16.5 at all valves and equipment except at true (double) union valves. Flange gaskets shall be natural rubber or other material fully compatible with the fluid being conveyed. Where flanged piping is used with chemical systems, the gasket material shall conform to the requirements of the following table. Flange bolts shall be type 316 stainless steel minimum, with higher grade materials used where necessary for fluid (chemical) compatibility.

Chemical	Acceptable Gasket Material
Ammonium Hydroxide	EPDM
Aluminum Sulfate	EPDM, Viton
Ammonium Sulfate	EPDM
Calcium Hypochlorite	Viton
Carbon Dioxide Solution	Viton
Chlorine Solution	Viton
Chlorine Dioxide Solution	Viton
Ferric Chloride	EPDM, Viton
Ferric Sulfate	EPDM, Viton
Hydrochloric Acid	Viton
Hydrofluosilicic Acid	Viton
Lime Slurry	EPDM, Viton
Magnesium Chloride	EPDM, Viton
Magnesium Hydroxide	EPDM, Viton
Methanol	EPDM
Ozone Solution	Viton
Phosphoric Acid	Viton
Polyaluminum Chloride	EPDM, Viton

- E. Solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.
- F. C900-Class 200 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chloride (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 14 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.
 - 1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (± 1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.
 - 2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.
 - 3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 914 psi for all sizes when tested in accordance with D2241.
 - 4. The pipe shall be designed to pass a quick burst test pressure of 985 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.
 - 5. Fittings for C900-Class 200, DR 14 shall be ductile iron, bolted mechanical joint.
- G. C900-Class 150 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chlorine (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 18 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.
 - 1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (± 1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.
 - 2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2677. Elastomeric gaskets shall conform to the requirements of ASTM F477.
 - 3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 435 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 755 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.
 5. Fittings for C900-Class 150, DR 18 shall be ductile iron, bolted mechanical joint.
- H. Pipe and fitting shall meet the requirements of ASTM D3034 for 4" through 15" SDR26.
1. The pipe shall be colored green for in-ground identification as sewer pipe.
 2. Pipe shall be made from quality PVC resin equal to or exceeding cell class 12454 or 12365 as defined in ASTM D1784.
 3. Provisions must be made for expansion and contraction at each join an elastomeric gasket.
 4. The bell shall consist of an integral wall section with a solid cross section elastomeric gasket which meets the requirements of ASTM F477.
 5. Gaskets shall be factory assembled and securely locked in place to prevent displacement during assembly.
 6. Standard laying length shall be 20'.
 7. For transitions between PVC and Ductile Iron Pipe, use ductile iron pipe adapter Model 501 Transition Coupling by Romac Industries, Inc. with Protecto 401 lining.
- I. PVC pressure rated pipe (PR 160) shall be in sizes between 1 1/2 inches and 12 inches and shall conform to all the requirements of ASTM D1784 and ASTM D2241 and shall be a minimum of SDR 26 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.
1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (1± inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed materials shall not be accepted.
 2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.
 3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 135 psi for all sizes when tested in accordance with ASTM D2241.
 4. The pipe shall be designed to pass a quick burst test pressure of 500 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. The pipe shall be designed to pass for 1000 hours a sustained test pressure of 340 psi when tested in accordance with ASTM D1598, as referenced in ASTM D2241.

J. Fittings for PR 160, SDR 26 shall be PVC and designed for the pipe being supplied.

K. Acrylonitrile-butadiene-styrene (ABS) shall conform to the requirements of ASTM D 2661. Pipe and fittings shall have socket type couplings with solvent cement joints. Solvent cement shall conform to ASTM D 2235.

L. Type PSM polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of ASTM D 3034 with a maximum SDR of 35. Pipe and fittings shall have bell and spigot ends with O-ring rubber gasketed, compression type joints. Joints shall conform to the requirements of ASTM Specification D 3212. Reruns of reclaimed materials shall not be accepted. Unless indicated otherwise, PVC wall pipes shall be provided for all piping passing through exterior walls. Wall pipes shall have a water stop solvent-welded to the pipe. Each wall pipe shall be of the same class and type as the piping to which it is joined.

2.2 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

A. CPVC shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. CPVC pipe shall be Type 4, Grade 1, Schedule 80, conforming to ASTM D 1784 and ASTM F 441. CPVC fittings shall be socket type conforming to ASTM F 439.

D. Solvent cement for socket type joints shall conform to ASTM F 493 for CPVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.

2.3 BEDDING MATERIAL FOR GRAVITY SEWERS

A. Use crushed stone or gravel conforming to American Society for Testing and Materials C33, Gradation 57.

1. If Contractor can demonstrate that Gradation 57 stone is not readily available, Gradation 57 stone may be used if approved by the Owner.

PART 3 - EXECUTION

3.1 GENERAL

A. Order of Work:

1. The Owner reserves the right to direct the Contractor as to which portion of work should be constructed first, and where applicable, to use any completed portion, on order from the Engineer that the work is as specified and is acceptable for service.

B. Operation of Charleston Water System Valves and Hydrants:

1. Only Charleston Water System personnel shall operate Charleston Water System valves or hydrants unless otherwise directed or approved by Charleston Water System.
2. Approval for non-Charleston Water System personnel to operate Charleston Water System valves or hydrants shall be determined on a case-by-case basis.

3.2 RIGHTS-OF-WAY, EASEMENTS, AND PERMITS

- #### A.
- Prior to the beginning of the Work, consult with the Engineer to determine that all rights-of-way, easements, permits or other legalities are in order and become familiar with the requirements thereof. Confine the Work as required to comply with such requirements. Any encroachment beyond such limits shall be the Contractor's responsibility.

3.3 ALIGNMENT AND GRADE

A. Gravity Sewer:

1. Establish grade and alignment by means of a laser or other method approved by the Engineer.
 - a. Pipe installed at incorrect grade because of un-calibrated laser or other cause shall be removed and re-laid at the Contractor's expense.
2. Gravity sewer pipe installation must comply with ANSI/ASTM D2321 as the minimum acceptable standard as well as any additional requirements as stated herein.
3. Before sewer pipe is placed in position in the trench the bottom and sides to the trench shall be carefully prepared as per manufacturer's specifications.

4. Each pipe shall be accurately placed to the exact line and grade called for on the approved drawings. Laser equipment shall be used in setting pipe.
5. Lay in a full bed of No. 57 stone.
6. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade.
7. Pipe shall be straight when placed in the trench.
8. Trench bottoms found to be at incorrect grade after pipe laying operations having begun shall be corrected and brought to exact line and grade.
9. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior.
10. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden deflections.
11. All jointing of pipe and fittings shall be in accordance with the pipe manufacturer's recommendations.
12. Any leaks or defects discovered after completion of the work shall be repaired immediately. All pipes in place shall be carefully protected from damage until the backfilling operations have been completed.
13. Water shall not be allowed to run through the pipe or stand in the trench.

B. Wastewater Force Main:

1. Fittings, valves and other appurtenances shall be located where shown on the approved plans, with the pipe being cut if necessary to assure accurate placement.
2. Install the pipe, valves, and appurtenances to the alignment and profile shown on the approved drawings.
 - a. Maintain a positive or negative grade as shown.
 - b. Unauthorized high points shall be corrected at the Contractor's expense.
3. Pipe lines intended to be straight shall be so laid.
4. Where vertical or horizontal alignment requires deflection from straight lines or grade, do not exceed 75% of maximum deflection recommended by the pipe manufacturer.

5. If alignment requires deflection exceeding recommended limits, furnish bends to provide angular deflections within the allowable limits.

3.4 SEPARATION OF WASTEWATER MAINS AND WATER MAINS

A. General:

1. Sewer lines in relation to water lines must conform to South Carolina Standards for Wastewater Facility Construction R.61-67 Section 67- 300, Paragraph A.14.
2. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which may permit the passage of any sewage or polluted water into the potable supply.
3. No potable water pipe shall pass through or come into contact with any part of a sewer system.
4. The term "wastewater main" shall include both "gravity sewer main" and "wastewater force main".

B. Sanitary Sewer Mains:

1. Horizontal:
 - a. Wastewater mains shall be laid at least ten (10) feet horizontally from any existing or proposed water main. The distance shall be measured edge to edge.
 - b. In cases where it is not practical to maintain a ten (10) foot separation, the wastewater main may be constructed closer with South Carolina Department of Health and Environmental Control (SCDHEC) approval provided:
 - 1) It is laid in a separate trench.
 - 2) It is laid in the same trench with the water main located at one side on a bench of undisturbed earth.
 - 3) In either of the above cases, crown elevation of the sanitary sewer main shall be at least eighteen (18) inches below the invert elevation of the water line.

2. Vertical:

- a. Crown elevation of the wastewater main shall be at least eighteen (18) inches below the invert elevation of the water main at a minimum diagonal of forty-five (45) degrees.
- b. If eighteen (18) inches of vertical separation is not practical, the wastewater main may be located closer provided:
 - 1) It is located below the watermain.
 - 2) A full length of pipe is installed in the wastewater main centered so that each joint is equidistant from the water main. Sanitary sewer pipe shall be PVC C900, C905, or ductile iron.
 - a) Provide restrained joint fittings when transitioning from Ductile Iron to PVC.
 - 3) Flowable fill is placed between the water main and sanitary sewer main.
- c. Requests to place a wastewater main over a water main will be reviewed on a case-by-case basis and requires Owner approval prior to installation.

3. Special Conditions

- a. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the water main should be constructed of ductile iron pipe, and the wastewater main constructed of ductile iron pipe.
- b. Pressure test both lines to assure water tightness.
- c. Approval from the Owner must be obtained prior to installation.

3.5 SEPARATION OF WASTEWATER MAINS AND STORM DRAINS

- A. No wastewater piping shall pass through or come in contact with any part of a storm drainage pipe or structure.
- B. Provide minimum 18" vertical separation between wastewater piping and storm drainage pipe or structure.
 - 1. Request for vertical separation less than 18" will be reviewed on a case-by-case basis.

- C. Where wastewater piping crosses beneath a storm drainage pipe or structure with less than 3' vertical separation, use PVC C900 or Ductile Iron Pipe.
- D. Where wastewater piping crosses above a storm drainage pipe or structure with less than 2' vertical separation, use PVC C900 or Ductile Iron Pipe.

3.6 TRENCH EXCAVATION

- A. Excavate pipe trench in accordance with Section 02221 - Trench Excavation and Backfill.

3.7 PREPARATION OF TRENCH BEDDING

- A. Excavate trench bottom to provide a level cross section with vertical walls extending to the top of the pipe zone.
- B. Excavate evenly to provide smooth profile grade without holes and ridges. Keep trench dewatered.

3.8 BACKFILL

- A. Backfill pipe trench in accordance with Section 02221 - Trench Excavation and Backfill.
- B. All trenches suspected of not meeting the compaction requirements shall be tested for conformance by a testing lab approved by the Owner and at the locations and depths requested by the Engineer.

3.9 PIPE HANDLING

- A. Distribution, Delivery, and Storage:
 - 1. Store and place pipe lengths on level ground.
 - 2. Store in unit packages as received from manufacturer until just prior installation.
 - 3. Store and stack per manufacturer's recommendations.
 - a. Stack units to prevent compression, damage, or deformation to pipe barrels and bells.
 - 4. Protect from direct sunlight by covering with opaque material.
 - a. Permit adequate air circulation above and around pipe as required to prevent excess heat accumulation.

5. Deliver the pipe to the job site in a safe manner.
6. Keep inside of pipe and fittings clean and free of dirt, debris, and foreign materials.
7. Store materials at the site so as not to block access to driveways, sidewalks, or any other traveled way.
8. Do not store nuts, bolts, glands, and other accessories directly on the ground.

B. Handling and Placing:

1. Handle pipe to ensure delivery to the trench in sound, undamaged condition.
2. Provide and use proper implements, tools, and facilities for the safe and proper prosecution of the work.
3. Exercise care to avoid cutting, gouging, scratching, or otherwise abrading the piping in any way.
4. Carry pipe into position – do not drag.
5. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of a derrick, ropes, belt slings, or other equipment approved by the manufacturer, in such a manner as to prevent damage to the pipeline materials and protective coatings and linings.
 - a. Thoroughly clean interior of pipe, fittings, and accessories before lowering into trench.
 - b. Keep clean during laying operations by plugging or other method approved by Engineer.
6. Do not drop or dump pipeline materials into the trench.
7. Use pinch bars, slings, or tongs for aligning or turning pipe.
8. Except where necessary in making connections to other lines, lay pipe with the bells facing in the direction of laying.
9. Rest the full length of each section of pipe solidly on the pipe bed with recesses excavated to accommodate bells, couplings, and joints.
10. Do not lay pipe in water or when trench conditions are unsuitable for the work. Keep water out of the trench until jointing is completed.

11. Take up and re-lay pipe that has the grade or joint disturbed after laying.

C. Pipe Condition

1. Inspect each piece of pipe and each fitting for damage and defects immediately before installation; examine pipe ends with particular care
 - a. Remove damaged and unacceptable pipe.
2. Keep interior and joint surfaces clean and free of foreign materials.
3. Securely close open ends of pipe, fittings, and valves when work is not in process.

3.10 CLEANING PIPE AND FITTINGS

- A. Remove all foreign material from the bell-and-spigot ends of all pipe and fittings. Wipe clean, dry, and free from oil and grease before the pipe is laid. Wipe rubber gaskets clean of all foreign matter.
- B. Wipe the ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of all dirt, grease, and foreign matter.

3.11 CUTTING PIPE

- A. Cut pipe neatly and without damage to the pipe or lining.
- B. Unless otherwise recommended by the pipe manufacturer, and authorized by the Engineer, cut pipe with hand saw or power saw.
- C. Cuts must be even and perpendicular with length of pipe.
- D. Dress cut ends of pipe in accordance with manufacturer's directives for the type of joint to be made.

3.12 DRESSING CUT ENDS

- A. Dress cut ends of pipe in accordance with the type of joint to be made.
- B. Dress cut ends of mechanical joint pipe to remove sharp edges or projections, which may damage the rubber gaskets.
- C. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.
- D. Dress cut ends of pipe for flexible couplings, flanged coupling adapters, and grooved end pipe couplings as recommended by the coupling or adapter manufacturer.

3.13 JOINTING PIPE

A. General

1. Lay pipe on bedding such that it is continuously supported along the barrel, and is not bearing on the bell.
2. After joint construction, place bedding material under bell.
3. Bell pipe using manufacturer's approved leverage bar.
 - a. Do not use machinery to bell pipe.
4. Home line is to be clearly visible when pipe is joined.

B. Flanged

1. Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material.
2. The rubber gaskets shall be checked for proper fit and thoroughly cleaned.
3. Care shall be taken to assure proper seating of the flange gasket is uniform.
4. Bolts shall be tightened so that the pressure on the gasket is uniform.
 - a. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible.
 - b. Alternately tighten bolts 180 degree apart until full gasket flow and seal are secured.
5. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.
6. Bias cut or unusual refacing of any flange will not be acceptable.

C. Mechanical, Push-On, and Restrained Joint

1. Join pipe with mechanical or push-on type joints in accordance with the manufacturer's recommendations.
2. Provide all special tools and devices required for proper installation.
3. Lubricant for the pipe gaskets shall be manufacturer's standard.

D. Restraining Glands:

1. Adjoining surfaces shall be clean, lubricated, and meet the requirements of ANSI/AWWA C111/A21.11.
2. Install using assembly recommendations established in ANSI/AWWA C111/A21.11 as well as installation instructions provided by the manufacturer.
3. If twist-off nuts are provided, tighten screws until nuts break loose.

3.14 CLEANING

- A. After each joint is complete, clean pipe interior to the next joint.

3.15 DEFLECTION

- A. The maximum permissible deflection at joints shall be 75% of the maximum allowed by AWWA Standard C600, Tables 5 and 6

3.16 CONNECTIONS TO EXISTING GRAVITY SEWER

- A. Gravity Sewer:

1. Connection of gravity sewer main to an existing system shall be made at an existing manhole or by constructing a cut-in Manhole.
 - a. Existing manhole:
 - 1) Connection to an existing manhole shall be made in the presence of the Charleston Water System inspector.
 - 2) New holes in manholes shall be core drilled.
 - 3) When connecting to an existing manhole, temporarily block and/or divert sewage flows. Use high early strength cement to form proper channels with minimum interruption of service.
 - 4) Seal around new pipe as specified in details.
 - b. Cut-in manhole:
 - 1) Temporarily block and/or divert sewage flows.
 - 2) Cut out length of existing pipe to accept new pipe in manhole.
 - 3) If benches are pre-formed:

- a) Insert short section of PVC pipe in the existing holes and seal.
 - b) Lower bottom section of manhole into hole and sleeve to existing piping.
 - c) See Drawings for additional details.
- 4) If benches are not pre-formed:
- a) Cut the PVC pipe to form the channel and insert the required length of pipe through the holes in the bottom section of the manhole, set to match existing slope, and seal.
 - b) Lower the assembly into the hole, sleeve to existing piping, and unblock sewage flows.
 - c) Using high early strength cement, form benches as in typical manholes.
 - d) See Drawings for additional details.

B. Wastewater Force Main:

1. Connection of new force main to an existing gravity system shall be made at an existing manhole or by constructing a cut-in manhole.
 - a. Existing manhole:
 - 1) Connection to an existing manhole shall be made in the presence of the Charleston Water System inspector.
 - 2) Connection shall be made at existing flow line. See Details.
 - 3) New holes in manholes shall be core drilled.
 - 4) When connecting to an existing manhole, temporarily block and/or divert sewage flows. Use high early strength cement to form proper channels with minimum interruption of service.
 - 5) Seal around new pipe.
 - 6) See Drawings for additional details.
 - b. Cut-in manhole:

- 1) If benches are pre-formed:
 - a) Insert short section of PVC pipe in the existing holes and seal.
 - b) Lower bottom section of manhole into hole and sleeve to existing piping.
 - c) See Details.
- 2) If benches are not pre-formed:
 - a) Cut the PVC pipe to form the channel and insert the required length of pipe through the holes in the bottom section of the manhole, set to match existing slope, and seal.
 - b) Lower the assembly into the hole, sleeve to existing piping, and unblock sewage flows.
 - c) Using high early strength cement, form benches as in typical manholes.
 - d) See Drawings for additional details.

c. Coatings:

- 1) Coat force main receiving manhole and the next manhole downstream.
- 2) Coating shall be Raven 405 Epoxy System, 120 mil nominal thickness, and shall be applied by a Raven Certified Applicator.
- 3) Coating shall be tested for pinholes using approved spark test method. Applicator shall be responsible for correcting any defects found during testing.

3.17 CONNECTION TO AN EXISTING FORCE MAIN

A. Connection to an existing force main shall be made by installation of a tee or wye.

1. NOTE: Under certain conditions, Charleston Water System will review submittals for direct taps. When approved by Charleston Water System, force mains less than 6" in diameter; use Type 316 stainless steel tapping saddles. Force mains 6" in diameter and larger; use Type 316 stainless steel tapping sleeves.

- B. Provide cushioned swing check valve with isolating plug valve on each side of check valve. See Details

3.18 ANCHORAGE

A. General

1. Retainer glands shall be used on all mechanical joint fittings.
2. All tees, plugs, caps, and bends equal to or exceeding 11-1/4 degrees, as shown, and at other locations where unbalanced forces exist, must have acceptable thrust restraint.

B. Thrust Blocking

1. Provide thrust blocking only at wet taps, as shown, or as directed by the Engineer.
2. The concrete mix shall have 28-day compressive strength of not less than 3,000 pounds per square inch.
3. The bearing surface shall be as shown or as directed by the Engineer.
4. Place the block so that the pipe and fitting joints will be accessible to repairs, unless otherwise shown.
5. Size of the blocking will be determined by the Engineer, based on soil bearing capacity.
6. Thrust blocking is not required where restrained joints are indicated.
7. Installation:
 - a. Locate thrust blocking between solid ground and the fitting to be anchored.
 - b. Unless otherwise shown or directed by the Engineer, place the base and thrust bearing sides of thrust blocking against undisturbed earth.
 - c. Sides of thrust blocking not subject to thrust may be placed against forms.
 - d. Protect steel rods and clamps by hot dipped galvanizing.

C. Restrained Joints

1. Provide restrained joint pipe and fittings on all piping as specified above and indicated on plans.

2. Provide for use with mechanical joint pipe and fittings where applicable.

3.19 METALLIC DETECTION TAPE

- A. All wastewater mains which are installed by the open-trench method shall also include the installation of metallic detection tape buried directly over the pipe twelve (12) inches below the ground surface continuously.

3.20 TRACER WIRE

- A. Install tracer wire on all wastewater force main installations, regardless of piping material.
- B. Tape to the top of the pipe with polyethylene tape during the pipe laying operation.
- C. Underground splice connections shall be minimized and shall be rated for direct burial service.
- D. The tracer wire shall be looped into "dummy" cast-iron water valve boxes (with caps labeled "SEWER" and painted white) installed at grade level, one being installed adjacent to the valve vault at the source pump station.
 1. Additional valve boxes shall be installed at intervals of no greater than every one thousand (1000') feet along the length of the force main (unless the main was installed by a trenchless method).
 2. A final valve box shall be installed at the discharge point of the force main, whether that be at a manhole or at a "tee" into another force main.
 3. The looped termination shall allow for the connection of an electronic locator transmitter.
- E. If interference is encountered from adjacent utilities or if the depth of bury or line length interferes with the signal, install a dummy valve box with access to the tracer wire at no additional cost to the Owner.
- F. Prior to acceptance of the main, the Contractor shall demonstrate to the Engineer or the Engineer's representative that the locator wire functions properly.
 1. Provide notice of at least seven (7) calendar days in advance of testing.
 2. The Contractor shall use one of several commercially available utility locating instruments to energize and trace the locator wire.
 3. When the wastewater force main is installed in the road shoulder, green-marking flags (pin flags) shall be installed along the length of the main at intervals of no greater than twenty (20') feet.

4. Where the main is installed under concrete or asphalt, green marking paint shall be used.
5. Testing of the locator wire and installation of the marking flags shall be done prior to scheduling a final inspection of the wastewater system.

3.21 TESTING GRAVITY SEWER MAINS

- A. Air Testing – See Section 15000 Part 3.09.
- B. Mandrel – See Section 15000 Part 3.10

3.22 HYDROSTATIC TESTING OF WASTEWATER FORCE MAINS

- A. See Section 15000 Part 3.08.

3.23 CLOSED CIRCUIT TELEVISION (CCTV) INSPECTION GRAVITY WASTEWATER MAINS

- A. See Section 15000 Part 3.11.

- END OF SECTION -

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SECTION 15020

PIPE SUPPORTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 05050, Metal Fastening.
- B. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 HANGERS AND SUPPORTS

- A. All piping shall be adequately supported and braced by means of adequate hangers, concrete piers, pipe supports, brackets, or otherwise as may be required by the location. Generally, concrete supports shall be used where pipe centerline is less than 3 feet above floor, and hangers above 6 feet unless specified or shown otherwise. Supports shall be not more than 10 feet on center for steel and cast iron, 5 feet on center for plastic unless otherwise shown on the Drawings or required by the specific manufacturer. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing hangers and supports to the structure.
- B. Hangers and supports shall conform to the following requirements:
 - 1. All hangers and supports shall be capable of adjustment after installation. Types of hangers and supports shall be kept to a minimum.
 - 2. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.
 - 3. Vertical piping shall be supported at each floor and between floors by stays or braces to prevent rattling and vibration.
 - 4. Supports and hangers for plastic piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.
 - 5. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless steel hangers.
 - 6. Ferrous pipes to be painted shall be painted in accordance with Section 09900 - Painting. Ferrous pipes that do not require painting shall be supported by galvanized hangers and supports.

7. Copper piping shall be supported by plastic coated or copper plated steel hangers and supports.
 8. Plastic piping shall be supported by plastic coated steel hangers and supports.
 9. Hangers and supports shall provide for thermal expansion throughout the full operating temperature range.
 10. Expansion type anchors used for pipe hangers and supports shall be Type 304 stainless steel.
- C. All metallic hangers and supports shall be standard make by Anvil International, Inc., "Witch" by Carpenter & Paterson, Ltd., B-Line Systems, Inc., or equal; and data on the types and sizes to be used shall be furnished to the Engineer for approval. Metallic support system brackets, rods, support clips, clevis hangers, hardware, etc. shall be cast iron or welded steel construction.
- D. Non-metallic support system shall be a heavy duty channel framing system. Channel frames shall be manufactured by the pultrusion process using corrosion grade polyester or vinylester resins. All fiberglass construction shall include suitable ultraviolet inhibitors for UV exposure and shall have a flame spread rating of 25 or less per ASTM E84. Piping accessories, pipe clamps, clevis hangers, support posts, support racks, fasteners, etc., shall be constructed of vinylester or polyurethane resin. Non-metallic support systems shall be standard make Aickinstrut by Aickinstrut, Inc., Unistrut Fiberglass by Unistrut, Inc., Enduro Fiberglass Systems, or equal. The Contractor shall submit data on the types and sizes of approval. Unless otherwise shown or specified the Contractor shall provide support spacings in the conformance with the pipe and support system manufacturer's requirements.

- END OF SECTION -

SECTION 15030

PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all components of the system for identification of piping and equipment as specified hereinafter. The system shall include the application of color coding to all new and altered plant piping. The Contractor shall paint the equipment and piping of all Contracts in the colors herein specified, and in accordance with the requirements of Section 09900, Painting.
- B. In addition to the legends specified herein the Engineer may order the Contractor to furnish and install additional identification legends and arrows at no additional cost to the Owner. Such additional signs may be requested near completion of the work and shall be limited to no more than five (5) signs for each type specified herein. The legends and color combinations for additional signs shall conform to the requirements specified herein.
- C. The Contractor shall submit a schedule of the colors and designations proposed in accordance with Section 01300, Submittals, and this Section. A minimum of four (4) color charts with cross-references to the colors listed herein shall be included with the Submittal.
- D. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 PIPING BAND

- A. All new and altered piping shall receive identification bands. Such bands shall be 6-inches wide, neatly made by masking, and spaced at intervals of 30-inches on centers regardless of the diameter of the pipe being painted. The Contractor may use approved precut and prefabricated metal bands on piping, in lieu of the masked and painted bands, where approved by the Engineer.

2.02 PIPING IDENTIFICATION LEGEND

- A. The Contractor shall apply identification legends to all types and sections of piping as shown on the Drawings or as designated by the Engineer. Such legends shall be in the form of plain block lettering giving the name of the pipe content in full or abbreviated form, and showing the direction of flow by arrows. All lettering and arrows shall be of the plastic snap-on type, Seton nameplate "setmarks", or equal, or they shall be formed by stenciling in an approved manner using white or black as directed and shall have an overall height in inches in accordance with the following table:

Diameter of Pipe or Pipe Covering

3/4 to 1-1/4 inches
1-1/2 to 2-inches
2-1/2 to 6-inches
8 to 10-inches
Over 10-inches

Height of Lettering

1/2-inches
3/4-inches
1-1/4-inches
2-1/2-inches
3-1/2-inches

- B. Identification lettering shall be located midway between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located each fifteen (15) feet in pipe length, and shall be properly inclined to the pipe axis to facilitate easy reading. In the event lettering and arrow identifications are required for piping less than 3/4-inch in diameter, the Contractor shall furnish and attach approved color coded tags where instructed.
- C. The colors referenced in the legend are as manufactured by KOP-COAT, or equal. They are used for convenience only.
- D. Piping, Equipment and Misc. Identification

Service	Legend	Base	Band
Pumps, Motors, Piping and Valves	Wastewater	Owner to Confirm	
Drains	Drain	Owner to Confirm	
Potable Water	Potable Water	Owner to Confirm	
Chemical Piping	Sodium Hypochlorite	Owner to Confirm	
Chemical Piping	Sodium Bisulfite	Owner to Confirm	

- END OF SECTION -

SECTION 15080

CONTRACTOR-INSTALLED WATER SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section includes material, installation and quality assurance specifications for all 3/4-inch through 2-inch metered water services.
- B. Contractor shall install the tap and service piping from the main to the property line, including the meter box.
- C. Contractor shall supply all approved material, except for the meter.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. The following specifications apply to the Work in this section. Use the most recent edition of each.

ANSI B1.20.1	General Purpose (Inch) Pipe Threads
ANSI B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
ASTM B32	Standard Specification for Solder Metal
ASTM B43	Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B62	Standard Specification for Composition or Ounce Metal Castings
ASTM B88	Standard Specification for Seamless Copper Water Tube
ASTM B584	Standard Specification for Copper Alloy Sand Castings
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile Iron Pipe Systems
ANSI/AWWA C600	Installation of Ductile Iron Water Mains and their Appurtenances

AWWA C116 Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Grey Iron Fittings for Water Supply

AWWA C800 Underground Service Line Valves and Fittings

1.3 SUBMITTALS

- A. Comply with pertinent provisions of Section 01001.

PART 2 - PRODUCTS

2.1 CASTINGS

- A. All brass components in contact with potable water must be made from either CDA/UNS Brass Alloys C89520 or C89833 with a maximum lead content of .25% by weight.
1. Brass alloys not listed in ANSI/AWWA C800 Paragraph 4.1.2 are not approved.
 2. All fittings shall be stamped or embossed with a mark or name indicating that the product is manufactured from the low-lead alloy.
- B. Service saddles shall be made of ductile iron in accordance with the chemical and mechanical requirements of ASTM A536.
- C. Straps, nuts, and bolts shall be made from Type 304 or 316 stainless steel.

2.2 EXTERIOR COATING

- A. Ductile iron saddles shall have fusion bonded nylon or epoxy coating with an average thickness of 10 mil in accordance with ANSI/AWWA Standard C116/A21.16.

2.3 JOINT MATERIAL

- A. All parts such as gaskets, seals, o-rings, and compression components may be of other materials selected for endurance, corrosion resistance, and strength, and must comply with AWWA standards and the latest amendments to the Safe Drinking Water Act (SDWA).

2.4 GENERAL DESIGN

- A. All materials used shall be acceptable for the purpose intended and installed to meet the latest Charleston Water System Minimum Standards for the Design & Construction of Water and Sanitary Sewer Systems.

2.5 DETAILED DESIGN

A. Corporation Valves:

1. Corporation Valves will have N.P.T. thread inlets.
2. The outlet connection will be CTS /OD, conductive compression (grip nut) type outlets.
3. Accepted manufacturers and models are:
 - a. Mueller – Ori-Corp, Model # H-15023 (1 ½" and 2")
 - b. Mueller – 300 Corp, Model # B-25028 (1")
 - c. Ford – Ball Corp, Model # FB1100-Q-G (1" through 2")
 - d. A.Y. McDonald Ball Corp, Model # 74704-BG (1" through 2")

B. Service Saddles

1. Service Saddles shall only be used on 1 ½" and 2" taps unless otherwise approved by the Owner.
2. Service Saddles will have a ductile iron body with an I.P.T. threaded outlet, double bolted or double strapped Type 304 or 316 stainless steel straps.
3. Ductile bodies are to be fusion bonded epoxy or nylon coated. Accepted manufacturers and models are:
 - a. Ford, model # FC 202
 - b. Mueller, model # DR2S
 - c. JCM, model # 406
 - d. Romac, model # 202N
 - e. Smith-Blair # 317

C. Service Line Fittings

1. Service Line Fittings used for installation shall be designed to connect service lines by means of threads and compression.

D. Copper Water Tube

1. Copper Water Tube shall be Type K copper tubing, 0.065" minimum wall thickness, suitable for underground water services and supplied in conformance with ASTM B88.

E. Curb Stops

1. Provide curb stops for 1 ½" and 2" services.
2. Accepted manufacturers and models are:
 - a. Mueller, Model # H-15209
 - b. A.Y. McDonald, Model # 76100-WG
 - c. Ford, Model # B44

F. Meter Boxes:

1. All meter boxes shall be provided by the Contractor.
2. ¾" Meter Box:
 - a. 5/8" x ¾" Ford Long Yokebox # LYLVV 344-233-TP-CPW-G, angle key valve inlet, outlet with grip nut, and CPW logo lid for electronic reading, equipped with removable plug for AMR setup.
 - b. A.Y. McDonald part # 76-208LLVV 337x005 for 5/8" x ¾" meter, ¾" CTS angle plug valve inlet x ¾" CTS angle plug valve outlet with grip nut, non-locking CPW logo lid, touchread hole with removable plug for AMR setup.
3. 1" Meter Box:
 - a. Ford Yokebox # YL 111-444-TP, 1" female IPT on inlet and outlet:
 - 1) 10" from meter to grade level; 13.5" overall depth.
 - 2) 15" base diameter, 12-3/8" top overall diameter.
 - 3) Lid shall be equipped with removable plug for AMR setup.
 - b. A.Y. McDonald part # 75-410BCGG 447 Straight 1" FNPT ball valve inlet x Straight 1" FNPT outlet:
 - 1) 10" meter centerline to grade level.

- 2) Non-locking lid equipped with 2" touchread hole with removable plug for AMR setup.
4. 1 1/2" and 2" Meter Box:
 - a. J&M Foundry CPW# - #P.C.1.5-2. Size: 29-5/8" Long x 16-1/8" Wide x 14" Deep. Material is ASTM A-48, Class 35B iron base with two-piece iron lid rated for heavy traffic embossed with Palmetto tree, crossed cannons and "Commissioners of Public Works, Charleston, S.C."

G. Meter Setter, 1-1/2-inch and 2-inch

1. Meter setters for 1-1/2-inch and 2-inch flanged meters are constructed of 85-5-5-5 brass and copper tubing, ball valve inlet with padlock wing, check valve outlet, brace pipe eyelet on FIP 90° Ells on inlet and outlet sides of set-up.
2. Accepted manufacturers and models are:
 - a. Ford Meter Box Co. #VBH76-15-44-66G for 1-1/2-inch and #VBH77-15-44-77G for 2-inch
 - b. Mueller Co. #B-2422-2 for 1-1/2-inch or 2-inch with 15-inch riser and 110 compression connection
 - c. A.Y. McDonald 21-615WDGG 660 for 1 1/2" and 21-715WDGG for 2"

PART 3 - EXECUTION

3.1 GENERAL

- A. Service shall not be installed in concrete or asphalt such as driveway, sidewalk, etc. Exceptions may be made in city setting with the approval of the Owner.

3.2 TAPS

A. Direct Taps

1. 1" direct taps are required for 3/4" and 1" services on ductile iron mains and will have N.P.T. threads.
2. All taps will be located at the 2 o'clock or 10 o'clock position on the main under system pressure and must be installed in accordance with AWWA Standard C-600.

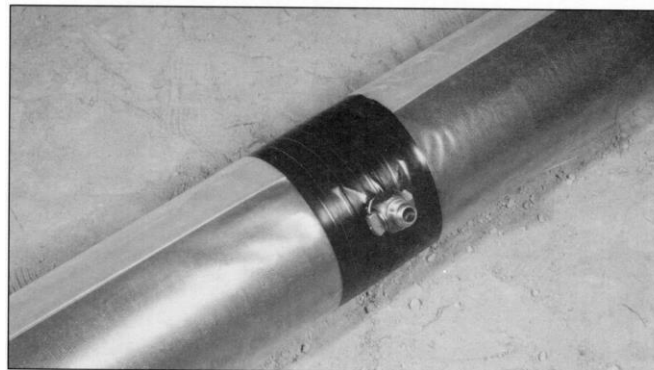
3. Polyethylene wrap will be protected and replaced in accordance with ANSI/AWWA C105/A21.5 and ANSI/AWWA C600, Section 8: Service Taps.

B. Saddle Taps

1. Saddle taps are required on all PVC mains and when making 1 ½" and 2" taps on ductile iron mains.
2. Taps will be made with through-the-saddle style tapping machines, using coupon-type tapping bits under system pressure.
3. The tapered iron drill bit shall be used where saddles are required on ductile iron.
4. All saddle taps are to be located at the 2 o'clock or 10 o'clock position on the main.

3.3 POLYETHYLENE ENCASEMENT

- A. When direct tapping on pipe encased in polyethylene, cover the area of the pipe to be tapped with dielectric tape to protect the poly-wrap from additional damage.
1. Make an "X" shaped cut at the tap location prior to making the tap.
 2. When using a saddle on ductile iron, remove only the portion of wrap that will allow the saddle gasket to come in complete contact with the pipe.
 3. Repair all rips or cuts with polyethylene tape, cover the saddle with wrap on all pipe and the copper service for 3-feet from the main.
 4. See figure below.



Direct service connection tapped through polyethylene adhesive tape and polyethylene film

3.4 PIPE INSTALLATION

- A. All service lines will be installed with a minimum of 36" to a maximum of 48" of cover on all street crossings, and a minimum of 24" under all open ditches.
- B. PVC sleeves are optional on service lines crossing streets, driveways or parking areas.
 - 1. The Contractor may install a capped 4" Schedule 40 PVC water service carrier pipe to provide the flexibility of installing the water service line at a later date during the construction period.
 - 2. The carrier pipe will be used to install copper water service lines.
 - 3. The carrier pipe shall be installed a minimum of 36" and a maximum of 60" below the surface of the road and made easily accessible.
 - 4. The carrier pipe shall be flagged with direct burial electronically detectable tape.
- C. Swing joints, double 90-degree bends at the service tap, are required on all 1 ½" and 2" services to allow for expansion and contraction to the service and to assist in establishing the correct grade for street crossings.

3.5 METER BOX INSTALLATION

- A. The contractor will be responsible for the final finished grade of boxes until all connections are complete, the system has received South Carolina Department of Health and Environmental Control (SCDHEC) approval to operate, and the Owner has accepted the system.
- B. Installations will comply with the following requirements:
 - 1. Boxes shall be placed on a 6" bed of gravel with the top of the box placed flush with the finished grade of the property. Concrete blocks 4" x 8" x 16" will be used to support and level the larger PC box for 1 ½" and 2" services.
 - 2. Meter setters shall utilize 1" PVC pipe through the eyelets to stabilize the setup during backfill procedures.
- C. Meter box shall not be installed within 3' of trees, bushes, shrubs, etc. If anything is planted, placed or installed within the 3' radius, the customer may be required to move, trim, prune, etc., so the Owner may gain access to its appurtenance(s).

1. If a meter box is requested to be installed in a flowerbed, the customer must remove plants for a 3' radius around the area and a 3' path to the public right of way. If plants are not removed, the Owner shall not be responsible for damages to the plants.

3.6 METER INSTALLATION

- A. Refer to Charleston Water System Minimum Standards for the Design & Construction of Water and Sanitary Sewer Systems for requirements to be met prior to the Owner installing a meter.

3.7 TESTING AND STERILIZING

- A. Pipe and fittings will be kept free of any debris and trash during installation and will be flushed completely after installation.
- B. Pressure testing may be required on contractor-installed service lines. If specified, each service shall be subjected to and successfully meet a pressure test of 150% of its working pressure, but not less than 150 psi.
 1. Test shall be performed in accordance with AWWA C600.
 2. No tests will be permitted using air pressure.
 3. Test must be made following installation of the new main and is to be treated separately.

3.8 BACKFILLING

- A. Backfill in accordance with Section 02221 - Trench Excavation and Backfill.

- END OF SECTION -

SECTION 15095

VALVES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.
- B. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated. Except where noted otherwise, valves designated for water service shall conform to pertinent sections of the latest revision of AWWA C500 Specifications. Cast iron valve bodies and parts shall meet the requirements of the latest revision of ASTM Designation A-126, "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B."
- C. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.
- D. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. The Contractor shall be responsible for coordinating connecting piping. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.

1.02 SUBMITTALS

- A. Shop Drawings conforming to the requirements of Section 01300, Submittals, are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn using a ladder-type format in accordance with JIC standards. Shop Drawings for pneumatically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.
- B. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall provide the services of a qualified representative of the manufacturer(s) of the equipment named below to check out and certify the installation(s), to supervise the initial operation, and to instruct the Owner's operating personnel in proper operation and maintenance procedures in accordance with the following schedule:

Item	Valve/Operator Type	Minimum On-Site Time Requirements
1.	Plug Valves	One (1) 4-hour visit
2.	Check Valves	One (1) 4-hour visit
3.	Air Release Valves	One (1) 8-hour day

- B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.
- C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies notes.
- D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

PART 2 -- PRODUCTS

2.01 VALVE BOXES

- A. The Contractor shall furnish and install valve boxes as shown on the Drawings and specified herein.
- B. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the valve box, sloped outwards.
- C. All valve boxes shall be full cast or ductile iron with iron covers suitable for heavy traffic use and conform to ASTM A-48, Class 20 Specifications and shall be 2-piece cast iron, screw type, 5-1/4" inside shaft diameter, with heavy duty traffic weight collar and the lid marked with the appropriate carrier product (i.e.: SEWER). Coat box and cover with two (2) shop coats of bitumastic paint. No part of the valve box is to rest on the buried valve. Boxes shall be as manufactured by Tyler Union #6850 Series, Bingham & Taylor #4905 Series of US manufacture only, AFC Box with external, and East Jordan Ironworks #8550 Series.

2.02 VALVE BOX PROTECTION RING

- A. Provide at each valve box in unpaved areas a precast concrete protection ring with the following:
 - 1. Two (2) rings of #3 reinforcing steel; one (1) 21-inch diameter and one (1) 15-inch diameter or;
 - 2. One (1) ring of #3 reinforcing steel, 19-inch in diameter with fiber-mesh concrete.
- B. Inside diameter to be 9 1/4-inch.
- C. Outside diameter to be 27-inch.
- D. Provide 5-inch thickness at interior with a continuous slope to 2-inch thickness at the outside.
- E. Minimum concrete strength 3,000 psi.
- F. Minimum weight of 110 lbs.

2.03 BACKFLOW PREVENTERS

- A. Backflow preventer shall be the size shown on the Drawings and shall be of the double check valve principle. Backflow preventer installation shall include isolation valves and four test cocks, furnished as an assembly. For backflow preventers less than 2-1/2", the installation assembly also shall include a strainer. Isolation valves for backflow preventers shall be ball valves, except for size 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The backflow preventer shall be a WATTS 709, or equal.
- B. Reduced Pressure Backflow Preventer shall be of the size shown on the Drawings, and shall be of the reduced pressure principle type in accordance with AWWA Standards C510 and C511, with two (2) independent operating spring loaded check valves and one (1) spring loaded, diaphragm actuated, differential pressure relief valve shall be installed between the check valves. Backflow preventer shall be bronze body construction, with EPT rubber discs and Buna-N and nylon diaphragm. Screws and springs shall be of stainless steel. End connections shall be screwed, unless otherwise specified or shown on the Drawings. Reduced pressure backflow preventer installations shall include isolation valves and four test cocks, furnished as an assembly. For reduced pressure backflow preventers less than 2-1/2" the installation assembly also shall include a strainer. Isolation valves for reduced pressure backflow preventers shall be ball valves, except for sizes 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The reduced pressure backflow preventer shall be a USC Foundation approved Reduced Pressure Principle backflow prevention assembly. Upon installation, the assembly shall be inspected by the assigned Charleston Water System Construction Inspector and tested by a Charleston Water System Approved Backflow Prevention Assembly Tester. Testing is the responsibility of the Contractor. An approved test must be received by the Charleston Water System Construction Inspector prior to placing the water system into operation.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Except where noted otherwise herein, all valves shall be installing and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes, and shall bear no stresses due to loads from the adjacent pipe. The Contractor shall be responsible for coordinating connecting piping.
- B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated and cylinder operated valves shall be tested for control operation as directed by the Engineer.
- C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.
- D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Engineer. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.
- E. Valve boxes shall be set plumb, and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

3.02 SHOP AND FIELD TESTING

- A. Shop and field testing of valves shall be as follows:
 - 1. Certified factory testing shall be provided for all components of the valve and operator system. Valves and operators shall be shop tested in accordance with the requirements in the latest revision of AWWA C500, including performance tests, leakage test, hydrostatic tests, and proof-of-design tests. The manufacturer through the Contractor shall submit certified copies of the reports covering the test for acceptance by the Engineer.

2. Shop testing shall be provided for the operators consisting of a complete functional check of each unit. Any deficiencies found in shop testing shall be corrected prior to shipment. The system supplier through the Contractor shall submit written certification that shop tests for the electrical/pneumatic system and all controls were successfully conducted and that these components provide the functions specified and required for proper operation of the valve operator system.
3. The Contractor shall conduct field tests to check and adjust system components, and to test and adjust operation of the overall system. Preliminary field tests shall be conducted prior to start-up with final field tests conducted during start-up. The factory service representative shall assist the Contractor during all field testing and prepare a written report describing test methods, and changes made during the testing, and summarizing test results. The service representative shall certify proper operation of the valve operator system upon successful completion of the final acceptance field testing.
4. Preliminary and final field tests shall be conducted at a time approved by the Engineer. The Engineer shall witness all field testing.
5. All costs in connection with field testing of equipment such as energy, light, lubricants, water, instruments, labor, equipment, temporary facilities for test purposes, etc. shall be borne by the Contractor. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.
6. Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components. Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly. The preliminary field test report must be approved by the Engineer prior to conducting final field acceptance tests. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation specified or otherwise directed by the Engineer.
7. Final field acceptance tests shall be conducted simultaneously with the start-up and field testing of the pumps, air compressors, process air blowers, etc. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing. Performance of pneumatic valves and compressed air system under normal operating conditions and during simulated power failures shall be checked.

8. Field testing shall include optimization of opening and closing times of the valves. The Contractor shall provide the means for accurate measurement of pipeline pressures as directed by the Engineer. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

- END OF SECTION -

SECTION 15100

VALVE OPERATORS AND ELECTRIC VALVE ACTUATORS

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions and Section 15000 – Basic Mechanical Requirements.
- B. Reference Section 15390 – Schedules for additional information on valves and operators/actuators.
- C. The electric valve actuators shall meet the signal requirements described in Specification 17060 – Signal Coordination Requirements, 17920 – Control System Input/Output Schedule, and 17950 – Functional Control Descriptions.
- D. Valve operators and electric valve actuators shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valves will be subjected.
- E. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Engineer. There shall be no mounting restrictions on the electric valve actuator.
- F. The valve operators and electric actuators shall be the full and undivided responsibility of the valve manufacturer in order to ensure complete coordination of the components and to provide unit responsibility.

1.02 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:
 - 1. Certification that the force required to operate all valves is as specified herein.

PART 2 -- PRODUCTS

2.01 GENERAL

- A. Manual operators shall be provided on all valves which do not receive electric actuators. Manual operator type shall be as specified herein and as shown on the Drawings.
- B. Quarter turn valves 8" and greater in size shall have geared operators. Gate valves 14" and greater in size shall have geared operators.

- C. Operators/actuators shall be furnished with conservatively sized extension bonnets, extension stems, or torque tubes, and all required appurtenances required for a complete installation. Operators furnished with extension bonnets shall include stainless steel extension stems, or stainless steel torque tubes.

2.02 MANUAL OPERATORS

- A. Unless otherwise specified or shown on the Drawings, manual operator type shall be as follows:
 - 1. Buried valves shall be equipped with nut operators, extended stems, and valve boxes.
 - 2. Exposed valves up to 6-inch shall be lever operated (except gate valves).
 - 3. Exposed valves 8-inches and larger shall be handwheel operated.
 - 4. Exposed gate valves shall be handwheel operated.
 - 5. Valves with centerline of operator located more than 6-feet above the floor or platform from which it is to be operated shall have a chainwheel operator. unless otherwise indicated on the Drawings.
- B. Manual operators shall be rigidly attached to the valve body unless otherwise specified or shown on the Drawings.
- C. All operators shall turn counter-clockwise to open and shall have the open direction clearly and permanently marked.
- D. Valve operators shall be designed so that the force required to operate the handwheel, lever, or chain (including breakaway torque requirements) does not exceed 80 pounds applied at the extremity of handwheel or chainwheel operator. Design pressures for sizing of valve operators shall be the piping test pressure for the piping in which the valve is to be installed as shown in the Piping Schedule in Section 15390 – Schedules.
- E. Handwheels for valves operators shall not be less than 12 inches in diameter. The maximum diameter of any handwheel shall not exceed 24”.
- F. Nut operators shall have standard 2-inch square AWWA operating nuts designed in accordance with AWWA C504-94.
- G. Geared manual operators shall be of the worm gear, traveling nut or scotch yolk type except manual operators for butterfly valves 18-inch in diameter or larger which shall be worm gear, unless otherwise indicated in the individual valve specification. Gear operators shall be of the worm gear or bevel gear type. Gear box designs incorporating end of travel stops in the housing shall be equipped with AWWA input stops. Each gearbox shall require a minimum of 10 turns for 90 degree rotation or full valve stem travel and shall be equipped with a mechanical valve position indicator.

- H. Manual operators on below grade (and vault installed) valves shall be permanently lubricated and watertight under an external water pressure of 10 psi.

2.03 SPARE PARTS

- A. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for electric actuators:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1
Services after Startup	1	1

3.02 INSTALLATION

- A. All valve actuators shall be installed in accordance with the manufacturer's published recommendations and the applicable specification sections for valves, and motor controls.
- B. Valve actuators shall be factory coated in accordance with the manufacturer's standard paint system.

3.03 SHOP TESTING

- A. Shop testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:
 - 1. Conduct a complete functional check of each unit. Correct any deficiencies found in shop testing prior to shipment.
 - 2. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment shall simulate each typical valve load.

3.04 FIELD TESTS

- A. Field testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:
 - 1. Valve actuators shall be field-tested together with the associated valves.
 - 2. Test all valves at the operating pressures at which the particular line will be used.

3. Test all valves for control operation as directed.
4. Field testing shall include optimization of opening and closing times of the valves. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

B. Preliminary Field Tests

1. General: Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components.
2. Scope: Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly.
3. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation, as specified or otherwise directed.

C. Final Field Tests

1. Final field tests shall be conducted in accordance with the latest revision of AWWA C500.
2. Final field tests shall be conducted simultaneously with the start-up and field testing of the pumps.
3. Final field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing.
4. Certification of Equipment Compliance: After the final field tests are completed and passed, submit affidavit according to Section 11000.

- END OF SECTION -

SECTION 15104

BALL VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.
- B. Valves required for chemical service shall be constructed of materials suitable for the intended service.

PART 2 -- PRODUCTS

2.01 BALL VALVES (WATER SERVICE)

- A. Ball valves (water service) shall be of the full port, single seated, metal to metal seated, tight-closing type conforming to the latest revision of AWWA C507 Specifications. The manufacturer shall have a minimum of 5 years experience in manufacturing ball valves of the sizes required in accordance with AWWA C507 Specifications. All ball valves shall be the product of one manufacturer. Ball valves shall be as manufactured by Willamette Valve, Inc., or equal.
- B. Each valve shall be performance and leak tested as specified in AWWA C507 revised as follows: In addition to the testing requirements of AWWA C507, each ball valve shall be thoroughly cleaned and opened and closed at least three (3) times prior to testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.
- C. Ball valves shall be AWWA Class 150, unless otherwise indicated in the valve schedules, design with flanged ends, and installed as shown on the Drawings.
- D. The valve body shall be constructed of epoxy coated cast iron conforming to ASTM A 48, Class 35, with a full, unrestricted circular inlet and outlet, with nominal opening diameter equal to the rated size of the valve. Each valve body shall be provided with flanged ends conforming in diameter and drilling to ANSI B16.1, Class 125. All flanges shall be flat faced and finished to true plan surfaces within a tolerance limit of 0.005 inch. Each flange face shall be perpendicular to the longitudinal axis of the valve within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter. Flange faces shall have concentric or spiral serrated finish. The body trunnions shall be fitted with ample sized bronze bearings of sufficient difference in hardness from the plug bearings to eliminate seizing and galling. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing teflon coated or other non-metallic material will not be acceptable. Bearings shall be machined in accurate alignment for reception of the plug trunnions.

- E. The body shall provide rigid means for supporting the valve operating mechanism without the necessity of additional supports and shall be of such design that it shall be capable of receiving the complete plug sub assembly. The valve body shall have integral hubs for housing shaft bearings and seals.
- F. The body shall have a rigidly attached metal seat. The body seat shall be Monel (Alloy 400) and shall be machined, ground and polished for contact with the stainless steel seat mounted on the plug.
- G. There shall be two (2) pipe connections, one for an air vent and the other for drain.
- H. The plug shall be constructed of epoxy coated cast iron conforming to ASTM A48, Class 35, with a full unobstructed, circular waterway with a diameter equal to the rated size of the valve. It shall have trunnion supports cast integral on the axis of rotation. An extension of one trunnion, called the operating shaft, shall pass through a shaft seal chamber and connect to the valve operation mechanism.
- I. The plug shall have a stainless steel seat conforming to ASTM A276, Type 304, mounted thereon which shall properly align with the body seat when the valve is in the closed position. The surfaces of the seat ring shall be spherically generated and shall be machined, ground and polished for contact with the body seat.
- J. The plug trunnions shall be fitted with bronze bearings of sufficient difference in hardness from the body bushings to eliminate seizing and galling.
- K. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing Teflon coated or other non-metallic bearing material will not be acceptable.
- L. Valve shafts shall be integral with the plug and shall connect the plug to the torque unit. The shaft shall be of chrome Molybdenum Steel (ASTM A 322 Grade 4140) with hard chrome plate through the seal chamber suitably sized to transmit the torques required to operate the valves under the conditions listed in the valve schedule with appropriate safety factor. Shafts shall be securely attached to valve plug by means of conservatively sized corrosion-resistant taper pins, threaded at one end and secured with lockwashers and nuts (i.e.: mechanically attached). Provide O-ring seal on taper pin if required to prevent leakage. Shaft key shall be constructed of corrosion-resistant material.
- M. Shaft bearings shall be contained in the integral hubs of the valve body and shall be the permanently self-lubricated, corrosion resistant, sleeve type of heavy-duty bronze. The valve assembly shall be furnished with a factory set thrust bearing designed to center the valve plug in the valve seat at all times. End cover bolts shall be of stainless steel construction.
- N. A shaft seal shall be provided of the type utilizing a plug shaft stuffing box, four (4) "O" ring seals, a bronze retainer and a corrosion resistant steel lock ring. The "O" ring material shall be BUNA-N rubber, as intended for use with potable water or wastewater.

- O. Manual operators for ball valves 18-inches in diameter or larger shall be the worm gear or travelling nut type conforming to AWWA C507. Manual operators for ball valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators. Operators shall be equipped with adjustable AWWA limit stops and shall require a minimum of 15 turns for 90 degrees or full stem valve travel. The capacity of the manual operator shall be adequate to drive the valve under the differential pressure of 150 psi and maximum anticipated flow, unless otherwise indicated in the appropriate valve schedule. Electric motor operators shall be as specified elsewhere in this Section.
- P. The torque unit (valve operating mechanism) shall be of the traveling-nut type and shall be the product of the valve manufacturer. The assembly shall be mounted, and attached to the valve body. The torque unit shall be designed to accept a manual, cylinder or electric motor actuator. The torque unit housing shall employ the following:
1. A traveling crosshead to impart positive rotary movement to the plug which will move transversely to the valve shaft.
 2. A cylinder piston rod or stainless steel Type 416 threaded leadscrew (reach rod or stem) with the crosshead directly attached thereto.
 3. A rotator lever (of cast steel construction).
 4. A matched set of interconnecting links (of cast steel construction) connecting the traveling crosshead to the rotator lever.
- Q. The traveling crosshead shall be confined to permit linear motion only and to prevent it from any tendency to rotate due to linkage reaction. A plug shaft support bearing shall be supplied on the cover.
- R. The torque unit shall be so designed that during the first 50 percent of stroke in closing the flow area is reduced by approximately 81 percent. The remaining 19 percent of flow area shall be gradually reduced to a complete shutoff throughout the last 50 percent of the closing stroke.
- S. The torque unit shall be totally enclosed in a suitable housing with a removable cover and shall be capable of being inspected, lubricated, adjusted and repaired without interfering with or removing the valve from the line and shall be permanently lubricated. All parts shall be of first class workmanship, easily replaceable and manufactured of the best materials suited for the purpose. All parts subject to rubbing shall be of significantly different hardness to prevent galling and shall be sized to result in a maximum bearing stress at full load of 2,000 psi. The main shaft shall be replaceable without removing the torque unit housing and while the valve is in the line under pressure.
- T. The manufacturer shall certify that the ball valves are capable of operating in continuous duty service under these pressures and flow conditions.
- U. Each valve shall be hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

- V. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

2.02 BALL VALVES (SERVICE AIR)

- A. Ball valves (service air) shall be manufactured by Apollo Ball Valve Division of Conbraco Industries, Inc., Pageland, SC., or equal. The body materials shall be cast bronze rated at 600 psi WOG, 150 psi saturated steam. Valves shall be tested by the manufacturer to MSS SP-72, 100 psi air under water, in the opened and closed position. The valve shall provide a port diameter equal to or exceeding the mating pipe size. Valves 2-1/2 inches in diameter and smaller shall have lever operators, unless otherwise specified herein or noted on the Drawings. Levers shall be cadmium plated steel covered with a vinyl grip and attached with a nut and have a hole for tagging purposes. The stem gland shall be adjustable and independent of the lever to compensate for wear. Bottom loaded stems shall be designed to be blow-out proof. The stuffing box seals and ball seats shall be composed of glass-reinforced TFE. The ball and stem shall be 316 stainless. Ball valves shall have NPT ends.

- END OF SECTION -

SECTION 15105

CHECK VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 BALL CHECK VALVES (SINKING TYPE)

- A. Ball check valves shall be designed to be non-clog, fully automatic, maintenance free and specifically suited for operation in sewage where solids, fibers, grit or highly viscous materials are encountered.
- B. Ball check valves shall have one moving part, the ball, which automatically rolls out of the path of flow providing an unobstructed and "full flow" opening equal to nominal pipe size. Upon discontinuation of flow, the ball shall automatically roll back to the closed position providing a positive seal against back pressure or backflow. The ball shall be of the sinking type.
- C. The ball shall have an exterior coating of vulcanized nitrile rubber resistant to grease, petroleum products, animal and vegetable fats, dilute concentrations of acids and alkalis, tearing or abrasion.
- D. The valve body and cover shall be nodular cast iron type GGG 40/ASTM 65-45-12/SAE 4512. The valve shall be of maintenance free design and so constructed that by unbolting and lifting of the cover shall allow the ball to be removed and replaced without removing the entire valve assembly.
- E. Sinking ball check valves shall be Flygt Model HDL-5087 or equal.

PART 3 -- EXECUTION

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SECTION 15107

YARD HYDRANTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 YARD HYDRANTS

- A. Service water system hydrants shall be of the 2-inch non-freeze post-yard type with bronze casing, neoprene plunger. The barrel shall be self-draining; operating parts must be removable through the top of the hydrant.
- B. The cold-rolled steel stem shall operate with a bronze operating nut. Stem threads shall be lubricated through the top of the operating nut tapped for grease fittings. Packing shall be double "O" rings to insure a positive shutoff with a minimum of packing friction when the hydrant is being operated. Each hydrant shall be equipped with suitable adapters to connect 2-inch and 3/4-inch hoses.
- C. Each hydrant shall be supplied with 10-inch operating hand wheel and a steel post-mounted hose rack.

The hydrants shall be Models 71702 as manufactured by Josam, Z-1390 as manufactured by Zurn, 5914 by Smith Company, or equal.

PART 3 -- EXECUTION

(NOT USED)

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SECTION 15108

GATE VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 GATE VALVES

- A. All gate valves between 2 inches and less than 4 inches shall be iron body, bronze trimmed, wedge disc, and minimum 150 psi non-shock cold water pressure rating. Exposed valves shall be of the outside screw and yoke (OS&Y), ANSI B-16.1, 125 pound flanges and shall be as manufactured by the Crane Company, Jenkins Bros. Corp., or equal.
- B. Valves less than 2 inches shall be of bronze body, rising stem, wedge disc and minimum 300 psi non-shock cold water pressure rating. Valves shall have screwed ends or as specified otherwise.
- C. Gate valves 4 inches through 16 inches shall be of the non-rising stem **design**, shall fully comply with the requirements of AWWA C509 for resilient-seated gate valves and shall be the Metroseal 250 as manufactured by U.S. Pipe and Foundry Co., Mueller, American AVK, or American Flow Control. Gate valves shall be designed for a minimum working pressure of 250 psi and a test pressure of 500 psi.
- D. Gate valve body and bonnet shall be cast iron conforming to ASTM A126, Class B with resilient seat gate and O-ring seals. The gate shall be cast iron with a vulcanized rubber coating with no metal to metal contact when in the fully closed position and a smooth unobstructed waterway when in the fully opened position. Gate valves 18 inches and larger shall fully comply with the requirements of AWWA C500 and shall be double disc parallel seat with bypass and inside screw spur geared operator, unless otherwise specified or shown on the Drawings. Valves shall be American Darling Series 50, Mueller, or equal.
- E. Valves shall be flanged mechanical joint as shown on the Drawings, with non-rising stems, and with a 2-inch square standard AWWA operating nuts unless otherwise shown on the Drawings or specified herein.
- F. All internal ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

- END OF SECTION -

SECTION 15109

PLUG VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.
- B. Install all valves in accordance with manufacturer's recommendations.
- C. Valves shall be installed plumb and level.
- D. After installation, valves shall be fully operated in the presence of the Charleston Water System inspector.

PART 2 -- PRODUCTS

2.01 PLUG VALVES

- A. Plug valves shall be of the non-lubricated, eccentric seating plug type with synthetic rubber-faced plugs as manufactured by DeZurik Company, Pratt or Milliken. All valves shall be provided with limit stops and rotate 90° from fully open to fully shut. The minimum working pressure for all valves shall be 150 psi, and the test pressure shall be at least 270 psi for valves up through 12-inch. The port area of valves shall be at least 80 percent of full pipe area for valves less than 24-inches unless otherwise specified herein or indicated in the appropriate Valve Schedule in Section 15390, Schedules. The body materials shall be of epoxy coated cast iron or semi-steel, unless specified otherwise. Seats shall have a welded overlay of 90 percent pure nickel and machined to a finish containing no stress cracks. Plug facings shall be of Hycar, or equal and completely suitable for use with domestic sewage. Plug valves shall open-left operation.
- B. The shaft seal shall be either the bronze cartridge type with at least two O-Rings, monolithic V-Type, or pull down packing type. If monolithic V-Type or pull down packings are utilized, it shall be self-adjusting, self-compensating type. Packing shall be as manufactured by Chevron, or equal. Plug valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator.
- C. All buried valves shall have mechanical joint ends (unless otherwise shown), conforming to ANSI A21.11 (AWWA C 111), and shall be operated with a standard AWWA 2-inch square nut through a totally enclosed worm gear actuator. Valve boxes shall be installed with all buried plug valves and shall be as specified herein.
- D. Unless otherwise shown, all exposed valves 4-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150-pound standard with face-to-face dimensions of standard plug valves.

- E. Valves 8-inches in diameter and larger shall be handwheel or floorstand operated where required or indicated on the Drawings through totally enclosed worm gear actuators, unless otherwise specified or shown on the Drawings. Valves 6-inches in diameter and smaller shall have lever operators, unless otherwise specified or noted on the Drawings. Valves shall open left.
- F. The manufacturer shall certify that the plug valves are capable of operating in continuous duty service under these pressures and flow conditions.
- G. Each valve shall be hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.
- H. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15114

MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.
- B. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

PART 2 -- PRODUCTS

2.01 COMBINATION AIR VALVE FOR SEWAGE

- A. Combination air valve assemblies shall be installed at all the locations specified herein or indicated on the Drawings and shall be installed complete with all appurtenant piping and valves as required for a complete and operable installation. The combination air valve shall be designed to handle raw sewage (future conditions).
- B. The valves shall be constructed of Type 316 stainless steel with stainless steel float, and all working parts shall be brass, stainless steel, or other corrosion resistant material. The valves shall be designed for a minimum working pressure of 200 psi and a test pressure of 350 psi.
- C. Valve shall have a drainage outlet that enables removal of excess fluids.
- D. The pressure air release valves shall have a 4-inch (minimum) flange connection, ANSI standard. The 4" combination air valve shall have an orifice size of 5/32".
- E. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.
- F. The air and vacuum valves and pressure air release valves shall be GA Industries.

Location	Size	Flow Rate @ 2 Bar	Flow Rate @ 4 Bar	ARV/PRV Model #	Connection
PS Site	2"	20 m ³ /h	27 m ³ /h	2"x2" GA Figure 942 Combination Air Valve for Wastewater	Threaded

2.02 CORPORATION VALVE

- a. Corporation valves shall have NPT thread inlets. The outlet connection will be CTS/OD, conductive compression (grip nut) type outlets.
- b. Acceptable products: Mueller: 300 Corp, Model #B-25028N, A.Y. McDonald Ball Corp, Model#74704-BG, or Ford Ball Corp, Model #FB1100-X-Q-NL.

2.03 CURB STOP

- a. Curb Stops
 - i. Provide curb stops for 1 ½-inch and 2-inch services
 - ii. Accepted products:
 - 1. Mueller: Model # B-25209N
 - 2. A.Y. McDonald: Model # 76100-WG
 - 3. Ford: Model # B44-XXX-Q-NL

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15115
PVC/CPVC VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

- A. Valves provided for chemical service shall be constructed of materials suitable for the intended service. PVC valves shall be provided in PVC piping and CPVC valves shall be provided in CPVC piping.
- B. Valve bodies shall be constructed of Class 12454-B PVC or Class 23447-B CPVC.

2.02 PVC/CPVC BALL VALVES

- A. Ball valves shall have 125 psi minimum non-shock cold water pressure rating. Valves shall have integral unions with socket, flanged or threaded ends as required and as specified in Section 15390 and shall have removable handles. Valves shall be manufactured by ASAHI/AMERICA, Chemtrol Products Division of NIBCO, Inc., IPEX Industrial Thermoplastics, Hayward Industrial Products, or equal.
- B. Ball valves for sodium hypochlorite service shall be single-seal type valves. The ball shall be drilled by the valve manufacturer at the factory and installed with vent hole facing upstream. The pressure rating shall be a minimum of 125 psi at 70°F.

2.03 PVC/CPVC SWING CHECK VALVES

- A. Swing check valves shall have an external lever and weight. Check valves shall have socket, flanged, or threaded ends as specified in Section 15390. Valves shall be capable of top entry to facilitate cleaning and repair without removal from the line. Valve shall incorporate a single disc design. Check valves shall be as manufactured by ASAHI/AMERICA, or equal.

2.04 PVC/CPVC BALL CHECK VALVES

- A. Ball check valves shall have 150 psi minimum non-shock cold water pressure rating and integral union with socket, flanged or threaded ends as specified in Section 15390. Valves shall be as manufactured by ASAHI/AMERICA, Chemtrol Products Division of NIBCO, Inc., Hayward Industrial Products, or equal.

2.05 PVC/CPVC DIAPHRAGM VALVES

- A. Diaphragm valves shall have socket, flanged or threaded ends as specified in Section 15390 and shall have a position indicator and adjustable travel stop. Diaphragm valves shall be similar to Type G, as manufactured by ASAHI/AMERICA, Hayward Industrial Products, or equal.

2.06 PVC/CPVC BUTTERFLY VALVES

- A. Butterfly valves shall be wafer style and shall have polypropylene discs. Butterfly valves shall provide bubble-tight seating, with 316 stainless steel shaft and gear operator, and shall be as manufactured by ASAHI/AMERICA, Hayward Industrial Products, or equal.

2.07 PVC/CPVC BUTTERFLY CHECK VALVES

- A. Butterfly check valves shall have flanged ends or be wafer-style, as shown on the Drawings. Body and internal materials shall be PVC or CPVC, and elastomer materials shall be completely resistant to corrosion by the chemical being conveyed. Valves shall be elastomer hinged check valves with unrestricted full-port seatless design, tight shutoff, and the ability to be mounted in any position. Valves shall be Techno Multi-Purpose Check Valves by Cameron, or equal.

- END OF SECTION -

SECTION 15170

ELECTRIC MOTORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all electric motors as shown on the Drawings and specified herein. All motors required for this Contract shall comply with this Section unless otherwise noted.
- B. Reference Section 09900, Painting and the applicable Sections of Divisions 11 and 15.

1.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

- a. All motors shall be shop tested and inspected in accordance with the equipment manufacturer's standard procedures. Shop tests for motors 100 horsepower and larger may be witnessed by the Engineer. The manufacturer's testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified, all other applicable requirements, and shall be approved by the Engineer. At least 10 days notice shall be given the Engineer prior to tests and inspection dates.
- b. In addition to the efficiency and power factor testing specified herein, each motor shall be tested to determine compliance with the applicable requirements of the IEEE, ANSI and NEMA. Tests shall be as follows:

(1) Motors less than 50 HP

- (a) Each motor shall be subjected to a standard, short commercial test including the following:
 - i) Running current, no load
 - ii) Locked rotor current
 - iii) High potential
 - iv) Winding resistance
 - v) Bearing inspection

(2) Motors between 50 and 100 HP

- (a) Each motor shall be subjected to the above tests and shall be furnished with certified test results.

(3) Motors larger than 100 HP

- (a) Each motor shall be furnished with certified test results. Each motor shall be subjected to a complete test consisting of full load heat run, percent slip, running load current, locked rotor current, breakdown torque (calculated), starting torque, winding resistance, high potential, secondary current and voltage at collector rings (wound rotor), efficiencies at 100, 75 and 50 percent of full load, power factors at 100, 75 and 50 percent of full load and bearing inspection. Tests will be witnessed by the Engineer where specifically indicated.

(4) Test Reports

- (a) All test results for motors over 100 horsepower shall be submitted to the Engineer for approval. Copies of witnessed test raw data shall be submitted to the Engineer immediately upon completion of such tests.

2. Field Tests

- a. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.
- b. All electric motors furnished for this project one (1) horsepower or larger shall have the information required in the following tabulation completed. See Exhibit "A".
- c. All field testing shall be witnessed by the Engineer.

(EXHIBIT A) MOTOR TEST RECORD					
Motor Identification Remarks	Location	Specified Horsepower	Nameplate Horsepower	Nameplate Amperage (FLA)	Measured Amperage Under Normal Operating Conditions

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings.
 - 2. Spare Parts List.
 - 3. Special Tools List.
 - 4. Proposed Testing Methods and Reports of Certified Shop and Field Tests.
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Individual shop drawings for electric motors shall be submitted in accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, unless submitted as a part of the shop drawings for the driven equipment.
- D. Shop drawings for electric motors shall include motor data sheets, dimensioned drawings, wiring diagrams (space heaters, temperature devices, etc.) identifying electric characteristics and design, mechanical construction, manufacturer's name, type and pertinent specifications for the use intended, along with the name of the equipment to be driven. For motors rated 50 horsepower or more, submittal of motor data for acceptance shall include, as a minimum, the following:
 - a. Manufacturer's type and frame designation
 - b. Horsepower rating
 - c. Time rating (per NEMA Standards)
 - d. Ambient temperature rating
 - e. Insulation system designation (see Item r. for full description)
 - f. RPM at rated load
 - g. Frequency
 - h. Number of phases
 - i. Rated-load amperes
 - j. Voltage
 - k. Code letter (starting KVA per horsepower)
 - l. Design letter for integral horsepower induction motors (per NEMA Standards)
 - m. Service factor

- n. Temperature rise at full load and at service factor load
- o. Efficiency at 1/4, 1/2, 3/4 and full load
- p. Power factor at 1/4, 1/2, 3/4 and full load
- q. Motor outline, dimensions and weight
- r. Insulation system description
- s. Horsepower required by connected machine at specified conditions (load curves) shall be supplied for all compressors, propeller and positive displacement pumps.

The foregoing data shall also be verified after manufacture and shall be included with the information to be furnished in the operation and maintenance manuals specified.

- E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 TOOLS, SUPPLIES AND SPARE PARTS

- A. Each motor shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

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. Electric motors shall be manufactured by Reliance Electric Company; U.S. Motors Division, Emerson Electric Company; Toshiba Industrial and Power Systems, Inc.; Siemens Energy & Automation, Inc.; General Electric Company; or equal.

2.02 ELECTRIC MOTORS

- A. Standards
 - 1. Motors shall be built in accordance with the latest standards of NEMA, including, but not limited to MG-1 and MG-2, IEEE, ANSI and to the requirements specified herein.
- B. Type
 - 1. Unless otherwise noted, motors specified herein are polyphase squirrel cage, NEMA Design B, or single phase capacitor or repulsion start induction motors. Special equipment requiring a motor drive with unusual characteristics shall be equipped with a definite purpose motor to meet the necessary requirements.

2. Unless otherwise shown or specified, all motors 1/2 horsepower or larger shall be three- phase, 60 Hertz, NEMA Design B, squirrel cage induction motors designed for operation at 208 volts or greater as specified herein or shown on the Drawings.
3. Unless otherwise specified in the individual motor specification for the driven equipment, or as required by the dynamic characteristics of the load as determined by the manufacturer of the machine to be driven, all polyphase squirrel cage motors shall be designed to withstand the starting voltage shown on the Drawings and shall have torque and locked rotor current characteristics as specified for NEMA Design B motors.
4. All motors 2 horsepower and smaller shall have windings encapsulated with a flexible epoxy compound, or insulated with a flexible epoxy compound, or insulated with the manufacturer's premium quality system which shall be subject to acceptance by the Engineer.
5. All motors above 3 horsepower shall have stator windings vacuum impregnated with a polyester insulation compound.
6. Unless otherwise noted, all motors smaller than 1/2 horsepower shall be standard single-phase capacitor start or repulsion start induction type designed for operation on 120 volts or 208 volts, 60 Hz alternating current. The motor shall deliver rated load without exceeding a 80 degrees C temperature rise while operating in a 40 degrees C ambient temperature. Small fan motors less than 1/4 HP may be split-phase or shaded pole type as standard with the drive. Shaded pole motors rated more than 1/4 horsepower will not be approved. Fractional horsepower motors shall be completely equipped with all necessary auxiliary components for starting and labeled as "Thermally Protected". Insulation shall be Class B, except that submersible motors shall have epoxy encapsulation. Unless otherwise noted, the motors shall be totally enclosed. Small fan motors may be of the open type where they are suitably protected from moisture dripping and lint accumulation. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.
7. Where specified, vertical hollowshaft motors shall be designed to carry the motors', pumps', and associated equipment's full thrust. The motors shall be equipped with grease lubricated spherical roller thrust bearings and lower radial guide bearings. Vertical adjustment shall be provided by means of a lockable nut at the top of the shaft.
8. Vertical hollowshaft motors shall have adequate thrust bearings to carry all motor loads and any other operating equipment loads. Horizontal motors shall not be installed where subjected to external thrust loads except where special motor construction is approved by the Engineer.

C. Rating

1. Each motor shall develop ample torque for its required service through its acceleration range and throughout its rated load range. The rating of the motors offered shall in no case be less than the horsepower shown on the Drawings or elsewhere specified. It should be noted that the motor sizes indicated on the Drawings or as otherwise specified herein, are motor sizes required to operate the specific equipment which is specified. Higher rated motor sizes may be determined from the actual equipment submitted, approved, purchased, and installed. Overload protection, starters, disconnect switches, and other necessary equipment shall be furnished and installed for the actual motor sizes required at no additional cost.
2. Motor ratings shall be based on continuous operation in an ambient temperature. The maximum temperature rise for open and drip proof type motors shall not exceed 90 degrees C, and for totally enclosed type motors shall not exceed 80 degrees C.

D. Insulation

1. Insulation shall be as specified for each particular type or class of motor. The insulation system shall provide a high dielectric strength, long life covering for the windings which may be required to operate in a continually damp and chemically contaminated environment. The insulation shall be resistant to attack by moisture, acids, alkalis, abrasives, and mechanical and thermal shock. Leads shall be sealed with a non-wicking, non-hydroscopic insulation material.
2. Motor insulation resistance may be checked at any time after delivery to the job site or during the warranty period. Encapsulated motor stators may be subjected to insulation testing while completely submerged in water. Any motor not meeting the requirements specified herein will be rejected and shall be promptly replaced at no cost to the Owner.
3. Torque and locked rotor current characteristics for three phase motors shall be NEMA Design B. The locked rotor KVA/HP input at full voltage for 10 horsepower. motors and larger shall not exceed that permitted for Code Letter "G", except for specialized equipment requiring a motor drive with special definite characteristics.
4. Unless otherwise specified, motors shall be furnished with a Class H insulation system. However, temperature rise shall be limited to that for Class B insulation. Output torque and speed characteristics of each motor shall be suitable to operate the driven equipment through the full range of acceleration and operating load conditions without exceeding the nameplates current rating, and/or temperature rise.
5. Fractional and integral horsepower motors specified with Class B insulation shall have a 1.15 service factor and shall be rated for not over 90 degrees C temperature rise while operating at service factor load in a 40 degrees C ambient temperature.

E. Nameplates

1. The motor manufacturer's nameplates shall be engraved or stamped on stainless steel and fastened to the motor frame with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall include as a minimum, Items a through m as listed in Article 1.04 in addition to that required by NEMA standards. The nameplate shall be positioned so as to be readily visible for inspection in the completed machine.

F. Design

1. Motors shall be designed to accelerate and drive the connected equipment under all normal operating conditions without exceeding nameplate ratings. Motors specified for operation with variable frequency drives shall be designed to output 100 percent of nameplate horsepower under continuous duty service without exceeding the temperature rise specified herein when controlled by the actual drives furnished.
2. Electric motors shall be furnished with service factors in accordance with NEMA Standards as follows:

<u>Type of Motor</u>	<u>Service Factor</u>
ODP, WP, TEFC, TENV	1.15
Inverter Duty (ODP, WP, TEFC, TENV)	1.0

3. Design selection with respect to the driven machine shall be such that the requirements do not exceed 85 percent of the motors' maximum rating modified by service factor, ambient temperature, enclosure, altitude and electrical service. The electrical service conditions shall be assumed to be 10 percent undervoltage, 5 percent underfrequency, and 3 percent voltage unbalance. Altitude shall be assumed to be the plant elevation plus 10 percent. Ambient temperature shall be assumed to be 95 degrees F in exterior locations, 104 degrees F (40 degrees C) in interior locations, and 122 degrees F (50 degrees C) within housings or enclosures; except where higher temperatures may be encountered within or on individual items of equipment. The applicable paragraphs of NEMA Standards shall be used in making the design selection.
4. Motors used with belt drives shall have sliding bases to provide for belt take up.
5. Terminal boxes shall be of sufficient size to accommodate the required quantity and size of conduits. Gasketed terminal boxes shall be furnished with all splash-proof and totally enclosed motors. NEMA ratings of the terminal boxes shall be suited for the application. Motors located in hazardous locations shall be furnished with terminal boxes suitable for the specific Class, Division, and Group suitable for the application. Terminal boxes shall be sized to accommodate accessory equipment such as motor differential current transformers.

6. Terminal boxes for horizontal motors shall be located on the left-hand side when viewing the motor from the drive shaft end and shall be so designed that conduit entrance can be made from above, below, or either side of the terminal box.
7. Motors larger than 250hp shall be manufactured with the six stator coil leads wired to the motor junction box for application in a differential relay scheme. Current transformers shall be provided by the motor manufacturer and installed in the factory. All ground connections and current transformer connections shall be made in the factory.

G. Construction

1. Frames, mounting means, and shafts shall meet NEMA Standards for the horsepower, RPM, and enclosure selected. Enclosures shall be selected according to the degree of mechanical protection required and shall not be of aluminum construction. All motors shall have a manufacturer's standard shop machinery finish, consisting of a rust-resisting priming coat of zinc chromate and a finish coat of alkyd machinery enamel. Reference Section 09900, Painting.
2. Motors shall have cast iron frames and a heavy gauge steel terminal box, with neoprene gaskets between the frame and the box and between the box and its cover. A grounding lug(s) shall be provided inside the terminal box.
3. Motors weighing more than 50 pounds shall be equipped with at least one lifting eye. All hardware shall be corrosion resistant.
4. Motors located in hazardous locations as defined by the NEC shall be totally enclosed and suitable for the specific Class, Division, and Group suitable for the application.
5. Motors located in Class I or II, Division 1 hazardous locations shall bear the U.L. label and shall be provided with a breather/drain approved for the hazardous location. The U.L. listed breather/drain shall prevent the entrance of contaminants while allowing moisture to drain out of the motor.
6. When located outdoors, or elsewhere if specified, motors shall be totally enclosed, non-ventilated (TENV) or totally enclosed, fan-cooled (TEFC) machines, unless otherwise noted. Totally enclosed motors shall be provided with two (2) 1/4 inch drain holes drilled through the bottom of the frame, which allows complete drainage of the frame. TEFC motors controlled by a variable frequency drive shall be provided with a separately powered cooling fan motor that runs at 60HZ to ensure proper cooling of the motor at low speeds. Cooling fan motor shall be suitable for 120VAC, single phase operation.

7. Motors rated 10 horsepower or greater located outdoors, in unheated structures, in below grade areas, or as otherwise indicated, shall be furnished with space heaters and embedded motor winding high temperature switches with leads brought out of the motor terminal box. Space heaters shall be suitable for 120VAC operation and for a maximum surface temperature of less than 200 degrees C. Spare heaters shall be of sufficient wattage to maintain the internal temperature of the motor at approximately 10 degrees C above the ambient temperature when the motor is not running.

Embedded motor winding temperature switches shall operate at temperatures well below the temperature rating of the motor winding insulation system. Motor winding temperature switches are not required where other temperature monitoring devices (e.g. RTD's) are required.

8. Motors rated 200HP or greater that are controlled by a VFD shall be inverter duty type and shall be furnished with resistance thermal detectors (RTD's) embedded in the stator windings, two per phase. RTD's shall be pre-wired to terminal blocks located in a separate terminal box as specified herein.
9. Motors rated less than 200HP that are controlled by a VFD shall be inverter duty type and shall be furnished with motor winding high temperature switches embedded in the stator windings with the leads brought out to the motor terminal box; unless otherwise specified.
10. If so specified and when located in indoor areas which are heated and weatherproof, motors shall be open drip-proof machines. Ventilation openings shall be arranged to prevent the entrance of drops of liquid or solid particles at any angle from zero to 15 degrees downward from vertical.
11. Unless otherwise specified, or required, motors rated less than 200 horsepower shall be furnished with bearings of the grease lubricated, antifriction ball type with conveniently located grease fittings and drain plugs. A means of preventing bearings from becoming overgreased shall be provided. Bearings shall have a minimum B-10 life of 20,000 hours.
12. Rotors shall be statically and dynamically balanced. Rotor windings shall be one-piece cast aluminum. Where applicable, rotors shall be constructed with integral fins.

H. Power Factor and Efficiency

1. All motors, including vertical hollowshaft motors, in the range of 1-500 horsepower, inclusive, shall be designed specifically for energy efficiency and high power factor. The motor efficiency and power factor shall meet or exceed the values listed in the table below when the motors are tested in accordance with the NEMA preferred test method IEEE 112A, Method B, Dynamometer. Each motor shall meet the minimum guaranteed efficiency value indicated in the table below. All tests shall be performed in accordance with the procedures contained in NEMA Standard MG1-12.58.

TABLE 12-11 FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS ENCLOSED MOTORS								
HP	2 POLE		4 POLE		6 POLE		8 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	75.5	72	82.5	80	80	77	74	70
1.5	82.5	80	84	81.5	85.5	82.5	77	74
2	84	81.5	84	81.5	86.5	84	82.5	80
3	85.5	82.5	87.5	85.5	87.5	85.5	84	81.5
5	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15	90.2	88.5	91	89.5	90.2	88.5	88.5	86.5
20	90.2	88.5	91	89.5	90.2	88.5	89.5	87.5
25	91	89.5	92.4	91	91.7	90.2	89.5	87.5
30	91	89.5	92.4	91	91.7	90.2	91	89.5
40	91.7	90.2	93	91.7	93	91.7	91	89.5
50	92.4	91	93	91.7	93	91.7	91.7	90.2
60	93	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75	93	91.7	94.1	93	93.6	92.4	93	91.7
100	93.6	92.4	94.5	93.6	94.1	93	93	91.7
125	94.5	93.6	94.5	93.6	94.1	93	93.6	92.4
150	94.5	93.6	95	94.1	95	94.1	93.6	92.4
200	95	94.1	95	94.1	95	94.1	94.1	93
250	95.4	94.5	95	94.1	95	94.1	94.5	93.6
300	95.4	94.5	95.4	94.5	95	94.1		
350	95.4	94.5	95.4	94.5	95	94.1		
400	95.4	94.5	95.4	94.5				
450	95.4	94.5	95.4	94.5				
500	95.4	94.5	95.8	95				

TABLE 12-12 FULL-LOAD EFFICIENCIES FOR NEMA PREMIUM™ EFFICIENCY ELECTRIC MOTORS RATED 600 VOLTS OR LESS (RANDOM WOUND) OPEN MOTORS						
HP	2 POLE		4 POLE		6 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
	77	74	85.5	82.5	82.5	80
1.5	84	81.5	86.5	84	86.5	81.5
2	85.5	82.5	86.5	84	87.5	81.5
3	85.5	82.5	89.5	84	88.5	86.5
5	86.5	84	89.5	84	89.5	87.5
7.5	88.5	86.5	91	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93	91.7	91.7	90.2
20	91	89.5	93	91.7	92.4	91
25	91.7	90.2	93.6	92.4	93	91.7
30	91.7	90.2	94.1	93	93.6	92.4
40	92.4	91	94.1	93	94.1	93
50	93	91.7	94.5	93.6	94.1	93

NOTES:

- (1) Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating.
- (2) TEFC efficiencies apply to both horizontal and vertical motors.

2. Motors rated 50 horsepower or greater shall be individually tested at the factory before shipment, with a copy of test results provided for the Engineer, to assure compliance with the efficiency and power factor specifications.

I. Power Factor Correction

1. The power factor shall be corrected as necessary to achieve 85% (minimum) with capacitors sized and installed per manufacturer's recommendations. Capacitors shall be installed such that the motor shall not be damaged by overvoltage or excessive transient electrical torque. The capacitor(s) shall be connected as close as possible or directly to the motor terminals. Any power factor corrections shall not decrease the motor efficiency below the stated minimum requirement of this Specification. All power factor corrections shall be noted on the Shop Drawings submitted to the Engineer for approval. POWER FACTOR CORRECTION, TO ACHIEVE 85%, SHALL BE PROVIDED ON ALL MOTORS ABOVE 15 HORSEPOWER EXCEPT FOR THOSE MOTORS CONTROLLED BY VARIABLE FREQUENCY DRIVES (VFD'S).

2. When required, power factor correction capacitors shall be connected on the line side of any type of reduced voltage starting motor controller (e.g. RVAT, RVSS, Part-Winding, Wye-Delta, etc.).

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Motors shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Motors shall be properly protected from weather hazards. Motors shall not be allowed to be wrapped tightly in plastic while outdoors. Motors delivered to the site which will not be put in service for a time in excess of 30 calendar days, whether in storage or installed, shall have the shafts rotated a minimum of five (5) rotations every 30 days.
- B. Motors provided with space heaters shall have temporary power applied to the heaters no later than 30 calendar days after delivery to the site until permanent power can be applied to the heaters.
- C. Motors that, in the opinion of the Engineer, have not been properly protected shall be inspected by the manufacturer's representative. Any required electrical corrections for testing shall be made at the Contractor's expense prior to acceptance and/or use.
- D. All motors shall operate without any undue noise or vibration and shall show no signs of phase unbalance.

- END OF SECTION -

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SECTION 15194

NATURAL GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
- C. Division 2 Section "Natural Gas Distribution" for natural gas service piping, specialties, and accessories outside the building.

1.02 SUMMARY

- A. This Section includes natural gas piping, specialties, and accessories within the building.

1.03 SUBMITTALS

- A. The Contractor shall submit shop drawings on all piping, equipment, accessories and appurtenances and all fabrication work or other work required, all in accordance with the requirements of Section 01300, Submittals.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.05 MANUFACTURER'S INSTRUCTIONS

- A. Installation of all equipment shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Submit all instruction books and manuals in accordance with Division 1.

1.06 CODES, PERMITS AND STANDARDS

- A. The Contractor shall obtain and pay for all permits (unless specifically excluded under Division 1 requirements) and shall comply with all laws and codes that apply to the Work.
- B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Ohio Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.
- D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. American Society of Mechanical Engineers (ASME)
 - 4. Factory Mutual (FM)
 - 5. South Carolina Building Code 2015 edition
 - 6. South Carolina Mechanical Code 2015 edition
 - 7. South Carolina Plumbing Code 2015 edition
 - 8. State and local codes, ordinances and statutes
 - 9. Underwriters Laboratories (UL)
 - 10. Others as designated in the specifications.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum five (5) years documented experience, who issues complete catalog data on total product.
- B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

- C. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- D. Touch up and/or repaint to match original factory finishes for all finished or painted equipment and materials which are scratched or marred during shipment or installation.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The Contractor shall ascertain that all openings are correctly located otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.
- B. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.
- C. Alignment of pipes may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.
- D. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

2.02 NATURAL GAS PIPING SYSTEM

- A. Piping 1½ inches and smaller shall be seamless Schedule 40 black steel, ASTM A53 Type "S", Grade A or B, with Class 150 black malleable iron threaded fittings conforming to ASME B16.3.
- B. Piping 2 inches and larger shall be Type "S" seamless or Type "E" electric resistance welded Schedule 40 black steel, ASTM A53, Grade A or B, with Schedule 40 wrought carbon steel fittings, ASTM A 234 and butt weld joints.
- C. Provide factory-applied, three-layer coating of epoxy, adhesive, and PE or field applied primer and epoxy paint coating on all pipe and fittings. Field applied coating is restricted to fittings and short sections of pipe necessarily stripped for threading or welding. Field coating shall be manufactured by Amercoat Type 240 or approved equal and applied in accordance with manufacturer's recommendations.
- D. All valves shall be designed, manufactured and approved for natural gas service.
 - 1. Line Shut-off Valves sizes 2 inches and smaller shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, wrench operation, rated for 200 WOG service pressure and -20 to 200 degrees F., manufactured by Resun Model R-1430 or Nordstrom Model 142.

2. Line Shut-off Valves sizes 2½ inches and larger shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with flanged ends, wrench operation, rated for 200 WOG service pressure and –20 to 200 degrees F., manufactured by Resun Model R-1431 or Nordstrom Model 143.
 3. Appliance/Equipment Shut-off Valves at local connections sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL or Milwaukee Model BB2-100.
 4. Manual Emergency Shut-off Valves sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL or Milwaukee Model BB2-100.
 5. Automatic Emergency Shut-off Valves shall be U.L. Listed F.M. Approved for natural gas service, 2-way electrically tripped solenoid type; fail safe closed; manual reset; Type 1 solenoid enclosure; NBR seals and disc; stainless steel core tube and springs; copper coil; manufactured by ASCO Red Hat Series 8044 or approved equal.
- E. All pressure regulators shall be designed, manufactured and approved for natural gas service.
1. Pressure regulators for individual service lines shall be capable of reducing distribution line pressure to pressures required for users. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulator shall have a single port with orifice diameter no greater than that recommended by manufacturer for the maximum gas pressure at the regulator inlet. Regulator vent valve shall be of resilient materials designed to withstand flow conditions when pressed against valve port. Regulator shall be capable of limiting build-up of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Commercial grade diaphragm type with internal relief valve, vent valve, cast iron body, Buna-N diaphragm. Manufactured by Rockwell or Fisher.
 2. Install pressure gauge adjacent to and downstream of each line pressure regulator.
- F. Unions in 2 inches and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, 2-1/2 inches and larger shall be ground flange unions. Companion flanges on lines at various items of equipment, machines and pieces of apparatus may serve as unions to permit disconnection of piping.
1. Unions connecting ferrous pipe to copper or brass pipe shall be Epco dielectric type.

2. Above grade flexible stainless steel appliance/equipment connectors shall conform with AGA under the ANSI Z21.69 Standard. Hose shall be braided stainless steel with a polyolefin heat-shrink tubing with high flame-retardant qualities. Hose shall be equipped with malleable iron unions and spring loaded brass quick-link couplings. An easily accessible manual shut-off valve shall be installed ahead of all hose connections. Specify T&S Brass "Safe-T-Link" or approved equal.
- G. Flanges: All 150 lb. and 300 lb. ANSI flanges shall be domestically manufactured, weld neck forged carbon steel, conforming to ANSI B16.5 and ASTM A 181 Grade I or II or A 105 71. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP 25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi finished hexagon nuts of American Standard Heavy dimensions. All thread rods will not be an acceptable for flange bolts. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi. Flat-faced flanges shall be required to match flanges on pumps, check valves, strainers, etc. Only one manufacturer of weld flanges will be approved for each project.
1. All flanges shall be gasketed. Contractor shall place gasket between flanges of flanged joints. Gaskets shall fit within the bolt circle on raised face flanges and shall be full face on flat face flanges. Gaskets shall be cut from 1/16 inch thick, non metallic, non asbestos gasket material suitable for operating temperatures from 150 degrees F to +75 degrees F, Klingersil C-4400, Manville Style 60 service sheet packing, or approved equal.
- H. Service line riser steel-to-polyethylene transition fittings shall provide pull-out strength greater than PE tubing to which they are connected. Anodeless service line riser shall meet or exceed the requirements of ASTM D 2513 Category I, ASTM F 1973, ANSI B1.20, ANSI B31.8, US DOT Part 192, NFPA 58 and CSA B137.4. Service line riser shall be by Elster Perfection or Approved Equal.

2.03 GASKETS AND CONNECTORS

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.
- C. Furnish all bolts, studs, nuts and fasteners for make up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 3 - EXECUTION

3.01 NATURAL GAS SYSTEM TESTING

- A. All natural gas systems shall be inspected, tested, purged and placed into operation in accordance with NFPA 54 and as required herein.
- B. All natural gas piping systems shall be very carefully inspected, tested, purged and placed into operation by a Licensed Plumber. All pneumatic tests shall be witnessed, recorded and countersigned by the OWNER's representative inspector.
- C. All necessary apparatus for conducting tests shall be furnished by the Contractor and comply with the requirements of NFPA 54.
- D. All new rough-in distribution piping and affected portions of existing systems connected to, shall be subjected to a pneumatic test pressure utilizing clean, dry air and must be demonstrated to be absolutely tight when subjected to the pressures and time durations listed herein. All equipment and components designed for operating pressures of less than the test pressure shall not be connected to the piping system during test.
- E. Systems on which the normal operating pressure is less than 0.5 pounds per square inch gauge (psig), the test pressure shall be 5.0 psig and the time interval shall be 30 minutes.
- F. Systems on which the normal operating pressure is between 0.5 psig and 5.0 psig, the test pressure shall be 1.5 times the normal operating pressure or 5.0 psig, whichever is greater, and the time interval shall be 30 minutes.
- G. Systems on which the normal operating pressure is 5.0 psig or greater, the test pressure shall be 1.5 times the normal operating pressure, and the time interval shall be one (1) hour.
- H. After testing is complete, the entire gas system shall be purged with dry nitrogen to eliminate all air, debris and moisture from the piping before natural gas is introduced into the system.
- I. After successful results of pressure test and purging have been completed, a leakage test shall be performed in accordance with NFPA 54 Appendix D.
- J. Connect, inspect and purge gas utilization equipment, lab hook-ups, outlets, etc., and place into operation only after successful results of pressure test, leakage test and purging have been completed and accepted.
- K. In all instances in which leaks are then found, they shall be eliminated in the manner designated by the Owner's duly authorized representative. Testing operations shall be repeated until gas-piping systems are absolutely tight at the pneumatic test pressures indicated above.
- L. The Contractor shall make all arrangements to assure that OWNER's inspectors view the final test and that a certificate is provided from the inspectors verifying that the installation meets requirements.

- M. Pressure test gas piping sleeve system with clean, dry compressed air at 15 psig by temporarily sealing all openings between gas carrier pipe and sleeve and vent openings. Sleeve systems must be demonstrated to be absolutely tight when subjected to this pressure for a period of four hours.

3.02 CLEANING

- A. Clean dirt and marks and other debris from exterior of equipment weekly.
- B. Remove debris and waste material resulting from installation weekly.

3.03 GUARANTEE

- A. All components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of one (1) year. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

-END OF SECTION-

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SECTION 15290

INSULATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install insulation as shown on the Drawings or otherwise specified. Insulation shall not be installed until piping has been field tested and approved by the Owner. The Contractor shall protect the insulation from moisture at all times.
- B. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 INSULATED PROCESS/CHEMICAL PIPING

- A. Fiberglass insulation shall be Owens Corning Fiberglass Corp., Fiberglass 25ASJ/SSC; Certain Teed Products Corporation, Certain Teed snap-on ASJ/SSL; or equal. Insulation shall be heavy density sectional pipe insulation with vapor barrier and self-sealing lap. Minimum density insulation density shall be 6 pounds per cubic foot. Contractor shall use manufacturer's recommended adhesives and tape for jointing material. Fittings shall be molded fiberglass. Minimum insulation thickness shall be 1-1/2 inches for 4" diameter pipe and larger, and 1 inch for smaller pipe. Insulation thickness for heat traced pipe is specified in Section 15390, Heat Tracing Systems.
- B. Weatherproof insulation jacket for process piping shall be Certain Teed Products Corporation; Childers Products Company, Lock On and Slip On; or equal. Jacket shall be smooth embossed aluminum metal jacket with minimum thickness 0.016 inches thick for interior installations and at least 0.031 inches thick for exterior installations. Fastening shall use preformed "2"-lock seam with 2 inch butt strap with sealant. Bonds shall be 1/2 inch aluminum with wing seals. Fittings shall be prefabricated 0.016/0.031 inches thickness aluminum.
 - 1. Contractor shall install weather proofing for outdoor piping. The field applied jacket with moisture barrier shall be slipped around pipe into preformed 2-lock position. Butt next jacket section adjacent to previous section leaving 3/8 inch gap. Place preformed 2 inch butt strap with sealant over the seam and secure with 1/2 inch aluminum band and wing seal. Contractor shall install preformed fittings identical in composition to pipe jacketing at all fittings.
- C. Insulation fitting covers and jacket for chemical piping shall be Zeston 2000 PVC by Manville, or equal. Fitting covers shall fit snugly over fittings, including all elbows and valves, etc. Jacketing shall be high-impact UV-resistant covering for insulated piping and shall match fitting covers. Fitting covers and jackets shall be white and suitable for painting. PVC jacketing shall be 30 mil thick and shall be factory curled to fit snugly. Fitting covers and jacketing shall be secured with tacks.

- D. The Contractor shall insure that surfaces of pipes, valves, heat tracing, and fittings are clean and dry prior to installation of insulation. Insulation shall be installed so as to make surfaces smooth, even, and substantially flush with the adjacent insulation. The Contractor shall follow the manufacturer's application instructions for the materials used.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15390

SCHEDULES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.

1.02 PIPING SYSTEM SCHEDULES

- A. Piping requirements for this Section are outlined on the Drawings, and in the Piping System Schedule. In the absence of a specified test pressure, pipe shall be tested at a pressure 50 percent greater than the normal operating pressure as determined by the Engineer or 10 psig, whichever is greater unless the Schedule indicates that no test is required.
- B. If the pipe material is not shown on the Piping System Schedule or otherwise specified, the following materials shall be used pending Engineer's approval:

<u>Pipe Size</u>	<u>Material</u>	<u>Type of Joint</u>	<u>Class/Design</u>	<u>Test Pressure</u>
4-in to 15-in (Gravity)	PVC	Bell/Spigot	SDR-26	(3)
18-in to 36-in (Gravity)	PVC	Bell/Spigot	PS-115	(3)
6-in to 12-in (Force Main)	PVC	Bell/Spigot (restrained)	C900	(1)
4-in and larger (Force Main)	DIP	Flanged (exposed) Restrained (buried)	53 (exposed), Pressure Class 350 (buried)	(1)
1-in or less than 4-in (Potable Water)	PVC, CPVC (2)	Socket	Sch 80	(1)

- (1) Test at 150 percent of normal operating pressure or 10 psi, whichever is greater.
- (2) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used.
- (3) All gravity sewer lines shall be tested in accordance with Uni-Bell "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe" (UNI-B-6-98 or latest revision).
- (4) Provide heat tracing and insulations as specified in Section 15391 on all exposed outdoor piping indicated.

- C. Non-critical gravity lines such as drains, floor drains, roof drains, etc., do not typically require a pressure test.
- D. The restraint system design pressure shall never be less than 1.25 times the pump shut-off head for centrifugal pumps or maximum pressure rise capability of positive displacement pumps.
- E. Valves not listed in the following valve schedule shall be manually operated, unless otherwise shown.
- F. Heat tracing will be needed on all exposed potable water piping.

PIPING SYSTEM SCHEDULE						
PIPE IDENTIFICATION	MATERIAL	TYPE OF JOINT	CLASS / DESIGN	RESTRAINT SYSTEM DESIGN* PRESSURE	TEST PRESSURE	PIPE BEDDING ⁽²⁾
D	304L SST	THREADED / WELDED	SCH 40	NA	NA	-
FM	PVC	RESTRAINED BELL / SPIGOT (BURIED)	C900 DR 18	150 PSI	150 PSI	RESTRAINED BELL/SPIGOT (BURIED)
	DIP ⁽¹⁾	FLANGED (EXPOSED)	CLASS 350	150 PSI	150 PSI	B
PW	< 4" PVC ⁽³⁾	SOCKET	SCH 80	150 PSI	150 PSI	-
V	DIP ⁽¹⁾	FLANGED	CLASS 53	NA	NA	-
SS	PVC	BELL / SPIGOT	SDR 26 (4-in through 18-in) PS-115 (>18-in)	NA	(see note 3 on previous page)	B

⁽¹⁾ PROVIDE WITH PROTECTO 401 LINING (SEE 15006).

⁽²⁾ TRENCH TYPE DETAILS SHALL BE IN ACCORDANCE WITH THE APPROPRIATE STANDARD DETAIL LOCATION IN THE CONTRACT DRAWINGS.

⁽³⁾ PROVIDE HEAT TRACING AND INSULATION AS SPECIFIED IN SECTION 15391 ON ALL EXTERIOR **EXPOSED** PIPING INDICATED. CPVC SHALL BE PROVIDED IN LIEU OF PVC WHERE HEAT TRACE IS INSTALLED.

PIPING SYSTEM DESIGNATIONS			
D	DRAIN	SS	SANITARY SEWER
FM	FORCE MAIN	V	VENT
PW	POTABLE WATER		

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 15391

HEAT TRACING SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install heat tracing and insulation systems as shown and required by notes in the drawings or as required by the Section 15390 - Schedules. All heat tracing components shall be supplied by the same manufacturer. The heat tracing and insulation system shall include but shall not be limited to self regulating heater cables, grommet end termination kits, power connection kits, splice kits, NEMA 4X enclosed thermostats, piping insulation and jacket and installation tape. The intent of this specification is for the contractor to supply all appurtenances needed for a complete and fully operational system at each location that a heat tracing system is required. The heat tracing system supplier shall be completely responsible for the design of the system such that the entire system meets all aspects of this specification and the system functions in the environment where it will be installed. All parameters of the system shall be sized and as recommended by the supplier.
- B. The heat tracing system(s) shall be provided in accordance with the requirements of Section 15000 - Basic Mechanical Requirements.
- C. Piping insulation and jacket shall be supplied with all heat traced piping and shall be in conformance with Section 15290 - Insulation. The thickness of the insulation shall be as stipulated in this specification.
- D. The minimum design ambient temperature for the heat tracing system design shall be - 10°F.
- E. All the components of the heat tracing system shall be individually Underwriters Laboratory (UL) listed. The system as supplied shall conform to all applicable parts of the following:
 - 1. National Fire Protection Association (NFPA)
 - 2. National Electric Code (NEC)
 - 3. Local and State Building Codes

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. Heat tracing system conductors and insulation for METAL piping shall be supplied in conformance with the following table:

Heat Tracing Conductors and Insulation for Metal Piping			
Pipe Size (in)	Insulation Thickness (in)	Cable Heat Rating Watts per Foot	
		Design Air Temperature -10°F	Design Air Temperature -40°F
≤3/4	1	3	3
1	1	3	5
1-1/4	1	3	5
1-1/2	1	3	5
2	1	3	5
2-1/2	1	3	5
3	1-1/2	3	5
4	1-1/2	5	8
6	2	5	8
8	2	5	8
10	2	8	10 ⁽¹⁾
12	2	8	10 ⁽¹⁾

(1) Two conductors shall be provided and shall be placed on top of and under the pipe.

- B. Heat tracing system conductors and insulation for NONMETALIC. Piping shall be supplied in conformance with the following table:

Heat Tracing Conductors and Insulation for Nonmetallic Piping			
Pipe Size (in)	Insulation Thickness (in)	Cable Heat Rating Watts per Foot	
		Ambient Air Temperature -10°F	Ambient Air Temperature -40°F
≤3/4	1	3	3
1	1	3	5
1-1/4	1	3	5
1-1/2	1	3	5
2	1	3	5
2-1/2	1	5	8
3	1-1/2	3	8
4	1-1/2	5	8
6	2	5	8
8	2	8	10
10	2	8 ⁽²⁾	(1)
12	2	8 ⁽²⁾	(1)

- (1) Consult the heat tracing system manufacturer for the cable rating and the number of passes for each pipe.
- (2) Two conductors shall be provided and shall be placed on top of and under the pipe.

1.03 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals:
 - 1. Submittal data on all components of the heat trace system and any other data recommended by the manufacturer
 - 2. Installation and maintenance instructions
 - 3. List of replacement parts for the entire system in table format
 - 4. Bill of materials list of the system as supplied in table format

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Each heat trace system shall be supplied by Thermon Manufacturing Company, Raychem Corporation or Chromalox. All system components shall be supplied by a single manufacturer.

2.02 MATERIALS

- A. The self regulating heater cable assembly shall consist of two parallel copper bus wires, minimum size 16 AWG, connected through a semi-conductive heating matrix. This heating element shall be covered with a cross-linked polyolefin insulation jacket. This insulation shall be covered by a tinned copper braid and then covered with a fluoropolymer insulating jacket. All heat cables shall be rated for 120 volt supply voltage. The heating cable shall be suitable for installation on metallic and nonmetallic pipe. All heating cable shall be properly marked by the manufactures number or nomenclature for ease of future maintenance. Cable shall be suitable for use in Class 1 (Division 1 and 2) or Class 2 (Division 1 and 2) hazardous locations where cable is shown to be installed in hazardous locations.
- B. Each heat tracing circuit shall be supplied with a power connection and end seal kit. Each end seal kit shall include a lighted end termination kit Chromalox model UESL or equal. It shall be the Contractor's responsibility to make sure that no circuit in the system be longer than as recommended by the heat tracing system manufacturer. All terminations, splices, junctions and tee's in the circuit shall be made using manufacturer recommended and supplied kits. Junction boxes shall be provided where required for access to all circuit appurtenances.
- C. Flexible heater elements shall be provided where indicated on the Drawings to protect pumps & other equipment. The flexible heater shall be 3 inches wide by 40 inches long and shall consist of a heater element encapsulated in silicone rubber. The silicone rubber shall be rated for a temperature range of -80°F to 390°F. The flexible heater shall be designed with eyelets in the ends and edges as required for mounting on the pump using manufacturer supplied silicone straps. The flexible heater shall be rated for 120 Vac and 600 watts of heat output. The flexible heater shall be supplied with a preset thermostat which will energize the flexible heater when the ambient temperature reaches 40°F and shut

down the heater when the ambient temperature reaches 50°F. The flexible heater shall be model SL-N as manufactured by Chromalox or equal

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

- A. A thermostat shall be furnished and installed for each heat trace circuit. The thermostat for each circuit shall be an adjustable ambient sensing thermostat designed for controlling the heating cable to provide freeze protection of pipes. The thermostat shall have an adjustable range of 15°F to 140°F. The enclosure for the thermostat shall be NEMA 4X. The Thermostat shall be rated to match the voltage of the heating cable and shall have a switch rating of 20 amps (minimum). Thermostat shall be suitable for use in Class 1 (Division 1 and 2) or Class 2 (Division 1 and 2) hazardous locations where thermostat is shown to be installed in hazardous locations.

2.04 SPARE PARTS

- A. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following:
1. 100 ft. of self-regulating cable for each cable wattage provided for the system(s)
 2. One (1) spare ambient thermostat controller for each heat tracing system
 3. One (1) spare ambient temperature RTD
 4. Two (2) each of the following: cable termination kits, cable splice kits and cable tee kits

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

3.02 INSTALLATION

- A. The installation of all heat tracing and insulation components shall conform to all instructions and requirements recommended by the heat tracing system manufacturer. All installation and terminations shall conform to the National Electric Code.

- B. All piping shall be pressure tested prior to installation of any heat tracing or insulation components. Thermal insulation shall only be installed when all heat tracing components are in place and satisfactorily tested as indicated herein. Once tested, the insulation shall be installed immediately to prevent damage to the heat tracing system components.
- C. No insulation shall be installed using staples. Insulation jackets shall be installed as recommended by the insulation system supplier such that no damage is done to the heat tracing system components.
- D. The installation of heat tracing cable on nonmetallic pipe shall be done in strict conformance with the heat tracing manufacturer's recommendations. Requirements shall include heat shielding tape or wrap as recommended by the heat tracing manufacturer
- E. Contractor shall install weather proofing for all outdoor piping. The field applied jacket with moisture barrier shall be slipped around pipe into preformed 2-lock position. Butt next jacket section adjacent to previous section leaving 3/8 inch gap. Place preformed 2 inch butt strap with sealant over the seam and secure with 1/2 inch aluminum band and wing seal. Contractor shall install preformed fittings identical in composition to pipe jacketing at all fittings
- F. The Contractor shall insure that surfaces of pipes, valves, heat tracing, and fittings are clean and dry prior to installation of insulation. Insulation shall be installed so as to make surfaces smooth, even, and substantially flush with the adjacent insulation. The Contractor shall follow the manufacturer's application instructions for the materials used
- G. A label shall be installed on the piping insulation jacket every 15 feet and readily visible from ground level: ELECTRIC HEAT TRACING: CAUTION

3.03 FIELD TESTING

- A. All heating cable shall be tested using a megohmmeter (megger) between the heating cable bus wires and the metallic ground braid. A 2,500 VDC megger test is required and the minimum acceptable resistance value shall be 20 megaohms regardless of the circuit length. Any cables found to be less than this value shall be replaced at no additional cost to the Owner. The megger tests shall be performed as follows:
 - 1. After installation of the cable and all fabrication kits but prior to installing any of the insulation system components.
 - 2. After installation of the insulation system components but prior to energizing the cables.
 - 3. All test reading for each megger test shall be recorded by the installer and submitted with the maintenance instructions.

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SECTION 16000

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- 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. Reference Section 17000, Control and Information System Scope and General Requirements for scope of work details as they relate to the Division 17 Subcontractor.
- C. The electrical scope of work for this project primarily includes, but is not limited to, the following:
 - 1. Furnish and installation new electrical service in accordance with the electrical utility.
 - 2. Install vendor furnished (Division 11) pump station control panel including reduced voltage motor starters.
 - 3. Furnish and install combination power units, and other low voltage electrical power distribution equipment.
 - 4. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, 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. Furnish and install lightning protection systems.

9. Other electrical work as specified herein and indicated on the Drawings.

- D. 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.
- E. 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.
- F. 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.
- G. 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.
- H. All electrical components and systems, including electrical equipment foundations, shall be designed to resist operational forces as well as lateral sway and axial motion from seismic and thermal forces. Seismic support design shall be in accordance with Section 01350 – Seismic Anchorage and Bracing.

1.02 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 ensure that proposed equipment will fit properly in spaces indicated.
- B. 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.

1.03 LOCAL CONDITIONS

- 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.
- C. 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 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 and non-reversible crimp-type terminations (material and labor)
- D. The electric utility will furnish and install the following equipment:
 - 1. Primary conductors and terminations (material and labor)
 - 2. Secondary terminations (labor)
- E. 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.
- F. The contact person at the serving electrical utility is:

Shane Kimble
Customer Service Engineering
SCE&G
843-576-8434
SHANE.KIMBLE@scana.com

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions, Section 01300, Submittals and the requirements of the individual specification sections, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Operation and Maintenance Manuals
 - 3. Spare Parts List
 - 4. Proposed Testing Methods and Reports of Certified Shop Tests.
 - 5. Reports of Certified Field Tests.
 - 6. Manufacturer's Representative's Certification.
- B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements.
- C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.
- D. Some individual Division 16 specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the 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.
- E. Seismic support design for all nonstructural electrical components (conduit, raceways, freestanding equipment, etc.) shall be in accordance with all applicable federal, state and local building code requirements and Section 01350 – Seismic Anchorage and Bracing.

1.05 APPLICABLE CODES AND REQUIREMENTS

- A. Conformance
 - 1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the following:

- a. Insurance Rating Organization having jurisdiction
 - b. The serving electrical utility company
 - c. The currently adopted edition of the National Electrical Code (NEC)
 - d. The National Electric Manufacturers Association (NEMA)
 - e. The Institute of Electrical and Electronic Engineers (IEEE)
 - f. The Insulated Cable Engineers Association (ICEA)
 - g. The American Society of Testing Materials (ASTM)
 - h. The American National Standards Institute (ANSI)
 - i. The requirements of the Occupational Safety Hazards Act (OSHA)
 - j. The National Electrical Contractors Association (NECA) Standard of Installation
 - k. National Fire Protection Association (NFPA)
 - l. International Electrical Testing Association (NETA)
 - m. 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.

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 PERMITS AND INSPECTIONS

- A. The Contractor shall reference the General Conditions and Section 01010, Summary of Work.

1.07 TEMPORARY LIGHTING AND POWER

- A. The Contractor shall reference the General Conditions and Section 01510, Temporary Utilities.

1.08 TESTS

- A. Upon completion of the installation, the Contractor shall perform tests for operation, load (Phase) balance, overloads, and short circuits. Tests shall be made with and to the satisfaction of the Owner and Engineer.
- B. The Contractor shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Contractor at no cost to the Owner. The Contractor shall show by demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.
- C. Refer to each individual specification section for detailed test requirements.
- D. The Contractor shall complete the installation and field testing of the electrical installation at least two (2) weeks prior to the start-up and testing of all other equipment. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Contractor shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.
- E. Before each test commences, the Contractor shall submit a detailed test procedure, and also provide test engineer resume, manpower and scheduling information for the approval by the Engineer. In addition, the Contractor shall furnish detailed test procedures for any of his equipment required as part of the field tests of other systems.

1.09 INFRARED INSPECTION

- A. Just prior to the final acceptance of a piece of equipment, the Contractor shall perform an infrared inspection to locate and correct all heating problems associated with electrical equipment terminations.
- B. The infrared inspection shall apply to all new equipment and existing equipment that is in any way modified under this Contract. All heating problems detected with new equipment furnished and installed under the Scope of this Contract shall be corrected by the Contractor. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Contractor.
- C. Any issues detected with portions of existing equipment that were not modified under this Contract are not the responsibility of the Contractor. Despite the Contractor not being held responsible for these problems, the Contractor shall report them to the Owner and Engineer immediately for resolution.

- D. The infrared inspection report shall include both digital and IR pictures positioned side by side. Both the digital and IR pictures shall be clear and high quality. Fuzzy, grainy, or poorly illuminated pictures are not acceptable. The IR picture shall be provided with a temperature scale beside it, and an indication of the hot spot temperature in each picture. Reports shall be furnished in a 3-ring binder, with all pages printed in full color, with equipment assemblies separated by tabs.

1.10 PROTECTIVE DEVICE SETTING AND TESTING

- A. The Contractor shall provide the services of a field services organization to adjust, set, calibrate and test all protective devices in the electrical system. The organization shall be a subsidiary of or have a franchise service agreement with the electrical equipment manufacturer. The qualifications of the organization and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted.
- B. All protective devices in the electrical equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.
- C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.
- D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers recommended test devices and procedures.
- E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.
- F. When completed, the Contractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.
- G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

1.11 POWER SYSTEM STUDIES

- A. The Engineer will provide the Power System studies to the firm providing the protective device setting and testing services. The Contractor shall notify the Engineer six (6) weeks in advance of the scheduled date for the protective device setting and testing. The testing firm shall submit to the Engineer a tabulated listing of all protective devices requiring setting six (6) weeks prior to the setting and testing date. This table shall include the protective device manufacturer, model number, ampere rating (if applicable), instrument transformer ratios, and all other required information.

1.12 SCHEDULES AND FACILITY OPERATIONS

- A. Since the equipment testing required herein shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules must be submitted to the Engineer for review and approval one (1) month prior to any work beginning. When testing has been scheduled, the Engineer must be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of facility equipment must be coordinated with the Owner/Engineer so as not to affect proper facility operations.
- B. At the end of the workday, all equipment shall be back in place and ready for immediate use should a facility emergency arise. In addition, should an emergency condition occur during testing, at the request of the Owner, the equipment shall be placed back in service immediately and turned over to Owner personnel.
- C. In the event of accidental shutdown of Owner equipment, the Contractor shall notify Owner personnel immediately to allow for an orderly restart of affected equipment.
- D. Maintaining the operation of these facilities during the duration of the construction period is essential and required. The Contractor shall furnish and install temporary equipment as required to maintain facility operation. Reference Section 01520 of the Specifications for construction sequencing and specific operational constraint information.

1.13 MATERIALS HANDLING

- A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be temporarily connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01550, Site Access and Storage.

1.14 WARRANTIES

- A. Unless otherwise specified in an individual specification section, all equipment and electrical construction materials furnished and installed under Division 16 shall be provided with a warranty in accordance with the requirements of Section 11000, Equipment General Provisions and the General Conditions.

1.15 TRAINING

- A. Unless otherwise specified in an individual specification section, all training for equipment furnished and installed under Division 16 shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

PART 2 -- PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.
- B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.
- C. All equipment and materials shall be new, unless indicated or specified otherwise.
- D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc., in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming to this requirement.

2.02 SUBSTITUTIONS

- A. Unless specifically noted otherwise, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition.

2.03 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 6 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.

PART 3 -- EXECUTION

3.01 CUTTING AND PATCHING

A. Coordination

- 1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.

B. Damage

- 1. The Contractor shall perform all chasing, channeling, drilling and patching necessary to the proper execution of his Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Contractor's expense. If, in the Engineer's judgment, the repair of damaged equipment would not be satisfactory, then the Contractor shall replace damaged equipment at his own expense.

C. Existing Equipment

- 1. Provide a suitable cover or plug for openings created in existing equipment as the result of work under this Contract. For example, provide round plugs in equipment enclosures where the removal of a conduit creates a hole and the enclosure. Covers and plugs shall maintain the NEMA rating of the equipment enclosure. Covers and plugs shall be watertight when installed in equipment located outdoors.

3.02 EXCAVATION AND BACKFILLING

- A. The Contractor shall perform all excavation and backfill required for the installation of all electrical work. All excavation and backfilling shall be in complete accordance with the applicable requirements of Division 2.

3.03 CORROSION PROTECTION

- A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

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SECTION 16111

CONDUIT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install conduits and conduit fittings to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.
- B. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Section 16190, Electrical Supporting Devices, for these requirements.
- C. Reference Section 16000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

- A. Conduits and conduit fittings shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. American National Standards Institute (ANSI)
 - a. ANSI B1.20.1 – Pipe Threads, General Purpose
 - b. ANSI C80.1 – Electrical Rigid Steel Conduit
 - c. ANSI C80.3 – Steel Electrical Metallic Tubing
 - d. ANSI C80.5 – Electrical Rigid Aluminum Conduit
 - e. ANSI FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
 - 2. Underwriters Laboratories (UL)
 - a. UL 1 – Standard for Flexible Metal Conduit
 - b. UL 6 - Electrical Rigid Metal Conduit-Steel
 - c. UL 6A – Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel
 - d. UL 360 – Standard for Liquid-tight Flexible Metal Conduit
 - e. UL 467 – Grounding and Bonding Equipment
 - f. UL 514B – Conduit, Tubing, and Cable Fittings

- g. UL 651 – Standard for Schedule 40 and 80 Conduit and Fittings
- h. UL 797 – Electrical Metallic Tubing-Steel
- i. UL 1203 - Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations
- j. UL 1479 – Standard for Fire Tests of Penetration Fire Stops
- k. UL 1660 – Liquid-tight Flexible Nonmetallic Conduit
- 3. National Electrical Manufacturer's Association (NEMA)
 - a. NEMA RN 1 – PVC Externally Coated Galvanized Rigid Steel Conduit
 - b. NEMA TC-2 – Electrical PVC Conduit
 - c. NEMA TC-3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

B. Others

- 1. ACI-318 – Building Code Requirements for Structural Concrete

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

- 1. Shop Drawings

- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets for conduits and fittings.
 - 2. Conduit identification methods and materials.
 - 3. Evidence of training for all personnel that will install PVC coated rigid metal conduit.

1.05 DEFINITIONS

- A. Conduits are categorized by the circuit type of the wiring to be installed inside. Conduits are defined as follows:
 - 1. Power Conduits – Conduits that carry AC or DC power wiring from a source to a load. Conduits that carry lighting and receptacle wiring.
 - 2. Control Conduits – Conduits that carry AC or DC discrete control wiring between devices and/or equipment. Conduits that carry fiber optic cables between devices and/or equipment.
 - 3. Instrumentation Conduits – Conduits that carry AC or DC analog signal wiring between devices and/or equipment.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Conduit and conduit fitting products are specified in the text that follows this article. Reference Part 3 herein for the application, uses and installation requirements of these conduits and conduit fittings.
- B. All metallic conduit fittings shall be UL 514B and UL 467 Listed, and constructed in accordance with ANSI FB 1. All metallic conduit fittings for use in Class I Division I hazardous areas shall be UL 1203 Listed. All non-metallic fittings shall be UL 651 Listed and constructed in accordance with NEMA TC-3.
- C. Flexible conduit couplings for use in Class I Division I hazardous areas shall have threaded stainless steel end fittings and a flexible braided core. Flexible braid shall be constructed of stainless steel where available in the conduit trade size required for the application. Where stainless steel braid is not available, the braid shall be provided with a PVC coating. No other braid types or materials are acceptable.
- D. Where threading is specified herein for conduit fitting connections, the fittings shall be manufactured to accept conduit that is threaded to ANSI B1.20.1 requirements.
- E. Conduit expansion fittings for all conduit materials of construction shall be capable of 4 inches of movement along the axis of the conduit for trade sizes 2 inches or less. Expansion fittings shall be capable of 8 inches of movement along the axis of the conduit for trade sizes greater than 2 inches.
- F. Conduit deflection fittings for all conduit materials of construction shall be provided with a flexible neoprene outer jacket that permits up to $\frac{3}{4}$ inch of expansion/contraction along the axis of the conduit as well as up to $\frac{3}{4}$ inch of parallel misalignment between the conduit axes. Outer jacket shall be secured to the conduit hubs by stainless steel clamps.
- G. Conduit seals shall either be Listed and labeled for 40% fill, or conduit reducing fittings and a trade size larger conduit seal shall be provided to achieve 25% or less fill within the seal. Percentage fill calculation shall be based on the conductors to be installed. Conduit seals shall be provided with breathers and/or drains where required by the NEC.

- H. Conduit insulating bushings shall be constructed of plastic and shall have internal threading.
- I. Additional conduit and conduit fitting requirements are specified in the articles that follow based on the specific conduit material of construction to be used.

2.02 RIGID NONMETALLIC CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

- 1. Conduit shall be Schedule 40 or 80 (dependent on application) polyvinyl chloride (PVC) construction, manufactured in accordance with NEMA TC-2, UL 651 Listed, and suitable for conductors with 90 degree C insulation.

B. Conduit Bodies for use with Rigid Nonmetallic Conduit

- 1. Conduit bodies shall be constructed of PVC. Conduit hubs shall be integral to the conduit body and shall be smooth inside to accept a glued conduit connection.
- 2. Conduit body shall be provided with cover that is affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Unions for use with Rigid Nonmetallic Conduit

- 1. Conduit couplings and unions shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

D. Conduit Expansion and Deflection Fittings for use with Rigid Nonmetallic Conduit

- 1. Conduit expansion fittings and conduit deflection fittings shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

E. Conduit Termination Fittings for use with Rigid Nonmetallic Conduit

- 1. Conduit hubs shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. Hubs shall have external threads and an accompanying PVC locknut, and shall be watertight when assembled to an enclosure.
- 2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts constructed of PVC and locknuts with integral gasket or seal are not acceptable.
- 3. Conduit end bells shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. End bell shall have a smooth inner surface that curves outward towards the edge of the fitting.

2.03 PVC COATED ALUMINUM CONDUIT AND ASSOCIATED FITTINGS

A. General

1. Where an external coating of polyvinyl chloride (PVC) is specified for conduit and fittings, the coating shall be 40 mil (minimum) thickness. Where an internal coating of urethane is specified for conduit and fittings, the coating shall be 2 mil (minimum) thickness.
2. All conduit fittings shall have a sealing sleeve constructed of PVC which covers all connections to conduit. Sleeves shall be appropriately sized so that no conduit threads will be exposed after assembly.

B. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside, and made of heavy wall high strength aluminum. Conduit shall be manufactured in accordance with ANSI C80.1, and shall be UL 6 Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.
3. Conduit shall be coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit shall be manufactured in accordance with NEMA RN-1.

C. Conduit Bodies for use with PVC Coated Aluminum Conduit

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I Division I hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.
3. Conduit bodies for all other areas shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Covers shall be affixed in place by stainless steel screws which thread directly into the conduit body and have a plastic encapsulated head. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

D. Conduit Couplings, Nipples, and Unions for use with PVC Coated Aluminum Conduit

1. Couplings and nipples shall be threaded and shall be constructed of aluminum which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Split-type couplings that use compression to connect conduits are not acceptable.

2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

E. Conduit Expansion and Deflection Fittings for use with PVC Coated Aluminum Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

F. Conduit Seals for use with PVC Coated Aluminum Conduit

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit seals shall have threaded conduit connections.

G. Conduit Termination Fittings for Use with PVC Coated Aluminum Conduit

1. Conduit hubs shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Hubs shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit bonding bushings shall be constructed of zinc plated malleable iron which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.04 RIGID ALUMINUM CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be made of heavy wall high strength 6063 alloy aluminum with temper designation T1. Conduit shall be manufactured in accordance with ANSI C80.5, and shall be UL 6A Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

B. Conduit Bodies for use with Rigid Aluminum Conduit

1. Conduit bodies shall be constructed of copper-free aluminum which is coated with an aluminum enamel finish. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I Division I hazardous areas shall be provided with integrally threaded covers constructed of copper-free aluminum which is coated with an aluminum enamel finish.
3. Conduit bodies for all other areas shall be provided with stamped copper-free aluminum covers that are affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings, Nipples, and Unions for use with Rigid Aluminum Conduit

1. Couplings and nipples shall be threaded and shall be constructed of heavy wall high strength 6063 alloy aluminum with temper designation T1. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of copper-free aluminum which is coated with an aluminum enamel finish.

D. Conduit Expansion and Deflection Fittings for use with Rigid Aluminum Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of copper-free aluminum which is coated with an aluminum enamel finish. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Seals for use with Rigid Aluminum Conduit

1. Conduit seals shall be constructed of copper-free aluminum which is coated with an aluminum enamel finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Aluminum Conduit

1. Conduit hubs shall be constructed of copper-free aluminum and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of copper-free aluminum. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.

3. Conduit bonding bushings shall be constructed of copper-free aluminum. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.05 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Trade size 1-1/4 inch and smaller conduits shall be provided with an integrally woven copper bonding strip.
2. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 360 Listed.

B. Conduit Termination Fittings for use with LFMC

1. Conduit termination fittings shall be constructed of either 304 stainless steel or an electro-galvanized malleable iron alloy which is coated on the exterior with a 40 mil (minimum) PVC jacket and coated on the interior with a 2 mil (minimum) layer of urethane. PVC coated fittings shall have a sealing sleeve constructed of PVC which covers the connection to conduit.
2. Termination fittings shall have a threaded end with matching locknut and sealing ring for termination to equipment, and shall have an integral external bonding lug where required for proper bonding. Termination fittings shall have a plastic insulated throat and shall be watertight when assembled to the conduit and equipment.

2.06 LIQUID TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be constructed of rigid polyvinyl chloride (PVC), fabricated to provide flexibility. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 1660 Listed.

B. Conduit Termination Fittings for use with LFNC

1. Conduit termination fittings shall be constructed PVC and shall have a threaded end with matching locknut and sealing ring for termination to equipment. Termination fittings shall be watertight when assembled to the conduit and equipment.

2.07 FLEXIBLE METAL CONDUIT (FMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Conduit shall be UL 1 Listed.

B. Conduit Termination Fittings for use with FMC

1. Conduit termination fittings shall be constructed of an electro-galvanized malleable iron alloy. Fittings shall have a threaded end with matching locknut for termination to equipment, and a compression-style connection to the associated conduit.

2.08 CONDUIT BENDS

- A. Rigid conduit bends, both factory fabricated and field fabricated, shall meet the same requirements listed in the articles above for the respective conduit type and material of construction.

- B. Conduit bend radii for standard radius bends shall be no less than as follows:

TRADE SIZE (inches)	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
MIN. RADIUS (inches)	4-1/2	5-3/4	7-1/4	8-1/4	9-1/2	10-1/2	13	15	16	24	30

- C. Conduit bend radii for long radius bends shall be no less than as follows:

TRADE SIZE (inches)	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
MIN. RADIUS (inches)	N/A	12	18	24	30	30	36	36	48	48	60

2.09 MISCELLANEOUS

A. Conduit Periphery Sealing

1. The sealing of the exterior surface of conduits to prevent water and/or air from passing around the conduit periphery from one space to another (where required) shall be through the use of one of the following:
 - a. A conduit sleeve and pressure bushing sealing system. Acceptable products are FSK by OZ-GEDNEY, Link-Seal by Crouse-Hinds, or Engineer approved equal.

- b. A conduit sleeve that is two trade sizes larger than the conduit being sealed, with 2-hour fire rated UL 1479 Listed caulk filling the entire void between the conduit and sleeve. This method is only suitable for penetrations in non-fire rated walls and floors between spaces within buildings. This method shall not be used for the sealing of conduits leaving a building and/or structure.
 - 2. Conduit penetrations through fire-rated walls and floors shall be made with an approved UL 1479 Listed product specifically intended for the trade size of the conduit.
- B. Primer and Cement
- 1. Nonmetallic conduit shall be cleaned with primer and connected to fittings with the manufacturer's recommended cement that is labeled Low VOC.
- C. Galvanizing Compounds
- 1. Galvanizing compounds for field application shall be the cold-applied type, containing no less than 93% pure zinc.
- D. Conduit Interior Sealing
- 1. The sealing of the inside of conduits against water ingress shall be achieved through the use of one of the following:
 - a. Two-part expanding polyurethane foam sealing compound, dispensed from a single tube which mixes the two parts as it is injected into the conduit. Expanding foam shall be compatible with the conduit material of construction as well as the outer jacket of the cables in the conduit. Acceptable products are Q-Pak 2000 by Chemque, FST by American Polywater Corporation, or Hydra-seal S-60 by Duraline.
 - b. Inflatable bag that provides seal around cables and around inside diameter of conduit. Provide appropriate quantity of additional fittings for applications with three or more cables in the conduit to be sealed. Acceptable products are Rayflate by Raychem, or Engineer approved equal. This sealing method is only applicable to conduits trade size 2 inch and larger.
 - c. Neoprene sealing ring provided with the required quantity and diameter of holes to accommodate the cables in each conduit. Sealing ring shall be compressed by two stainless steel pressure plates. Acceptable products are type CSB by OZ-GEDNEY, or Engineer approved equal. This sealing method is only applicable to metallic conduits containing 4 or less cables.
 - 2. The use of aerosol-based expanding foam sealants or any other method of sealing against water ingress not listed above is not acceptable.

E. Pull Rope

1. Pull ropes for empty and/or spare conduits shall be woven polyester, 1/2 inch wide, with a minimum tensile strength of 1250 lbs.
2. Pull ropes for the Contractors use in installing conductors shall be the size and strength required for the pull, and shall be made of a non-metallic material.

PART 3 – EXECUTION

3.01 GENERAL

- A. Minimum trade size for all rigid conduits shall be 3/4 inch in exposed applications and 1 inch in embedded applications. Conduits installed within ductbanks shall be allowed to be increased in size to trade size 2 inch, at the Contractor's option, to accommodate the saddle size of the ductbank spacers. However, no combining of circuits shall be allowed in the larger conduits.
- B. Minimum trade size for flexible conduits (where specifically allowed herein) shall be 1/2 inch in all applications.
- C. Conduit routing and/or homeruns within structures is not shown on the Drawings. Conduits shall be installed concealed wherever practical and within the limitations specified herein. All other conduits not capable of being installed concealed shall be installed exposed.
- D. Empty and/or spare conduits shall be provided with pull ropes which have no less than 12 inches of slack at each end.
- E. Nonmetallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, cleaned of debris, and primer shall be applied to ready each joint for fusing. Conduits shall then be fused together with the conduit manufacturer's approved cement compound.
- F. Metallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, be cleaned of all debris and be de-burred, then threaded. Conduit threading performed in the field shall be 3/4 inch per foot tapered threads in accordance with ANSI B1.20.1.
- G. Conduits shall be protected from moisture, corrosion, and physical damage during construction. Install dust-tight and water-tight conduit fittings on the ends of all conduits immediately after installation and do not remove until conductors are installed.
- H. Conduits shall be installed to provide no less than 12 inches clearance from pipes that have the potential to impart heat upon the conduit. Such pipes include, but are not limited to, hot water pipes, steam pipes, exhaust pipes, and blower air pipes. Clearance shall be maintained whether conduit is installed in parallel or in crossing of pipes.

- I. Where non-metallic instrumentation conduits are installed exposed, the following clearances to other conduit types shall be maintained:
 - 1. Instrumentation conduits installed parallel to conduits with conductors energized at 480V or above shall be 18 inches.
 - 2. Instrumentation conduits installed parallel to conduits with conductors energized at 240V and below shall be 12 inches.
 - 3. Instrumentation conduits installed at right angles to conductors energized at 480V and below shall be 6 inches.
 - 4. Instrumentation conduits installed at right angles to conductors energized at voltages above 480V shall be 12 inches.
- J. Where conduit fittings do not include an integral insulated bushing, an insulated bushing shall be installed at all conduit termination points.
- K. Conduits which serve multi-section equipment shall be terminated in the section where wiring terminations will be made.
- L. Conduits shall not penetrate the floors or walls inside liquid containment areas without specific written authorization from the Engineer. Liquid containment areas are indicated on the Drawings.
- M. In no case shall conduit be supported or fastened to another pipe or be installed in a manner that would prevent the removal of other pipes for repairs. Spring steel fasteners may only be used to affix conduits containing lighting branch circuits within EMT conduits to structural steel members.
- N. All field fabricated threads for rigid galvanized steel conduit shall be thoroughly coated with two coats of galvanizing compound, allowing at least two minutes to elapse between coats for proper drying.
- O. The appropriate specialized tools shall be used for the installation of PVC coated conduit and conduit fittings. No damage to the PVC coating shall occur during installation. Conduit and conduit fittings with damaged PVC coating shall be replaced at the Contractor's cost. The use of PVC coating touch-up compounds is not permitted.
- P. Conduits which emerge from within or below concrete encasement shall be PVC coated rigid galvanized steel in accordance with Standard Detail 1611102 where the conduit is not protected by an equipment enclosure that surrounds the conduit on all sides at the point where it emerges from the encasement.
- Q. Aluminum conduits shall not be installed in direct contact with concrete surfaces. Where aluminum conduits are routed along concrete surfaces, they shall be installed with one-hole electro-galvanized malleable iron alloy straps with matching clamp-backs to space the conduit $\frac{1}{4}$ inch away from concrete surface. Where aluminum conduit passes through concrete, CMU or brick walls, the penetration shall be made such that the aluminum conduit does not come in contact with concrete, CMU, brick or mortar.

3.02 CONCEALED AND EMBEDDED CONDUITS

- A. Conduits are permitted to be installed concealed and/or embedded with the following requirements:
1. Conduits shall not be installed horizontally when concealed within CMU walls, only vertical installation is acceptable.
 2. Conduits installed embedded within concrete floors or walls shall be located so as not to affect the designed structural strength of the floor or wall. Embedded conduits shall be installed in accordance with Standard Detail 0331604 and ACI-318.
 3. Where conduit bends emerge from concrete embedment, none of the curved portion of the bend shall be visible. Only the straight portion of the bend shall be visible.
 4. Where multiple conduits emerge from concrete embedment or from concealment below a concrete floor, ample clear space shall be provided between conduits to allow for the appropriate and required conduit termination fittings to be installed.
 5. Conduits installed embedded within concrete encasement of any kind shall be installed such that conduit couplings for parallel conduits are staggered so that they are not side by side.
- B. Conduits are NOT permitted to be installed concealed and/or embedded for the following situations:
1. Conduits shall not be installed embedded within any water-bearing floors or walls. Conduits shall not be installed embedded within any liquid containment area floors or walls.
 2. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to Class I and II hazardous areas (Division I and Division II).
 3. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to indoor Type 1 or Type 2 chemical storage/transfer areas.

3.03 CONDUIT USES AND APPLICATIONS

- A. Rigid Conduit
1. Rigid conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

RIGID CONDUIT FOR NON-HAZARDOUS AREAS		
<u>INSTALLATION AREA DESIGNATION/ SCENARIO</u>	<u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u>	
	Power and Control	Instrumentation
Exposed in outdoor areas	Rigid aluminum conduit	Same as Power and Control
Concealed within underground direct-bury or concrete-encased ductbanks	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid aluminum conduit
Concealed within non-elevated (i.e. "slab-on-grade" construction) concrete slabs	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid aluminum conduit
Concealed below concrete slabs (within earth or fill material)	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid aluminum conduit
Concealed within concrete walls	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid aluminum conduit
Concealed within CMU walls	Schedule 40 rigid non-metallic PVC conduit or Electrical Metallic Tubing	Rigid galvanized steel conduit or Electrical Metallic Tubing
Emerging from concealment within or below a concrete floor and transitioning to exposed conduit (Reference Detail 1611102)	PVC coated rigid aluminum conduit	Same as Power and Control

2. Rigid conduit for hazardous areas shall be furnished and installed in the materials of construction as follows:

RIGID CONDUIT FOR HAZARDOUS AREAS		
<u>INSTALLATION AREA HAZARD/SCENARIO</u>	<u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u>	
	Power and Control	Instrumentation
Exposed in Class I and II areas (Division I and Division II)	Rigid aluminum conduit	Same as Power and Control
Concealed within concrete slabs in Class I and II areas (Division I and Division II)	PVC coated rigid aluminum conduit	Same as Power and Control
Concealed below concrete slabs (within earth or fill material) in Class I and II areas (Division I and Division II)	PVC coated rigid aluminum conduit	Same as Power and Control
Concealed within concrete walls in Class I and II areas (Division I and Division II)	PVC coated rigid aluminum conduit	Same as Power and Control
Concealed below concrete slabs encased in at least two inches of concrete and buried 24 inches below top of slab in Class I Division I areas	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid aluminum conduit

3. The tables for the materials of construction for rigid conduits are intended to exhaustively cover all possible scenarios and installation areas under this Contract. However, if a scenario or installation area is found that is not explicitly governed by these tables, it shall be assumed for bid purposes that the conduit material of construction is to be rigid aluminum. This discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution.

B. Conduit Bends

1. All conduit bends shall be the same material of construction as the rigid conduit listed in the tables above, with the following exceptions:
 - a. All 90 degree bends or combinations of adjacent bends that form a 90 degree bend where concealed within concrete or below a concrete slab shall be PVC coated aluminum.
2. Field fabricated bends of metallic conduit shall be made with a bending machine and shall have no kinks. Field fabricated standard radius and long radius bends shall have minimum bending radii in accordance with the associated tables in Part 2 herein.
3. Field bending of non-metallic conduits is not acceptable, factory fabricated bends shall be used.
4. Long radius bends shall be furnished and installed for the following specific applications, all other bends shall be standard radius:
 - a. Where specifically indicated on the Drawings.

C. Flexible Conduit

1. Flexible conduit shall only be installed for the limited applications specified herein. Flexible conduit shall not be installed in any other application without written authorization from the Engineer. Acceptable applications are as follows:
 - a. Connections to motors and engine-generator sets (and similar vibrating equipment)
 - b. Connections to solenoid valves and limit switches
 - c. Connections to lighting fixtures installed in suspended ceilings
 - d. Connections to lighting transformers
 - e. Connections to pre-fabricated equipment skids
 - f. Connections to HVAC equipment
 - g. Connections to instrument transmitters and elements
 - h. Where specifically indicated in the Standard Details

2. Flexible conduit length shall be limited to three (3) feet, maximum. Flexible conduit shall not be installed buried or embedded within any material.

Flexible conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

FLEXIBLE CONDUIT FOR NON-HAZARDOUS AREAS		
<u>INSTALLATION AREA DESIGNATION/SCENARIO</u>	<u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u>	
	Power and Control	Instrumentation
Exposed in outdoor areas	Liquid-tight flexible metal conduit	Same as Power and Control

3. For Class I Division I hazardous areas, the NEC does not permit the installation of flexible conduit. In lieu of flexible conduit in these areas, flexible conduit couplings shall be installed as specified in Part 2 herein. Flexible conduit for all other hazardous areas shall be furnished and installed in the materials of construction as follows:

FLEXIBLE CONDUIT FOR HAZARDOUS AREAS		
<u>INSTALLATION AREA HAZARD/SCENARIO</u>	<u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u>	
	Power and Control	Instrumentation
Exposed in Class I Division II areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in Class II (Division I and Division II) areas	Liquid-tight flexible metal conduit	Same as Power and Control
Concealed above suspended ceilings in Class I and II (Division I and Division II) areas	Same material as exposed conduit in same area	Same as Power and Control

3.04 CONDUIT FITTING USES AND APPLICATIONS

A. General

1. Conduit fittings shall be furnished and installed in the materials of construction as indicated in Part 2, herein. Conduit fitting materials of construction are dependent on the material of construction used for the associated conduit.
2. Conduit fittings shall be provided in the trade size and configuration required to suit the application.

B. Conduit Bodies

1. Conduit bodies shall be installed where wire pulling points are desired or required, or where changes in conduit direction or breaking around beams is required.

2. Where conduit bodies larger than trade size 2 inches are intended to be used as a pull-through fitting during wire installation, oversized or elongated conduit bodies shall be used. Oversized or elongated conduit bodies shall not be required if the conduit body is intended to be used as a pull-out point during wire installation.

C. Conduit Nipples and Unions

1. Conduits with running threads shall not be used in place of 3-piece couplings (unions) or close nipples. After installation of a conduit fitting of any kind, there shall be no more than ¼ inch of exposed threads visible. Factory fabricated all-thread nipples may be used between adjacent enclosures, however, the same restriction applies regarding the length of exposed threads that are visible.

D. Conduit Expansion and Deflection Fittings

1. Conduit expansion fittings shall be installed where required by the NEC and where indicated on the Drawings. Expansion fittings shall also be installed for exposed straight metallic conduit runs of more than 75 feet, in both indoor and outdoor locations. Expansion fittings for runs of non-metallic conduit shall be installed in accordance with the NEC.
2. Conduit deflection fittings shall be installed where required by the NEC and where conduits are installed (exposed and concealed) across structural expansion joints.

E. Conduit Seals

1. Conduit seals shall be installed for conduits installed within or associated with hazardous areas and other areas as required by the NEC.

F. Conduit Termination Fittings

1. Where conduits terminate at enclosures with a NEMA 4, 4X, or 3R rating and the enclosure does not have integral conduit hubs, an appropriately sized watertight conduit hub shall be installed to maintain the integrity of the enclosure. The use of locknuts with integral gasket in lieu of watertight conduit hubs is not acceptable.
2. Where conduits terminate at enclosures that do not require conduit hubs, a two-locknut system shall be used to secure the conduit to the enclosure. One locknut shall be installed on the outside of the enclosure, and the other inside, drawn tight against the enclosure wall. The locknut on the interior of the enclosure shall be the type with integral bonding lug, or a conduit bonding bushing may be used in place of the locknut.
3. Conduits shall not be installed such that conduit fittings penetrate the top of any enclosure located outdoors, except in cases where specifically required by the serving electric utility. Conduits which serve outdoor equipment or an enclosure from above shall instead be routed into the side of the enclosure at the bottom. The conduit termination fitting shall be provided with a conduit drain to divert moisture from the raceway away from the enclosure.

3.05 MISCELLANEOUS

A. Conduit Periphery Sealing

1. All conduit penetrations through exterior walls shall be sealed around the periphery using the appropriate products specified in Part 2 herein to prevent air and/or water entry into the structure.
2. All conduit penetrations through interior walls and floors shall be sealed through the use of with conduit sleeves and caulk as specified in Part 2 herein. Alternatively, mortar may be used to seal around the conduit periphery.
3. Conduit penetrations through fire-rated walls as floors shall be made with the appropriate fire rated penetration product.

B. Conduit Interior Sealing

1. All conduits (including spares) entering a structure below grade shall be sealed on the interior of the conduit against water ingress. Sealing shall be at an accessible location in the conduit system located within the building structure and shall be via one of the methods specified in Part 2 herein. If conduit sealing cannot be achieved at an accessible location within the building structure, sealing shall be placed in the conduits in the nearest manhole or handhole outside the structure.

3.06 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, 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: 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: Pump Station Control Panel). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.
 3. For conduits trade sizes 3/4 inch through 1-1/2 inch, the text shall be a minimum 18 point font. For conduits trade size 2 inch and larger, the text shall be a minimum 24 point font.

4. Label height shall be 3/4 inch 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. 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.
- C. Conduits for lighting and receptacle circuits shall not require identification.
- D. Any problems or conflicts with meeting the requirements above shall immediately be brought to the attention of the Engineer for a decision.

3.07 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
1. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swab followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling rope.

3.08 TRAINING OF INSTALLATION PERSONNEL

- A. 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. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract to be considered valid. 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.

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SECTION 16118
UNDERGROUND ELECTRICAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install underground duct systems and electric handholes as specified herein and as indicated on the Drawings. The work shall be complete and shall include excavation, concrete construction, backfilling, and all materials, items, and components required for a complete system.
- B. The provisions of this Division are applicable to all underground conduit work. All work shall be coordinated with that of the various utility companies and other Contractors. The Contractor shall adhere to all utility company requirements including the serving electric utility.
- C. Reference Section 16000, Basic Electrical Requirements; Section 16111, Conduit; Section 16170, Grounding and Bonding; the applicable sections of Division 2, Sitework; Section 03200, Reinforcing Steel; and 03300, Cast-In-Place Concrete.

1.02 CODES AND STANDARDS

- A. Products specified herein shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. AASHTO H20
 - 2. ANSI/SCTE 77-2010 – Specification for Underground Enclosure Integrity

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit Shop Drawings. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to, the following:

1. Product data sheets.
2. Outline and dimensional drawings including detailed sections of the handholes.

1.05 IDENTIFICATION

- A. Each electric handhole cover shall be lettered with the word "Electric", the handhole identification number (e.g. EHH-1, etc.), manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

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. The underground duct system shall be comprised of conduits, conduit bends, and conduit fittings as specified in Section 16111, Conduit. Conduits shall be encased in reinforced concrete envelopes, unless otherwise specified herein or indicated on the Drawings.
- B. 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.

2.03 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 and cover design and test load rating shall be Tier 15. Covers shall be provided with cover hooks.
- 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. The electric handholes shall be manufactured by Hubbell, Pencil Plastics equivalent, Highline Products equivalent, or equal.

PART 3 -- EXECUTION

3.01 GENERAL

- A. The underground duct system 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 03300. Reinforcing steel shall be furnished and installed in accordance with Section 03200. Concrete electrical duct banks shall contain red dye; the red dye shall be mixed into the concrete mix before being poured. Red dye applied to the top of concrete encasement after placement of concrete is not acceptable.
- B. Concrete pours shall be complete from handhole to handhole 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 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 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. Where connections to existing underground conduits are indicated, excavate to the maximum depth necessary. After addressing the existing conductors, cut the conduits and remove loose concrete from the conduits before installing new concrete encased ducts. Provide a reinforced concrete collar, poured monolithically with the new duct line, to take the shear at the joint of the duct lines.
- K. 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.
- L. 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.
- M. 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.
- N. All conduit joints in the duct system shall be staggered such that adjacent conduits do not have joints in the same location.

3.03 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.

3.04 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

- 1. Field tests

- a. Field tests for all completed duct systems shall consist of pulling a swab through each conduit followed by a mandrel equal in size to 85% of the conduit inside diameter.
- b. After testing, all conduits shall be capped after installation of a suitable pull rope. All field tests shall be witnessed by the Engineer.

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SECTION 16123

LOW VOLTAGE WIRE AND CABLE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition, all low voltage wire and cable indicated on the Drawings and as specified herein and/or required for proper operation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of wire and cable systems shall be furnished and installed by the Contractor.
- B. The scope of this Section does not include internal wiring factory installed by electrical equipment manufacturers.
- C. Reference Section 16000 – Basic Electrical Requirements and Section 16130 – Boxes.

1.02 CODES AND STANDARDS

- A. Low voltage wire, cable, and appurtenances shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. Underwriters Laboratories (UL)
 - a. UL 13 – Standard for Power-Limited Circuit Cables
 - b. UL 44 – Thermoset-Insulated Wires and Cables
 - c. UL 83 – Thermoplastic-Insulated Wires and Cables
 - d. UL 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
 - e. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords
 - f. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
 - g. UL 2250 – Standard for Instrumentation Tray Cable
 - h. UL 2556 – Wire and Cable Test Methods
 - 2. American Society for Testing and Materials (ASTM)
 - a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire
 - b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - c. ASTM B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

- d. ASTM D69 – Standard Test Methods for Friction Tapes
 - e. ASTM D4388 – Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes
- 3. Insulated Cable Engineers Association (ICEA)
 - a. ICEA S-58-679 – Standard for Control, Instrumentation and Thermocouple Extension Conductor Identification
 - b. ICEA T-29-250 – Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210,000 B.T.U./Hour
- 4. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE 1202 – Standard for Flame Testing of Cables

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the wire and cable manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Reports of Field Tests
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets for wire and cable, terminations, and pulling lubricant.
 - 2. Cable pulling calculations (if required).
 - 3. Wiring identification methods and materials.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.06 CABLE PULLING CALCULATIONS

- A. Prior to the installation of the wire and cable specified herein, the Contractor shall submit cable pulling calculations for engineer review and approval when all of the following are true:
 - 1. The amount of cable to be installed will be greater than 200 linear feet between pull points.
 - 2. The installation will have one or more bends.
 - 3. The wire and cable is size #1/0 AWG and larger.
- B. Cable pulling calculations shall be performed by a currently registered professional engineer in the State of South Carolina and shall define pulling tension and sidewall loading (sidewall bearing pressure values).

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.

2.02 POWER AND CONTROL WIRE AND CABLE

- A. Power wire and control wire shall consist of insulated copper conductors with a nylon (or equivalent) outer jacket. Conductor insulation shall be rated 90°C for dry locations, 75°C for wet locations, and 600V. Insulated conductors shall be UL 83 Listed as NEC Type THHN/THWN.
- B. Unless specified otherwise herein, conductors shall be stranded copper per ASTM B-8 and B-3, with Class B or C stranding contingent upon the size. Power conductors for lighting and receptacle branch circuits shall be solid copper per ASTM B-3.
- C. Power conductor size shall be no smaller than No. 12 AWG and Control conductor size shall be no smaller than No. 14 AWG.
- D. Multi-conductor cable assemblies shall include a grounding conductor and an overall PVC jacket. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Multi-conductor cable assemblies shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- E. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, Encore Wire, or equal.

2.03 INSTRUMENTATION CABLE

- A. For single-analog signal applications, instrumentation cable shall consist of a single, twisted pair or triad of individually insulated and jacketed copper conductors with an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- B. For multiple-analog signal applications, instrumentation cable shall consist of multiple, twisted pairs or triads (i.e. groups) of individually insulated and jacketed copper conductors with individual pair/triad shields (i.e. group shields) and an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- C. Cable and group shields shall consist of overlapped aluminum/polyester tape/foil providing 100% coverage. Instrumentation cables shall include an overall copper shield drain wire. Cables containing multiple twisted pairs or triads shall also include group shield drain wires.
- D. Conductors, including drain wires, shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM B-8, with Class B stranding unless otherwise specified.
- E. Instrumentation signal conductor size shall be no smaller than No. 16 AWG.
- F. Instrumentation cable shall be Okoseal-N Type P-OS (for single pair or triad applications) or Okoseal-N Type SP-OS (for multiple pair or triad applications) as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or equal.

2.04 CONDUCTOR IDENTIFICATION

- 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
 - a. Phase A - BROWN
 - b. Phase B - ORANGE
 - c. Phase C - YELLOW
 - d. Neutral – GREY
 - 2. 120/208V or 120/240V AC Power
 - a. Phase A - BLACK
 - b. Phase B - RED
 - c. Phase C - BLUE
 - d. Neutral - WHITE

3. DC Power
 - a. Positive Lead - RED
 - b. Negative Lead - BLACK
 4. DC Control
 - a. All wiring - BLUE
 5. 120VAC Control
 - a. 120 VAC control wire shall be RED except for a wire entering a motor control center compartment, motor controller, or control panel which is an interlock. This interlock conductor shall be color coded YELLOW. For the purposes of this Section, an interlock is defined as any wiring that brings voltage into the above mentioned equipment from a source outside that equipment.
 6. 24VAC Control
 - a. All wiring - ORANGE
 7. Equipment Grounding Conductor
 - a. 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 part of multi-conductor 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 CABLE PULLING LUBRICANTS
- A. Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Yellow #77 Plus by Ideal, Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

PART 3 -- EXECUTION

3.01 WIRE AND CABLE INSTALLATION

A. General

1. Wire and Cable shall be installed as specified herein and indicated on the Drawings. Unless specifically indicated otherwise on the Drawings, wire and cable shall be installed in separate raceways according to wiring type. For example, power wiring shall not be combined with control wiring, and control wiring shall not be combined with instrumentation wiring.
2. Wire shall be furnished and installed as single conductor cables, with limited exceptions. Multi-conductor cable assemblies shall only be installed where indicated on the Drawings, required by the NEC, or after obtaining written permission from the Engineer.
3. Where instrumentation cables are installed in control panels, motor controllers, 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.
4. Instrumentation cable shielding shall be continuous and shall be grounded at one point only.

B. Splices

1. Splices shall not be allowed in power or control wire and cable unless approved in writing by the Engineer. If unique field conditions exist or pulling calculations indicate that splices may be required, the Contractor shall submit a detailed request indicating why splices are required to the Engineer. The Engineer shall be under no obligation to grant such request.
2. Splicing materials shall be barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits.
3. No splicing of instrumentation cable is permitted.

C. 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%.

D. Additional Conductor Identification

1. 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.

2. Multi-conductor cables shall be provided with heat shrinkable identification tags in accordance with Part 2 herein.
3. 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.
4. 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.
5. 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.
6. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.
7. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.
8. 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.
9. 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.

E. Wiring Supplies

1. Rubber insulating tape shall be in accordance with ASTM D4388. Friction tape shall be in accordance with ASTM D69.

F. Training of Cable in Manholes, Handholes, and Vaults

1. The Contractor shall furnish all labor and material required to train cables around cable vaults, manholes, and handholes. 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 and bundled separate from AC 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 24VAC wiring

G. 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 box 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. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
4. 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.
5. 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.

H. Pulling Temperature

1. Cable shall not be installed when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling, the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the work day for which the cable is removed from the protected

storage. Any cable reels with wire remaining on them shall be returned to storage at the completion of the workday.

3.02 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. Wires and cables 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:
 - i. For #8 AWG and larger 600V wire and cable, apply 1,000 VDC from a Megohmmeter for one (1) minute. Resistance shall be no less than 100 Megohms. Insulation testing is not required for power and control cables smaller than #8 AWG.
 - ii. 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 Megohms or greater.
- B. Wires and cables shall be tested after required terminations are made, but before being connected to any equipment.
- 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. All conductors of a multi-phase circuit shall be replaced if one conductor fails the required testing. If part of a multi-set (parallel conductors per phase) circuit fails testing, only the set containing failure shall be replaced.
- 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.

(EXHIBIT A) TEST DATA - MEGOHMS TEST NO. ____							
Date:			Company:				
Time:			Location:				
Circuit:	Circuit Length:	Aerial:	Duct:	Buried:	No. of Conductors	Size:	AWG MCM Shield:
Insulation Material:			Insulation Thickness:		Voltage Rating:		Age:
Type: ____ Pothead ____ Terminal					Location: Indoors____ Outdoors____		
Number and Type of Joints:							
Recent Operating History:							
Manufacturer:							
State if Potheads or Terminals were grounded during test:							
List associated equipment included in test:							
Miscellaneous Information:							

(EXHIBIT A) TEST DATA - MEGOHMS TEST NO. ____							
Part Tested:				Test Performed: _____ Hours/Days: _____ After Shutdown: _____			
Grounding Time:				Dry Bulb Temperature: _____ Wet Bulb Temperature: _____			
Test Voltage:				Equipment Temperature: _____ How Obtained: _____ Relative Humidity: _____ Absolute Humidity: _____ Dew Point: _____			
Megohmmeter: Serial Number: _____ Range: _____ Voltage: _____ Calibration Date: _____							
Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground	Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground
1/4 Minute				5 Minutes			
1/2 Minute				6 Minutes			
3/4 Minute				7 Minutes			
1 Minute				8 Minutes			
2 Minutes				9 Minutes			
3 Minutes				10 Minutes			
4 Minutes				10/1 Minute Ratio			
Remarks:							

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SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The scope of work under this Section includes furnishing and installing all pull boxes, junction boxes, and outlet boxes.
- B. Requirements for other boxes and enclosures are not included in this Section. Reference each specific Division 16 equipment Section for requirements related to that equipment's respective enclosure.
- C. Reference Section 16000, Basic Electrical Requirements, and Section 16111, Conduit.

1.02 CODES AND STANDARDS

- A. Boxes shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. UL 514A - Metallic Outlet Boxes
 - 2. UL 514C - Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers
 - 3. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations
 - 4. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations
 - 5. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
 - 6. NEMA 250 – Enclosures for Electrical Equipment

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer(s) and submit the following:
- B. Shop Drawings
- C. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets for boxes, terminal strips, and all accessories
 - 2. Overall bill of material for all boxes included under this Contract to summarize exactly what is being submitted for review. Bill of material shall at a minimum show each box type (i.e. pull, junction, or outlet), quantity, material of construction, dimensions, and proposed installation location.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.
- B. As-built drawings showing dimensions, internal box layout, terminal strip information, and terminal strip identification information shall be provided for all junction boxes. As-built drawings are not required for pull boxes or outlet boxes.

1.06 IDENTIFICATION

- A. Each pull and junction box shall be identified with the box name as indicated on the Contract Drawings 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 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 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. Tack welded boxes are not acceptable.

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. Other screw types are not acceptable. 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 (20) 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. Isolation 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 a matching gasketed cover held in place by machine screws. Other screw types are not acceptable.
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 junction boxes to isolate conductors and terminal blocks of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation 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 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 (20) percent of the total amount of 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. Terminals shall be lettered and/or numbered to conform to the wiring labeling scheme in place on the project.
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. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
All Outdoor Areas	NEMA 4X, Type 316 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.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Type 316 Stainless Steel
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 4X, Type 316 Stainless Steel

3. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.

2.03 OUTLET BOXES

A. General

1. Outlet boxes shall be provided with a trim appropriate for the wiring device installed inside. Reference Section 16141, 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. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
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.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
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 a 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 CMU 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 are not acceptable for this application. 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.

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 of 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. Reference Section 16111, 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 requirements in Part 2 herein, and the area designations indicated on the Drawings.

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.
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, 48 inches
 - b. 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, and the area designations indicated on the Drawings.

- END OF SECTION -

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SECTION 16141

WIRING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all switches, occupancy sensors, and receptacles of the type and at the locations as shown on the Drawings.
- B. All switches and receptacles shall be furnished and installed in outlet boxes. Reference Section 16130, Boxes, for outlet box requirements.
- C. Reference Section 16000, Basic Electrical Requirements, and Section 16123, Low Voltage Wire and Cable.

1.02 CODES AND STANDARDS

- A. Wiring devices shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. UL 20 – General Use Snap Switches
 - 2. UL 498 – Standard for Attachment Plugs and Receptacles
 - 3. UL 943 – Ground Fault Circuit Interrupters
 - 4. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include, but not be limited to:

1. Product data sheets.

1.05 SPARE PARTS

- A. The Contractor shall furnish 10% (minimum of 1) spare of each receptacle, switch, and plug furnished and installed for this project.
- B. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.06 IDENTIFICATION

- A. Each switch and receptacle shall be identified with the equipment item number, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

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 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.

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 INSTALLATION

- A. Where more than one (1) switch occurs at one (1) location, gang plates shall be used.
- B. All device plates shall be set true and plumb, and shall fit tightly against the finished wall surfaces and outlet boxes.
- C. Wiring device box (outlet box) mounting heights shall be as specified in Section 16130, Boxes.
- D. When indicated height would place any of the equipment at an unsuitable location such as at a molding or break in wall finish, the Contractor shall bring it to the attention of the Engineer for a decision.
- E. Ground fault circuit interrupter receptacles shall be furnished and installed in locations where indicated on the Drawings, and as required by the NEC.
- F. 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. Labels shall have a white background and black lettering in 14 point font.

3.02 CIRCUITING

- A. Convenience receptacles shall be grouped on circuits separate from the lighting circuits. A maximum of eight (8) convenience receptacles are permitted per 20A, 120V circuit, unless otherwise indicated on the Drawings.

- END OF SECTION -

SECTION 16170
GROUNDING AND BONDING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install grounding systems complete in accordance with the minimum requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered a minimum requirement for compliance with this Specification.
- B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100. Conflicts shall be promptly brought to the attention of the Engineer.
- C. In addition to the NEC requirements, building structural steel columns and metallic fences shall be permanently and effectively grounded:
- D. Reference Section 16000, Basic Electrical Requirements

1.02 CODES AND STANDARDS

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. UL 467 – Grounding and Bonding Equipment
 - 2. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - 3. IEEE 1100 – Recommended Practice for Power and Grounding Electronic Equipment

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Reports of certified field tests.
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by these specifications shall 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 GROUND RODS AND GRID

- A. Ground rods shall be rolled to a commercially round shape from a welded copper-clad steel manufactured by the molten-welding process or by the electro-formed process (molecularly bonded). They shall have an ultimate tensile strength of 75,000 pounds per square inch (psi) and an elastic limit of 49,000 psi. The rods shall be not less than 3/4 inch in diameter by 10 feet in length; and the proportion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of 0.010 inch at any point on the rod. Ground rods shall be UL 467 listed. The ground rods shall be manufactured by Erico Products, Blackburn, or equal.
- B. Except where specifically indicated otherwise, all exposed non current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductors in nonmetallic raceways and neutral conductors of wiring systems shall be grounded.
- C. The ground connection shall be made at the main service equipment and shall be extended to the ground grid surrounding the structure. The ground grid shall also be connected to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flanged connection.
- D. Where ground fault protection is employed, care shall be taken so that the connection of the ground and neutral does not interfere with the correct operation of the ground fault protection system.

2.03 FITTINGS

- A. Grounding connections to equipment shall be bolted. Cable end connections shall be made by hydraulic crimp or exothermically welded. Split bolt type connectors are not acceptable. Fittings shall be UL 467 listed.

2.04 EQUIPMENT GROUNDING CONDUCTORS

- A. An insulated equipment grounding conductor, which shall be separate from the electrical system neutral conductor, shall be furnished and installed for all circuits. Insulation shall be of the same type as the ungrounded conductors in the raceway and shall be green in color. Equipment grounding conductors shall be furnished and installed in all conduits. Use of conduits as the NEC required equipment grounding conductor is not acceptable.

2.05 EQUIPMENT GROUNDS

- A. Equipment grounds shall be solid and continuous from a connection at earth to all distribution panelboards. Ground connections at panelboards, outlets, equipment, and apparatus shall be made in an approved and permanent manner.
- B. For all control panels, disconnect switches, and other electrical enclosures, equipment grounds and bonding jumpers shall be terminated individually on a ground bar or mechanical lugs. No wire nuts will be permitted.

2.06 EXOTHERMIC WELDS

- A. All exothermic welding shall be completed per welding kit manufacturer's instructions. Exothermic welds shall be CadWeld by Erico or ThermoWeld.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt. Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.
- B. 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. Ground rods shall be driven straight down into the earth, or if objects are encountered, at an angle to avoid the obstruction.

2. 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. Grounding conductors shall be continuous between points of connection; splices shall not be permitted.
4. Where conductors are exposed and subject to damage from personnel, traffic, etc., conductors shall be installed in metal raceway. The raceway shall be bonded to the grounding system.
5. Where subsurface conditions do not permit use of driven ground rods to obtain proper ground resistance, rods shall be installed in a trench or plate electrodes shall be provided, as applicable and necessary to obtain proper values of resistance.
6. Buried exothermic welds and ground ring shall not be backfilled until inspected by Engineer.

C. Raceways

1. Conduit which enters equipment such as switchgear, motor control centers, transformers, panelboards, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus or ground lug, where provided, and as otherwise required by the NEC.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
1. Witnessed Shop Tests
 - a. None required.
 2. Field Tests
 - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

- b. Fall of potential tests shall be performed on the ground grid per IEEE81 recommendations by a third party, independent testing firm. A fall of potential plot shall be submitted at the conclusion of testing for Engineer review. Documentation indicating the location of the rod and grounding system as well as the resistance and soil conditions at the time the measurements were made shall be submitted. Testing shall show that the ground grid has 5 ohms resistance or less. Due to soil conditions and/or unforeseen field conditions, ground resistances greater than 5 ohms may be acceptable if specifically approved in writing by the Engineer. Ground resistance measurements shall be made in normally dry weather not less than 48 hours after rainfall and with the ground grid under test isolated from other grounds.
- c. Continuity tests for the grounding electrode conductor shall be performed. Test will be accepted when a resistance of less than 1 ohm is shown for this conductor.

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SECTION 16190
SUPPORTING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install structural supports for mounting and installing all conduit, electrical equipment, lighting, alarm systems, instrumentation, and communications equipment furnished under this Contract.
- B. Equipment shall be installed strictly in accordance with recommendations of the manufacturer and best practices of the trade resulting in a complete, operable, and safe installation. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation.
- C. Reference Section 16000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
 - 3. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 4. ASTM A276 – Standard Specification for Steel Bars and Shapes
 - 5. ASTM B783 – Standard Specification for Materials for Ferrous Powder Metallurgy Structural Parts

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop drawings
 - 2. Structural support calculations (if required)

- B. Each submittal shall be identified by the applicable Specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
1. Product data sheets.
 2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

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 MATERIALS

- A. Support channel shall be 1-5/8" by 1-5/8" minimum, with 12 gage material thickness.
- B. Support channel, support channel fittings, and threaded rod shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	MATERIAL OF CONSTRUCTION
All Outdoor Areas	Type 316 Stainless Steel
All Hazardous Areas	Type 316 Stainless Steel

- C. Fastening hardware (bolts, nuts, washers, and screws) shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	MATERIAL OF CONSTRUCTION
All Outdoor Areas	Type 316 Stainless Steel
All Hazardous Areas	Type 316 Stainless Steel

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Concrete or Masonry Inserts

1. The Contractor shall be responsible for the furnishing and installation of all anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.
2. If a time delay for the arrival of any special inserts or equipment drawings, etc. occurs, the Contractor may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and, upon subsequent installation, the Contractor shall be responsible for filling in such recesses and openings. Any additional costs that may be incurred by this procedure shall be borne by the Contractor.
3. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar floor mounted equipment. The leveling channels shall be provided for embedment in the equipment housekeeping pads. Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain concrete coverage of the reinforcement bars while not causing associated equipment to exceed the maximum mounting height requirements of the NEC.

B. Support Fastening and Locations

1. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel.
2. All holes made in reflected ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling grid bars where possible, to facilitate removal of ceiling panels.
3. Support channel shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.
4. All equipment, devices, and raceways that are installed on the dry side of a water bearing wall shall not be installed directly onto the wall. Support channel shall be used to allow ventilation air to pass behind the equipment, devices, or raceway.
5. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework.
6. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.

7. Actual designs for supporting framework should take the nature of a picture frame of support channels and bracket with a plate for mounting the components. The Contractor is responsible for the design of supporting structure; he shall submit design details to the Engineer for acceptance before proceeding with the fabrication.
8. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.
9. For all installations where fiberglass supporting materials are required, the Contractor shall submit structural calculations and the details of the proposed system of support. Structural calculations shall be signed and sealed by a registered professional engineer in the State of South Carolina.
10. For the following installations where conduits are provided with a support system suspended from the above or attached to a vertical structure, the Contractor shall submit structural calculations and details of the proposed system of support. Structural calculations shall be signed and sealed by a registered professional engineer in the State of South Carolina.
 - a. A quantity of twelve (12) or more conduits trade size 1" and smaller are proposed for a conduit support rack.
 - b. A quantity of eight (8) or more conduits trade sizes 1 1/2" to 2 1/2" are proposed for a conduit support rack.
 - c. A quantity of four (4) or more conduits trade sizes 3" and larger are proposed for a conduit support rack.
11. Single conduits installed exposed along walls and ceilings shall be secured to the wall or ceiling with a one-hole conduit clamp and clamp-back. Where multiple conduits are installed exposed together, support channel and conduit clamps shall be used.

- END OF SECTION -

SECTION 16195

ELECTRICAL - IDENTIFICATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All switchgear, switchboards, motor control centers, variable frequency drives, lighting and distribution panelboards, combination starters, control panels, pull and junction boxes, enclosures, disconnect switches, control stations, and similar equipment shall be identified in the manner described, or in an equally approved manner.
- B. The types of electrical identification specified in this section include, but are not limited to, the following:
 - 1. Operational instructions and warnings.
 - 2. Danger signs.
 - 3. Equipment/system identification signs.
 - 4. Nameplates.

1.02 LETTERING AND GRAPHICS

- A. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

- A. The material covered by these Specifications 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 NAMEPLATES

- A. Nameplates shall be engraved, high pressure plastic laminate, black with white lettering.
- B. 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.

2.03 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.

2.04 CONDUIT IDENTIFICATION

- A. Conduit identification shall be as specified in Section 16111, Conduit.

2.05 WIRE AND CABLE IDENTIFICATION

- A. Field installed wire and cable identification shall be as specified in Section 16123, Low Voltage Wire and Cable.
- B. A plastic laminate nameplate shall be provided at each panelboard, motor control center, switchgear assembly, and switchboard assembly. This nameplate shall be used to clearly convey the conductor identification means used at that piece of equipment (i.e. Phase A=Brown, Phase B=Orange, C = Yellow).
- C. Wiring identification for factory installed wiring in equipment enclosures shall be as specified in the respective section.

2.06 BOX IDENTIFICATION

- A. Pull, junction and device box identification shall be as specified in Section 16130 – Boxes.

PART 3 -- EXECUTION

3.01 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.

3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

3.03 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 (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.

- END OF SECTION -

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SECTION 16280

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, and place in satisfactory operation, the surge protective devices (SPD) as specified herein and indicated on the Drawings.
- B. The surge protective devices specified under this Section shall be provided as a stand-alone unit, separate from the enclosure of the equipment to which they are connected. The requirements of this Section shall not apply to equipment where an integral SPD is specified.
- C. Reference Section 16123 – Low Voltage Wire and Cable.

1.02 CODES AND STANDARDS

- A. The surge protective device shall be designed, manufactured, and listed to the following standards:
 - 1. Underwriters Laboratories, Inc. (UL)
 - a. UL1449, latest edition: Surge Protective Devices
 - b. UL1283, latest edition: Electromagnetic Interference Filters
 - 2. American National Standards Institute (ANSI)/Institute of Electrical & Electronic Engineers (IEEE)
 - a. C62.41.1: 2002 Guide for Surge Voltages in Low-Voltage AC Power Circuits
 - b. C62.41.2: 2002 Recommend Practice on Characterization of Surges in Low Voltage (100V and Less) AC Power Circuits.
 - c. C62.45: 2002 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits
 - d. C62.62: 2000 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits
 - 3. National Electric Code (NEC), Latest Edition

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Operation and Maintenance Manuals
 - 3. Spare Parts List

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for re-submittal.
- C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.
- D. Shop drawings for each SPD shall include but not be limited to:
 - 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. Product Data Sheets.
 - 3. Detailed drawings showing weights and dimensions.
 - 4. Wiring diagrams showing field connections.

5. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL1449, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.
6. Proof of Short Circuit Current Ratings (SCCR), Voltage Protection Ratings (VPRs) for all modes, Maximum Continuous Operating Voltage rating (MCOV), Nominal Discharge Current (In), and device listing Type shall be submitted using the same means as described in the paragraph above.
7. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL 1283, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.
8. Warranty Information

- E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.
- B. The Contractor shall furnish one (1) spare field replacement module of each rating provided under this Contract.
- C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.

- E. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

1.07 IDENTIFICATION

- A. Each SPD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each SPD. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.08 CONSTRUCTION SEQUENCING

- A. The Contractor shall reference Section 01520, Maintenance of Utility Operations During Construction, of these Specifications.

1.09 WARRANTY

- A. All SPDs, associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years after acceptance of the equipment by the Owner.
- B. Any component or subassembly contained within the surge protection system that shows evidence of failure or incorrect operation during the five (5) year warranty period, shall be replaced by the manufacturer at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The SPD units shall be UL 1449 Listed and must bear the UL mark. Units that are "manufactured in accordance with" UL 1449 or tested by other testing agencies "in accordance with" UL 1449 are not acceptable and will be rejected.
- B. Type II SPD units shall be UL 1283 Listed and must bear the UL mark. Units that are "manufactured in accordance with" UL 1283 or tested by other testing agencies "in accordance with" UL 1283 are not acceptable and will be rejected. Further, SPD units using UL 1283 capacitors but not tested to UL 1283 will be rejected.
- C. SPDs shall be provided as a stand-alone unit, separate from the equipment to which they are connected.
- D. All SPDs furnished and installed under this Contract shall be from the same manufacturer.

2.02 PRODUCTS

- A. Type I surge protective devices (SPD) shall be furnished and installed when shown without upstream overcurrent protection on the Drawings. Type II SPDs shall be provided in all other locations. Type II SPDs shall not require the use of a specific upstream overcurrent device. SPDs shall be provided in the location and quantity as shown on the Drawings.
- B. Each SPD shall be rated for the voltage and configuration of the equipment to which it is connected.
- C. Each Type II SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of - 50dB at 100kHz.
- D. The short circuit current rating of each SPD shall match or exceed the rating of the equipment to which it is connected. The Contractor shall reference the Drawings for short circuit current rating of each piece of equipment.
- E. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

SYSTEM CONFIGURATION	MODES OF PROTECTION	NUMBER OF MODES
3-Phase Wye	L-N, L-G, N-G	7
3-Phase Delta	L-L, L-G	6
3-Phase Impedance Grounded	L-L, L-G	6
Single-Phase	L-N, L-G, N-G	3

- F. Each SPD shall have a Maximum Continuous Operating Voltage (MCOV) of at least 115% of the nominal voltage of the equipment to which it is connected.
- G. The Nominal Discharge Current (I_n) of each SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.
- H. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

SYSTEM VOLTAGE	L-N	L-G	L-L	N-G
208Y/120	800V	800V	1200V	800V
480Y/277	1200V	1200V	2000V	1200V
480 DELTA	N/A	1800V	2000V	N/A
240 DELTA	N/A	1200V	1200V	N/A
120/240	800V	800V	1200V	800V

- I. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated on single line diagrams and in panel schedules. Surge current rating indicated is on a per phase basis.
- J. Each SPD shall be provided in an enclosure to match or exceed the NEMA rating of the equipment enclosure that it is serving (i.e. NEMA 4X 316 SST, for this application).

- K. Each SPD shall be provided with the following accessories:
1. Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any single component is taken off-line, the LED shall turn off and another LED shall illuminate, providing individual module as well as total system status indication.
 2. Surge counter and audible alarm with reset/silence switch.
 3. One set of Form C (SPDT) dry contacts rated for at least 5A at 120VAC.
- L. SPDs shall be as manufactured by Eaton, Thor Systems, ASCO/Emerson Network Power, or Square D.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The SPD units shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- B. The SPD units shall be mounted such that the conductor lengths are as short as possible, but no greater than 36 inches. Any installation resulting in a conductor length of greater than 36 inches shall be reviewed with the Engineer as a special type of cable may need to be installed. For equipment such as panelboards, the Contractor shall relocate the circuit breaker that is to be connected to the SPD as needed to achieve the shortest conductor length possible.
- C. The Contractor shall use a close nipple to enclose the conductors between the SPD and the equipment served. However, if due to field conditions a 90 degree conduit bend is required to connect the SPD to the equipment that it serves, the bend shall have a minimum radius of 36 inches to eliminate any potential for sharp bends in the conductors.
- D. Conductors between the equipment served and the SPD shall be 600V power wire and cable as specified in Section 16123 – Low Voltage Wire and Cable. The individual conductors shall be gently twisted, and shall be sized as indicated on the Drawings.
- E. Prior to energizing, the Contractor shall verify that the SPD unit voltage and configuration is suitable for the system to which it is connected.
- F. Prior to energizing, the Contractor shall also verify that any Neutral to Ground bonding jumpers are installed as required.
- G. Prior to energizing, the Contractor shall also verify that the impedance of the equipment grounding conductor between the SPD and the grounding electrode system is less than 1 ohm.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Shop Tests

- a. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA, ANSI, and UL standards.
- b. All surge protective devices, subassemblies, and components shall be 100% tested and certified by the manufacturer to meet their published performance parameters.

2. Field Tests

- a. None required.

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SECTION 16470

PANELBOARDS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install panelboards of voltage and current ratings as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles and locations conforming to the panelboard schedules on the Drawings.
- B. Reference Section 16000, Basic Electrical Requirements; Section 16195, Electrical Identification; and Section 16280, Surge Protective Devices

1.02 CODES AND STANDARDS

- A. Panelboards shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. Underwriters Laboratories
 - a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations
 - b. UL 67 – Standard for Panelboards
 - c. UL 489 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
 - d. UL 943 – Ground Fault Circuit Interrupters
 - e. UL 1449 – Standard for Surge Protective Devices
 - 2. NEMA PB1 - Panelboards
 - 3. National Electrical Contractors Association (NECA) Standard 407 – Standard for Installing and Maintaining Panelboards

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings.
 - 2. Spare Parts List.
 - 3. Operation and Maintenance Manuals.

4. Reports of Field Tests.

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.

3. Complete panelboard schedules indicating circuit designations as shown on the Drawings for each panelboard.

4. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g., MPZ-1, etc.).

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:

1. Instruction books and/or leaflets.

2. Recommended spare parts list.

3. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process and during field installation.

1.06 SPARE PARTS

A. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer. All spaces in the panelboards shall be furnished with a spare breaker as indicated in the panelboard schedules shown on the Drawings.

B. Spare parts lists shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.07 IDENTIFICATION

- A. Each panelboard shall be identified with the identification name/number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard. Nameplates shall be as specified in Section 16195, Electrical - Identification.

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 UL 67 Listed and shall be constructed to NEMA PB1 standards. 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 be UL 50 listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI #61 light gray. The

enclosure shall have wiring gutters on sides and shall be at least 5-3/4 inches deep.

2. 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.
3. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

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 tin 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 and UL 489 Listed. 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. Ground fault circuit interrupter style circuit breakers shall be UL 943 Listed. 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. Main circuit breakers shall be individually mounted. Branch mounted circuit breakers are not acceptable unless specifically indicated on the panel schedules. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location.
5. 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 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 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 transformer and a lighting panelboard. Transformer rating, primary circuit breaker rating, secondary circuit breaker 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.
- B. Combination power units located outdoors shall be suitable for outdoor use and be provided in a 316 Stainless Steel, NEMA 3R enclosure unless otherwise indicated on the Drawings.
- C. Combination power units shall have all copper windings and terminations. The transformer shall be 115°C temperature rise and epoxy resin encapsulated.
- D. 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.

2.05 SURGE PROTECTIVE DEVICES

- A. The panelboards shall be furnished with integrated Type II surge protective devices (SPD). SPDs shall be provided in the location and quantity as shown on the Drawings. SPD shall be installed within the panelboard enclosure in a location that allows the required quantity and rating of branch circuit breakers to be installed. Reducing the quantity of branch circuit breakers to less than that required by the panel schedules is not acceptable.
- B. The SPD shall be rated, designed, tested, listed, and labeled in accordance with UL-1449, latest edition.
- C. The SPD shall be factory installed by the panelboard manufacturer using a direct bus connection. There shall be no cable connection between the bus bar and the SPD device.
- D. The SPD shall have a fault current rating equal to or greater than that of the fault current rating of the panelboard. The SPD shall employ metal-oxide varistor (MOV) technology. If integral fusing is used, the fuses shall allow the maximum rated surge current to pass without fuse operation.
- E. The SPD shall have a maximum continuous operating voltage (MCOV) of at least 115% of the nominal voltage of the panelboard. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

SYSTEM VOLTAGE	L-N	L-G	L-L	N-G
208Y/120	700V	700V	1200V	700V
480Y/277	1200V	1200V	1800V	1200V
480 DELTA	N/A	1200V	2000V	N/A
240 DELTA	N/A	1200V	1200V	N/A
120/240	700V	700V	1200V	700V

- F. The Nominal Discharge Current (In) of the SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.
- G. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated in panel schedules. Surge current rating indicated is on a per phase basis.
- H. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

SYSTEM CONFIGURATION	MODES OF PROTECTION	NUMBER OF MODES
3-Phase Wye	L-N, L-G, N-G	7
3-Phase Delta	L-L, L-G	6
3-Phase Impedance Grounded	L-L, L-G	6
Single-Phase	L-N, L-G, N-G	3

- I. The SPD shall be furnished with an audible alarm and silence pushbutton, integral SPD status LEDs (one per phase), and a Form C dry contact for remote indication of alarm. A surge counter shall also be provided.
- J. The SPD equipment shall be SPD Series by Eaton, SurgeLogic by the Square D Company, Tranquell by the General Electric Company, Siemens Energy and Automation Inc. equivalent, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Panelboards and combination power units shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer, and as required by NECA 407.
- B. Panelboards shall be set true and plumb in locations as shown on the Drawings. The top of panelboard enclosure shall not exceed six (6) feet above finished floor elevation.
- C. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.
- D. The Contractor shall not use factory furnished knockouts with surface mounted back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush mounted back boxes with manufacturer's standard pattern of knockouts.
- E. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush mounted enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.
- F. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) KVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practical.
- G. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Field Tests

- a. Prior to termination of any conductors to the circuit breakers, all bus work and circuit breakers shall be tested from phase to phase and phase to ground with a 1000 VDC megaohmmeter for 1 minute in accordance with NECA 407. Resistance values shall be recorded and shall not be less than 100 megohms.
- b. Prior to terminating any wires to the circuit breakers, the resistance of the connection between the bus work and each circuit breaker shall be tested through the use of a low-resistance ohmmeter. Record the resistance values for each circuit breaker.

- END OF SECTION -

SECTION 16476

ENCLOSED CIRCUIT BREAKERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install enclosed circuit breakers of voltage and current ratings as specified herein and indicated on the Drawings.
- B. This specification is intended to apply to circuit breakers separately-mounted from other equipment in an individual enclosure. This Section does not apply to circuit breakers as part of an equipment assembly such as motor control centers, panelboards, switchboards, etc.
- C. Reference Section 16000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

- A. Enclosed circuit breakers shall comply with the following codes and standards:
 - 1. UL 489 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
 - 2. NEMA 250 – Enclosures for Electrical Equipment
 - 3. National Electrical Code

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings.
 - 2. Spare Parts List.
 - 3. Operation and Maintenance Manuals.
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each enclosed circuit breaker.

1.05 SPARE PARTS

- A. For each enclosed circuit breaker, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer.

1.06 IDENTIFICATION

- A. Each enclosed circuit breaker shall be identified with the identification name and/or number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on the front of each enclosed circuit breaker. Nameplates shall be as specified in Section 16195, Electrical - Identification.

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.
- B. Enclosed circuit breakers shall be manufactured by Eaton, the General Electric Company, the Square D Company, or Siemens Energy and Automation, Inc.

2.02 ENCLOSED CIRCUIT BREAKERS

- 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. Circuit breakers in hazardous locations shall be UL 1203 Listed.
- D. 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. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
All Outdoor Areas	NEMA 4X, Type 316 Stainless Steel

- E. 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.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

- F. 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.
- G. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the enclosure.
- H. Enclosed circuit breakers shall be suitable for use as service entrance equipment where indicated on the Drawings and so labeled to suit the application.
- I. Where indicated on the Drawings, enclosed circuit breakers shall be 100% rated.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The enclosed circuit breaker shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.
- B. Enclosed circuit breakers shall be set true and plumb in locations as shown on the Drawings. The top of enclosure shall not exceed six (6) feet above finished floor elevation.
- C. Enclosed circuit breakers 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.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
1. Witnessed Shop Tests
 - a. None required

2. Field Tests

- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

- END OF SECTION -

SECTION 16481

INDIVIDUAL MOTOR CONTROLLERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install separately mounted, individual motor controllers for 120 volt single phase, and 208 and 480 volt three phase motors as specified herein and indicated on the Drawings. Individual motor controllers specified in this Section include magnetic motor starters, manual motor starters, and reduced voltage solid state starters (RVSS).
- B. Reference Section 16000, Basic Electrical Requirements; Section 16123, Low Voltage Cable; Section 16195, Electrical Identification; and Section 16902, Electric Controls and Relays.

1.02 CODES AND STANDARDS

- A. Individual motor controllers shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. UL 508 – Standard for Industrial Control Panels
 - 2. NEMA 250 – Enclosures for Electrical Equipment

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings.
 - 2. Spare Parts.
 - 3. Reports of Certified Shop and Field Tests.
 - 4. Operation and Maintenance Manuals.
 - 5. Manufacturer's Field Startup Report.
 - 6. Manufacturer's Representatives Installation Certification.
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 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. Product data sheets.
 - 3. 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.
 - 4. 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. 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.
 - 5. Bill of material list for each individual motor controller.
 - 6. Nameplate schedule for each individual motor controller.
 - 7. Manufacturer's installation instructions.
 - 8. Time-current curves for each type and size protective device if requested by the Engineer.
 - 9. Approximate total shipping weight of each RVSS.

- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.
- E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for individual motor controller. These final drawings shall be plastic laminated and securely placed inside each individual motor controller unit door and included in the O&M manuals.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The Contractor shall furnish the following additional spare parts:
 - 1. One (1) solid state overload relay for each type, size, and rating used.
 - 2. One (1) motor circuit protector & motor contactor for each type, size, and rating used.
 - 3. One (1) spare control power transformer for each type and size used.
 - 4. Two (2) spare fuses for each size and type used.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 IDENTIFICATION

- A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved with the equipment name and/or number with which it is associated. Equipment identification shall be in accordance with Section 16195, Electrical - Identification.

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.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
All Outdoor Areas	NEMA 4X, Type 316 Stainless Steel

- C. In hazardous locations, motor starters 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.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

- D. Starters shall be provided with all coils and controls for 120 VAC operation, unless otherwise indicated on the Drawings.
- E. 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. 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

- F. 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.

G. 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 16902, Electric Controls and Relays:
 - a. Pilot devices (switches, indicating lights, etc.)
 - b. Relays and timers
 - c. Control Terminal blocks
- H. 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 as specified in Section 16123, Low Voltage Cable.
- I. 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.
- J. 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 REDUCED VOLTAGE SOLID STATE STARTER

- 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.
- 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. RVSS integrated into pump station control panels shall meet the requirements of the enclosure in which it is installed.
- 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.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
All Outdoor Areas	NEMA 3R, 316 Stainless Steel

- O. The complete starter assembly shall be rated per UL 508 for a minimum withstand rating of 65kAIC 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 16902, 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 manufactured by the General Electric Company or the Square D Company. No other manufacturers are acceptable.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. All individual motor starters shall be installed as indicated on the Drawings and as recommended by the equipment manufacturer.
- B. Individual motor starters 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.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Witnessed Shop Tests
 - a. None required.
 - 2. Field Tests
 - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications, latest edition.

3.03 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and startup of the RVSS equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform all startup and field acceptance testing as specified herein.
- C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of two (2) hours each. Training shall not take place until after the motor controllers have been installed and tested. Training shall be conducted at times coordinated with the Owner.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
 - 1. One (1) trip of two (2) working days during installation of the motor controllers.

2. One (1) trip of two (2) working days to perform startup and field acceptance testing of the motor controllers.
 3. One (1) trip of one (1) working day two (2) months before the warranty expiration to identify any issues to be corrected under warranty.
 4. One (1) trip of one (1) working day to perform training as specified herein.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

- END OF SECTION -

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SECTION 16496

AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test and place in satisfactory operation automatic transfer switches as specified herein and indicated in Drawings.
- B. All devices and components of the automatic transfer switch shall be NEMA rated. IEC rated devices are unacceptable and shall be cause for rejection of the submittals/equipment.

1.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Witnessed Shop Tests
 - a. Shall be made available at manufacturing facilities if requested.
 - 2. Certified Shop Tests and Reports
 - a. Automatic transfer switches shall be given routine factory tests. The factory tests shall demonstrate that the completed switches function correctly and that the required timing has been set. Certification of these settings shall be submitted to the Engineer upon request.
 - b. Test procedures shall be in accordance with UL-1008. During the 3-cycle withstand tests, there shall be no contact welding or damage.
 - c. The three cycle tests shall be performed without the use of current limiting fuses.
 - d. Oscillograph traces across the main contacts shall verify that contact separation has not occurred and there is contact continuity across all phases after completion of the test.
 - e. When conducting temperature rise tests in accordance with UL-1008, include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
 - f. Manufacturer shall submit test reports upon request.

3. Field Tests

- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.
- b. Prior to acceptance of the installation, load test the equipment with all available motor load, but do not exceed the generator's or automatic transfer switch's nameplate rating. Correct defects which become evident during this test.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 1. Shop Drawings
 2. Operation and Maintenance Manuals
 3. Spare Parts Lists
 4. Reports of certified shop tests shall be submitted which indicates a closing and withstand ampere rating as required based on short circuit study requirements. Rating shall be symmetrical, 3 cycles at 480 VAC.
 5. Guarantee/Warranty Program
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor for resubmittal without review.
- C. Shop drawings for each automatic transfer switch shall include but not be limited to:
 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. Product data sheets.
 3. Complete assembly, layout, and installation drawings with clearly marked dimensions and conduit entrance locations.
 4. Example equipment nameplate data sheet.
 5. Complete internal schematic and interconnecting wiring diagrams.
 6. Nameplate schedule.
 7. Manufacturer's standard installation instructions.
 8. Manufacturer's standard warranty.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.
- E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each automatic transfer switch. These final drawings shall be plastic laminated and securely placed inside each transfer switch and included in the O&M manuals.
- 1.05 OPERATION AND MAINTENANCE MANUALS
- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.
- 1.06 SUPPLIES AND SPARE PARTS
- A. The automatic transfer switches shall be furnished with spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 IDENTIFICATION

- A. Each automatic transfer switch shall be identified with the identification number indicated on the Drawings (e.g. ATS-1 etc.). A nameplate shall be securely affixed in a conspicuous place on each switch. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.08 WARRANTY

- A. The manufacturer shall warrant each automatic transfer switch for a minimum of five (5) years from date of shipment. In addition, the manufacturer shall repair or replace equipment found faulty under the terms of the warranty. The manufacturer shall submit data outlining the guarantee/warranty program.

1.09 CONSTRUCTION SEQUENCING

- A. The Contractor shall reference Section 01520, Maintenance of Utility Operations During Construction, of these Specifications.

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. The equipment described herein, as a minimum, shall meet all of the requirements specified in this Section and shall be a product of a manufacturer who has produced automatic transfer switches for a period of at least five (5) years. The equipment shall be compatible with the loads to be served. Assembly of the switches by a fabricator is not acceptable.
- C. 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.
- D. The automatic transfer switches shall be contactor style, Type ATV (Open Transition) as manufactured by Eaton, Siemens Energy and Automation Inc. equivalent, General Electric equivalent.

2.02 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 transfer switch shall be housed in a NEMA 4X (gasketed) enclosure fabricated from 316 SST. Enclosures shall be free standing or suitable for wall mounting as indicated on the Drawings. The enclosure shall exceed the UL-1008 minimum wire bending space requirements. The enclosure shall be equipped with an internal, welded steel, door-mounted print pocket.
4. The transfer switch shall have both top and bottom mounted cable access.
5. The switch shall be capable of switching all classes of load and rated for continuous duty when installed in a non-ventilated enclosure.
6. The three-cycle closing and withstand current rating of the switch shall be 42,000 amperes RMS (minimum). This rating shall not be restricted by the use of a specific manufacturer's circuit breaker.
7. This switch shall be complete with all accessories and listed by UL under Standard UL-1008 for use on emergency systems.
8. 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.
9. 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.
10. Switches shall be capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation.

B. Design Requirements

1. The switch shall be double throw, actuated by two (2) electrical operators momentarily energized and connected to a simple over-center linkage. A center-off-position shall be provided as a neutral position during switching. Minimum transfer time shall be 400 milliseconds.
2. Switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.

3. The time delay between the opening of the closed contacts and the closing of the open contacts shall allow for voltage decay before transfer, allowing the motor and transformer loads to be re-energized after transfer with normal in-rush current. Switches using in-phase monitors are not acceptable.
4. Utility and Generator 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.
5. 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 Utility 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, contact(s) shall close to connect the Generator source.
2. Transfer to the Generator power source shall occur when 90 percent of rated voltage and frequency has been reached by the Generator 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 Utility source. Should the Generator source fail during this time delay period, the switch shall automatically retransfer to the Utility source.

D. Controls

2. For power contactor type automatic transfer switches, the controller shall be a Model ATC-600 IQ transfer device as manufactured by Eaton Corporation, or equal. The controller shall be programmed by the manufacturer at the factory.
3. The microprocessor-based control system shall provide all the operational functions of the automatic transfer switch. The controller shall include a LCD display with keypad, and shall display the following:
 - a. Connected Source and Load voltages on all phases

- b. Connected Source and Load frequency
 - c. Condition Status (e.g. Under-voltage, Under-frequency)
 - d. Real time clock for Time/Date Stamp
 - e. Historical Data
 - f. Programming and set point information
 - g. Timer countdown for each timer while functioning
- 4. Controller shall be capable of communicating to the manufacturer's or the Owner's furnished remote supervisory control system via Ethernet/IP.
 - 5. The controller shall have password protection to limit access to authorized personnel.
 - 6. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection, and phase differential monitoring on both Utility and Generator sources.
 - 7. The controller shall be capable of storing the following records in memory for access either locally or remotely:
 - a. engine run time.
 - b. Utility source available time.
 - c. Generator source available time.
 - d. Utility source connected time.
 - e. Generator source connected time.
 - f. Load energized time.
 - g. Number of Transfers.
 - h. Date, time and reason for last sixteen (16) transfers.
 - 8. The controller shall include individual LED's for indicating the following:
 - a. Switch is in Utility position.
 - b. Switch is in Generator position.
 - c. Controller is in Automatic Mode.
 - d. Controller is in Test Mode.

- d. Availability of Utility source.
- e. Availability of Generator source.
- 9. A digital LCD voltage readout, with 1% accuracy shall display phase-to-phase voltages for both the Utility and Generator source.
- 10. A digital LCD frequency readout with 1% accuracy shall display frequency for both the Utility and Generator source.
- 11. 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
- 12. 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. Relay contacts which close when normal source fails wired to a terminal strip.
10. Relay contacts which open when normal source fails wired to a terminal strip.
11. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on normal and wired to a terminal strip.
12. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on standby and wired to a terminal strip.
13. Provide a Utility source selector switch to permit the selection of either source as the "Utility" source which the ATS will always seek if that source is available. The two-position selector switch shall have a legend plate which reads "Source A/Source B."

2.03 PAINTING

- A. Painting shall conform with the requirements of Section 09900. Finish coat shall be ANSI #61.
- B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Each automatic transfer switch shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- B. The automatic transfer switch shall be provided with adequate lifting means for installation of wall or floor mounted enclosures.
- C. The Contractor shall tighten all assembled bolted connections to the manufacturer's torque recommendations prior to energizing.
- D. Install each switch to allow complete door swing required for component removal. This is specifically required where a switch is set next to a wall to the left of the switch enclosure.

3.02 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined elsewhere in Division 1 and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
 - 1. One trip of one (1) working day during installation of the equipment.
 - 2. One trip of one (1) working day after acceptance of the equipment.
 - 3. One trip of one (1) working day during the warranty period.
- B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Field Representative on each day he is at the project.
- C. The manufacturer shall have an established network of service centers capable of servicing the specified equipment. The manufacturer shall have a service center within 100 miles of the project site which shall stock parts necessary to service the switch. The manufacturer shall include an 800 telephone number for a field service contact affixed to each enclosure.
- D. Service center personnel shall be on call 24 hours a day, 365 days a year. Personnel shall be factory-trained and certified in the maintenance and repair of the specified equipment.
- E. After-warranty service contracts shall be made available to the Owner by the manufacturer, through the service centers, to provide periodic maintenance and/or repair of the specified equipment.

3.03 TRAINING

- A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be in accordance with the requirements of Section 11000, Equipment-General Provisions.
- B. Provide the services of an experienced, factory trained technician or service engineer of the switch manufacturer at the jobsite for minimum of three (3) days for training of Owner personnel, beginning at a date mutually agreeable to the Contractor and the Owner. The technician shall be on duty at the site for at least 8 hours per day and shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.

- END OF SECTION -

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all lighting fixtures, labor, and material, in accordance with the preceding Specifications, the requirements of this Section, and as shown on the Drawings.
- B. Lighting shall be in accordance with the latest requirements of the Illuminating Engineering Society, and all lighting fixtures shall have the Underwriters Laboratories, Inc. label of approval.
- C. All wiring shall be placed in conduit and shall comply with the Specifications for conduit, outlet boxes, pull and junction boxes, wires and cables, grounding, and other Sections as set forth in these Specifications and as noted herein.
- D. Reference Section 16000, Basic Electrical Requirements, and Section 16170, Grounding and Bonding.

1.02 CODES AND STANDARDS

- A. The equipment specified herein shall comply with the following codes and standards, where applicable.
 - 1. Underwriter's Laboratories, Inc. (UL):
 - a. UL 924 – Emergency Lighting and Power Equipment
 - b. UL 935 – Fluorescent Lamp Ballasts
 - c. UL 844 – Luminaires for Use in Hazardous (Classified) Locations
 - d. UL 1029 – High Intensity Discharge Lamp Ballasts
 - e. UL 1598 – Luminaires
 - 2. American National Standards Institute (ANSI):
 - a. ANSI C82.11 – High Frequency Fluorescent Lamp Ballasts
 - b. ANSI C62.41 – Guide for Surge Voltages in Low-Voltage AC Power Circuits
 - 3. National Electrical Code (NEC), latest edition.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Operation and Maintenance Manuals
 - 3. Spare Parts Lists
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor for resubmittal without review.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Catalog cuts for each fixture type showing performance and construction details of standard fixtures, and complete working drawings showing all proposed construction details of special or modified standard fixtures.
 - 3. Photometric curves.
 - 4. LED data including efficiency (Efficacy lumens/watt) information.
 - 5. LED Driver information
 - 6. Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.
 - 7. Manufacturer's warranty information
 - 8. System (entire fixture assembly) efficiency data.
 - 9. Pole calculations.
- D. Shop drawings shall be submitted to the Engineer for review and acceptance for all fixtures before fixtures and poles are manufactured. Substitutions will be permitted only if acceptable to the Engineer.

- E. Manufacturer's catalog number and description in the fixture schedule on the Contract Documents establishes a level of quality, style, finish, etc. The use of a catalog number describing the various types of fixtures shall be used as a guide only, and does not exclude all the required accessories or hardware that may be required for a complete installation.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit Operation and Maintenance Manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The following minimum spare parts shall be furnished:
 - 1. A minimum of one (1) LED driver for every two (2) drivers (of the same type) installed.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 WARRANTY

- A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of delivery of fixtures to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, shipping costs, expendables used during the course of repair, or complete replacement of the failed lighting unit.
- B. Warranty for LED fixtures shall be provided for the entire fixture and shall include all parts and accessories. Warranty for non-LED fixtures shall be provided for the entire fixture and shall include all parts and accessories except the replaceable bulb. Submittals received without written warranties as specified shall be rejected in their entirety.

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 FIXTURES

- A. Each fixture shall bear the Underwriters Laboratories, Inc. label. All lighting fixtures shall be furnished complete with lamps of the size and type as indicated on the Drawings and all fittings and hardware necessary for a complete installation. Lighting fixtures shall have all parts and fittings necessary to completely and properly install the fixtures.
- B. Fixture leads shall be as 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 well rounded and free from chips or rough edges.
- D. Fixtures for use in hazardous locations shall be UL 844 Listed.
- E. Fixtures specified to be damp or wet locations rated shall be UL 1598 listed.
- F. Fixtures shall be as specified in the fixture schedule below.

FIXTURE TYPE	LAMP/ FIXTURE WATTAGE	DESCRIPTION	MFR AND MODEL
LC1	61W (max)	Ceiling-mounted, 120-277VAC, LED light fixture, color temperature of 4100K, lineal ribbed frosted acrylic lens, general distribution, gasketed fiberglass housing, polycarbonate latches, 4ft, 4000 lumen minimum, and wet location Listed.	Holophane EMW LED Series
LL1	195W (max)	Pole-mounted, 120-277VAC, LED light fixture, color temperature of 4000K, prismatic borosilicate glass lens, IESNA Type 5 low angle distribution, corrosion-resistant gray cast aluminum housing, 15,000 lumen minimum, and wet location Listed. Round, gray base mounted, tapered, 10ft. anodized aluminum pole.	Holophane Petrolux PLED2 Series

2.03 LED DRIVERS

- A. Drivers shall have a voltage range of (120-277) +/- 10% at a frequency 60Hz.
- 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 protected.
- E. Drivers shall be furnished with a fused primary.
- F. Drivers shall have an output current ripple <30%
- G. Drivers shall be manufactured by Advance, Universal or equal.
- H. Drivers shall be UL Listed for damp location, UL1012, UL935, ROHS.
- I. Drivers shall meet FCC 47 Sub Part 15.
- J. All drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

2.04 LEDs

- A. Luminaires provided with LED technology shall utilize high brightness LEDs with a group binning code of P and/or Q.
- B. Color Temperature: as specified in fixture schedule.
- C. Junction point shall be designed and manufactured to allow adequate heat dissipation.
- D. LEDs shall be rated for 50,000 hours of life, minimum (based on IESNA L70).

2.05 POLES

- A. Poles shall be designed to withstand calculated wind force based on wind velocity in accordance with the provisions of the South 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.

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 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. The Contractor shall furnish and install a concrete foundation for the pole mounted fixtures as indicated on the Drawings and as required. This applies to foundations that are part of a structure (e.g. elevated platform). Foundation shall be designed and approved by a professional structural engineer currently registered in the State of South Carolina. The wind design shall be in accordance with ASCE 7 and the South 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.
- R. One (1), 3/4" diameter, 10'-0" long ground rod, furnish in accordance with Section 16170, 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 as indicated in the standard details.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Certified Shop Tests
 - a. The lighting fixtures shall be given routine factory tests in accordance with the requirement of ANSI, NEMA and Underwriters Laboratories standards.
 - 2. Field Tests

- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

- END OF SECTION -

SECTION 16620

PACKAGED ENGINE GENERATOR SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install a standby power engine generator set complete with natural gas fuel piping, exhaust silencer, batteries, charger, enclosure, and devices for automatic and manual control.
- B. It is the intent under this Contract to require an installation complete in every detail whether or not indicated on the Drawings or specified. Consequently, the Contractor is responsible for all details, devices, accessories and special construction necessary to properly install, adjust, test, place in successful and continuous operation the engine-generator set.
- C. Use materials which are new, unused, and as specified, or, if not specifically indicated, the best and most suitable of their kinds for the purpose intended, and for the design and expected conditions of service, subject to the approval of the Engineer.
- D. Provide workmanship that is first class in every respect. Employ workers thoroughly experienced in such work. A neat and workmanlike appearance in the finished work shall be required.
- E. All materials used must bear the inspection labels of the Underwriter's Laboratories, if the material is of a class inspected by the Laboratory.
- F. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.
- G. The engine generator sets shall fully comply with all current Environmental Protection Agency (EPA) emission regulations including, but not limited to, the New Source Performance Standards (NSPS) for stationary and non-road generator sets. The engine generator set(s) must meet the EPA new source performance requirements required at the time the engine generator set(s) submittal is approved by the engineer. Engines manufactured prior to the submittal approval date that do not meet the current regulated emissions levels are not acceptable.
- H. Reference Section 16000 - Basic Electrical Requirements and Section 16496 – Automatic Transfer Switch.

1.02 CODES AND STANDARDS

A. The packaged engine-generator system shall comply with the following Codes and Standards as a minimum:

1. NEMA MG 1, Motors and Generators.
2. NEMA MG 2, Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators.
3. ISO STD 8528, Reciprocating Internal Combustion Engines.
4. ISO STD 3046, Performance Standard for Reciprocating Internal Combustion Engines.
5. NFPA 37, Standard for Installation and use of Stationary Combustible Engine and Gas Turbines.
6. NFPA 54, National Fuel Gas Code
7. NFPA 70, National Electrical Code
8. NFPA 70E, Standard for Electrical Safety in the Workplace
9. NFPA 110, Standard for Emergency and Standby Power Systems.
10. UL 508, Industrial Control Equipment.
11. EGSA, Electrical Generating Systems Association.
12. UL 1004 - Standard for Systems of Insulating Materials - General
13. UL 1446 - Standard for Rotating Electrical Machines - General Requirements
12. UL 2200 – Stationary Engine Generator Assemblies
13. ANSI C57, Dry-Type Transformers.
14. UL 1236 – Standard for Battery Chargers for Charging Engine Starter Batteries.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings
2. Spare Parts List
3. Reports of Certified Shop and Field Tests

4. Operation and Maintenance Manuals
5. Manufacturer's Field Start-up Report
6. Manufacturer's Representative's Installation Certification

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings for each engine-generator set shall include but not be limited to:

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. Manufacturers printed specification sheets showing critical engine and generator set specifications including the following:
 - Dimensions, and weights
 - Guaranteed fuel consumption at 25%, 50%, 75% and 100% of full rated load
 - Engine bhp available
 - Brake Mean Effective Pressure (BMEP)
 - Engine jacket water heat rejection
 - Exhaust flow rate and temperature at 100% of rated load
 - Ventilation and combustion air requirements
 - Exhaust backpressure limitation
 - Liquid refill capacities
 - Voltage regulation characteristics

- Guaranteed noise levels
3. Alternator technical electrical data, including, but not limited to:
 - Alternator efficiency at 50%, 75%, and 100% load
 - Telephone Interference Factor (TIF)
 - Harmonic waveform distortion
 - Type of winding insulation and generator temperature rise
 - Per unit subtransient impedance X'' and X/R ratios for positive, negative, and zero sequences
 - Transient reactance (X_d')
 - Synchronous reactance (X_d)
 - Sub transient time constant (T_d'')
 - Transient time constant (T_d)
 - DC time constant (T_{dc})
 - Decrement curve
 4. Manufacturer's printed warranty statement of the engine and generator set showing single source responsibility by the engine manufacturer.
 5. Generator control panel equipment and features. Include a written explanation of the auto start/stop logic and operation.
 6. Engine-generator set and accessory product data sheets including, but not limited to, the following:
 - Alternator strip heater
 - Radiator
 - Seismically rated vibration isolators
 - Flexible exhaust coupling
 - Exhaust silencer
 - Batteries
 - Battery charger
 - Engine manufacturers shutdown contactors
 - Jacket coolant heater
 - Fuel system devices
 - Output circuit breaker and trip unit
 - Conduit
 - Wire and Cable
 - Wiring Devices
 - Panelboards/combination power unit (if applicable)

7. Standard dealer preventative maintenance contract for review and possible adoption under a separate contract. Dealer must have existing contracts and personnel and contractual detailed performance information available.
8. Normal operating ranges for systems temperature, pressure and speed.
9. Manufacturer's part number for the engine and generator operation guide, parts book, service manual, warranty policy, and installation guide.
10. Location of other similar units showing compliance with the experience requirements specified herein.
11. Phone numbers of twenty-four (24) hour products support contacts and locations.
12. Drawing showing right hand, left hand, and top views of proposed assembly; battery rack, isolators, exhaust silencer, conduit stub up locations, and flexible fittings; wiring schematics, interconnection diagrams (point to point), and written description of engine generator controls and alarm circuits.
13. Control panel layout drawings and wiring diagrams.
14. EPA Certificate of Conformity for Exhaust Emissions
15. Detailed drawings showing plan, front, and side views as well as appropriate section views of the weatherproof, engine-generator enclosure. Include product data sheets for all appurtenances (e.g. exhaust fan, thermostat, lighting, switches, receptacles, combination power unit, etc.) to be furnished and installed in the enclosure. Drawings shall be of sufficient detail to assure proper installation by the Contractor.

- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 REPORTS OF CERTIFIED SHOP AND FIELD TESTS

- A. Submit two (2) certified copies of all test reports. This includes all shop tests and field tests. Certified shop test reports for prototype engine-generator sets are unacceptable. The manufacturer's serial number for the actual engine-generator set furnished for this project shall appear on all test reports.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Two (2) preliminary copies of Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals shall be provided to the Engineer not more than 10 days after the equipment arrives on the project site.

- B. The preliminary manuals shall be reviewed by the Engineer prior to the Contractor submitting final copies for distribution to the Owner. Following review of the preliminary copies of the Operation and Maintenance Manuals, one (1) copy will be returned to the Contractor with required revisions noted, or the acceptance of the Engineer noted.
- C. Manuals shall contain complete information pertaining to assembly, operation, lubrication, adjustment, wiring diagrams and schematics, maintenance, and repair, including detailed parts lists with drawings or photographs identifying the parts. Manuals shall contain all information submitted as part of the shop drawing review process.
- D. Manuals furnished shall be assembled and bound in separate volumes, by major equipment items or trades, and properly indexed to facilitate locating any required information. In addition, manuals should be labeled in the front cover with the project, name, equipment description, and manufacturer contract information.
- E. Engineer and the Owner shall be the sole judge of the acceptability and completeness of the manuals and may reject any submittal for insufficient information included, incorrect references and/or the manner in which the material is assembled.
- F. Following the Engineer's review of the preliminary manuals, the Contractor shall submit five (5) paper copies and two (2) electronic copies of the final Operation and Maintenance Manuals to the Owner. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents, as well as any changes made during installation. Failure of the final manuals to reflect the required revisions noted by the Engineer as well as changes made during installation will result in the manuals being returned to the Contractor. Acceptable final Operation and Maintenance Manuals shall be provided not more than one (1) month after receipt of the Engineer's comments.

1.07 SPARE PARTS

- A. Routine maintenance and adjustments shall be performed without the use of special tools or instruments. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.
- B. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts for each engine-generator set:

<u>No. Required</u>	<u>Description</u>
1	Set of Fuel Filters (if applicable)
1	Set of Air Filters
1	Set of Lube Oil Filters
1	Set of Coolant Filters

- C. The dealer shall have sufficient parts inventory to maintain over-the-counter availability of at least 90% of any required part and 100% availability within 48 hours.

1.08 IDENTIFICATION

- A. Each engine-generator set shall be identified with the identification name/number indicated on the Drawings (e.g., Generator). A nameplate shall be securely affixed in a conspicuous place on the generator main circuit breaker or output termination box enclosure. Nameplates shall be as specified in Section 16195 – Electrical - Identification.

1.09 WARRANTY TERMS

- A. The manufacturer's and Dealer's warranty shall in no event be for a period of less than two (2) years or two-thousand (2,000) hours of operation, whichever comes first, from date of delivery of equipment to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, coolant, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified shall be rejected in their entirety.
- B. Provided warranty shall cover all equipment included in the scope of supply. This warranty shall include, but is not limited to, the following:
- Engine-generator set and respective auxiliary equipment
 - All controls for the engine-generator set

1.10 OIL SAMPLING KIT

- A. The generator set supplier shall provide an oil sampling analysis kit which operating personnel shall utilize for scheduled oil sampling. All equipment needed to take oil samples shall be provided in a kit and shall include the following:

- 1 Sample extraction gun
- 10 Bottles
- 10 Postage-paid mailers
- 1 Written instructions

An additional oil sampling kit shall be made available to the Owner to continue the sampling when the above specified kit has been depleted. All kits in addition to that specified above shall be at an additional cost to the Owner, if the Owner desires to continue the sampling service.

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. The engine-generator set shall be natural gas fueled as manufactured by Cummins or Caterpillar. The engine-generator set manufacturer and/or dealer shall be responsible for the entire engine-generator package including the engine-generator set with all accessories and equipment specified herein and all other devices required for a complete and operable system.

2.02 GENERAL DESCRIPTION

- A. The engine-generator set shall be rated as specified herein and as indicated on the Drawings. It shall have the capability to operate at its standby rating for the duration of any power outage with all accessories including engine running devices, silencer, radiator, cooling fans, fuel system, and all appurtenances complete as it would be installed in the field.

2.03 ENGINE

- A. The engine shall be natural gas fueled, 4 cycle, radiator cooled, and shall be turbocharged having an operating speed of 1800 RPM. Engine shall operate on a City supplied natural gas service. The Contractor shall coordinate natural gas service requirements with the generator manufacturer's gas supply requirements.
- B. The engine will not be acceptable if the design is a conversion of a naturally aspirated engine to which a turbo-blower has been attached, unless the engine is certified by the manufacturer as having been analyzed and redesigned with ample provisions for increased stresses and bearing or heat loads due to increased pressures and rate of heat liberation.
- C. Break mean effective pressure (BMEP) shall not exceed 246 psi at rated load. Brake Horsepower (BHP), and Engine-Generator efficiency shall conform with ASME, IEEE and NEMA standards that electrical energy delivered by the machine is within the minimum certified guaranteed oil consumption rate and evidence that these parameters have been met shall be furnished.
- D. Only engine manufacturers' standard ratings shall be acceptable. No dealer special ratings will be acceptable.
- E. The specified standby kW rating shall be for continuous electrical service during interruption of the normal utility source, per NEMA standards.
- F. Engine speeds shall be governed by an electronic isochronous governor that will sense generator speed and provide accurate load transient correction capability at less than 0.5 percent regulation, from no load to full load generator output.

2.04 ALTERNATOR

- A. The alternator shall conform with NEMA and IEEE standards and be rated as indicated on the Drawings. The alternator shall have a UL 1004 and UL 1446 Listing. The alternator shall be brushless, salient pole, 2/3 pole pitch and synchronous for operation at 480VAC, wye connected, as indicated on the Drawings. The generator shall be capable of delivering 218 SkVA (minimum) at an instantaneous voltage dip of no more than 30% voltage drop.

- B. Laminations and windings shall be designed for minimum reactance, low voltage waveform distortion and maximum efficiency.
- C. The main stator coils shall be random wound. Insulation shall be Class H, 105 degrees C rise according to NEMA standards. The insulation system shall be made of epoxies and polyesters which are inorganic compounds and shall prevent fungus growth.
- D. The rotor shall be dynamically balanced and include amortisseur windings to minimize voltage deviations and heating effects under unbalanced load conditions.
- E. Radio interference suppression (both directions) shall be provided in accordance with NEMA and IEEE Standards.
- F. The alternator shall have a brushless, permanent magnet generator (PMG) excitation support system to provide input to the automatic voltage regulator to enable the alternator to support 300% of rated current for 10 seconds to allow fault clearing.
- G. Waveform deviation shall not exceed 5% from true sine wave. The transient response from no load to full load in one step of the engine-generator set shall not exceed a voltage dip of 35%, a frequency dip of 20%, and shall recover to complete steady state performance within 12 seconds for both voltage and frequency. The transient response from full load to no load in one step shall not exceed a voltage overshoot of 7% and shall recover to steady state performance within 3 seconds. Transient performance shall be in accordance with ISO 8528.
- H. The Telephone Influence Factor (TIF) shall be less than 50.
- I. The voltage regulator shall be an adjustable, solid-state, three-phase RMS sensing, volts/hertz type. Voltage regulation shall be a minimum of +/-1% from no load to continuous rating. The voltage regulator shall provide +/-10% voltage adjustment. The voltage regulator shall be located within the engine control panel.
- J. An alternator mounted strip heater shall be furnished and installed as part of the system. The strip heater shall be energized to prevent condensation when the engine generator set is not running.

2.05 CONTROLS

- A. Engine-generator monitoring and controls shall be mounted in a single NEMA 1 (gasketed) dust-tight enclosure. A suitable accessible terminal strip having all wires properly identified shall be furnished within the enclosure. The control panel shall be mounted at a height of 4'-8" measured from the center of the panel to the equipment pad or enclosure floor.
- B. The control panel shall accept a dry contact input for engine starting from remote locations. The starting and stopping of the engine-generator set shall be initiated through the control panel only. When the engine starts, starting control shall automatically disconnect cranking controls. Four (4) cranking cycles of 10 seconds "ON", 10 seconds "OFF" shall be provided. The starting controls shall prevent re-cranking for a definite time after source voltage has been reduced to a low value, or the four (4) cranking cycles have been reached without a successful start. The automatic engine starting controls shall use

industrial rated control type elements throughout, and controls shall have the capability to operate at 50% battery voltage.

- C. Speed sensing shall be provided to protect against accidental starter engagement with a moving flywheel. Battery charging alternation output voltage is not acceptable for this purpose.
- D. A generator/exciter field circuit breaker with shunt trip device shall be furnished and installed as part of the engine generator set. Shunt trip shall be activated upon engine-generator fault conditions.
- E. A main line circuit breaker as specified herein and sized as indicated on the Drawings shall be installed as a load circuit interrupting and protection device in a NEMA 1 (gasketed) dust-tight enclosure. It shall operate both manually for normal operation and automatically for protection against overload or short circuits. Generator/exciter field circuit breakers are not acceptable for this service.

The circuit-breakers described above shall be manufactured and tested in accordance with U.L. and NEMA AB1 standards. Their interrupting rating shall be suitable for the available fault current. All electrical ratings shall be suitable for the application.

- F. Engine-generator monitoring and control shall be provided using a microprocessor based control panel complete with an LCD display. The devices necessary for automatic starting shall be on the engine and in the engine control panel.
- G. The following parameters (minimum) shall be shown on the LCD display or otherwise be indicated at the control panel:
 - 1. Engine oil pressure
 - 2. Coolant temperature
 - 3. Generator output voltage
 - 4. Generator output current
 - 5. Generator elapsed run time
 - 6. Generator output frequency
 - 7. Engine run
 - 8. Engine fail
 - 9. Low coolant temperature
 - 10. Pre-high engine temperature
 - 11. Engine speed (RPM)

- H. The following events (minimum) shall cause an immediate shutdown of the engine-generator set if it operating, or prevent starting if it is not operating. The specific event that causes the shutdown/prevents starting shall be shown on the LCD display or otherwise be indicated at the control panel. A reset shall be required to clear the fault and allow the unit to operate:
1. Engine coolant high temperature
 2. Engine low oil pressure
 3. Engine overspeed
 4. Engine overcrank
 5. Engine tried to start but failed
 7. Low coolant level
- I. The generator control panel shall have a communication port capable of transmitting all available engine-generator set data via Modbus RTU protocol.
- J. The generator control panel shall have Form C dry contacts rated 5A (minimum) at 120VAC/24VDC for the following signals:
1. Engine coolant high temperature
 2. Engine low oil pressure
 3. Engine overspeed
 4. Engine overcrank
 5. Engine tried to start but failed
 6. Low coolant level
 7. Engine fail
 8. Engine run

The normally closed (NC) contacts for all of the above signals (except engine run) shall be wired in series to provide a common "Generator System Failure" alarm for remote indication. Other contacts shall also be wired as a part of this alarm as specified elsewhere herein.

- K. The generator package shall be furnished with a wall-mountable remote annunciator panel for remote monitoring of engine-generator status and alarm conditions.

2.06 ENGINE ACCESSORIES

- A. Furnish and install the engine with all accessory equipment and appurtenances which are required for proper operation, including the following:
 - 1. Heavy duty dry type air filter with restriction indicator
 - 2. Heavy duty lubricating oil filter, bypass type, with replaceable absorbent-type elements
 - 3. Lubricating oil cooler, water cooled
 - 4. Heavy duty lubricating oil filter, spin-on, with non-replaceable absorbent-type elements
 - 5. Oil/water separator

2.07 MOUNTING

- A. Couple the engine and generator together through a flexible, non-backlash type, all metal coupling which overcomes all normal misalignment stresses and transmits full engine torque with ample safety factor. Also provide flexible connections for piping connections.

2.08 COOLING SYSTEM

- A. Provide a radiator manufactured of a non-corrosive material mounted on the engine. The radiator core shall be coated with a corrosion resistant coating. Corrosion resistant coating shall be a corrosion resistant baked phenolic coating or similar.
- B. Connect the radiator to the engine internal cooling system with flexible piping. Furnish appropriately sized coolant expansion tank for the cooling system.
- C. The engine shall be cooled through a radiator sized to continuously maintain safe operation at full load and at 105°F outside ambient air with 50% ethylene glycol coolant. A blower type fan and low noise fan drive and controls shall be furnished. The fan and all rotating members and drive belts shall be guarded and meet OSHA standards. Proof of 105°F ambient temperature capability shall be required.
- D. Coolant
 - 1. After the cooling system is flushed and cleaned, provide an initial fill of coolant consisting of 50% ethylene glycol. An anti-corrosion treatment shall be added during the initial fill.
 - 2. The coolant shall meet the requirements of the generator manufacturer including corrosion inhibitors provided in the coolant to protect the engine cooling system.
- E. The engine shall be equipped with coolant heater(s). Heater(s) shall be in accordance with the following:

1. Unit mounted thermal circulation type coolant heater (with coolant recirculation pump, if available) shall be furnished to maintain engine jacket coolant temperature as recommended by manufacturer in an ambient temperature of minus 20°F. The heater shall be 208 VAC, 60 hertz, 1-phase, thermostatically controlled.
2. The heater shall be of sufficient capacity to keep the coolant at a suitable temperature for trouble-free starting.
3. Each heater shall be provided with a suitable contactor to automatically disconnect the heater when the engine is started.

2.09 ENGINE STARTING AND CHARGING SYSTEM

- A. Engine starting batteries shall be sealed, lead-acid type, rated 12 volts, wired for 12V starting. Batteries shall have adequate capacity for rolling the engine for five (5), ten (10) second cycles without starting, and then operating the control devices in the local generator controls for two (2) hours. The batteries shall be mounted on a suitable non-corrosive rack. Batteries shall have battery cables with lugs and shall be provided with lugs for connection to the battery charger.
- B. Battery charger shall be a U.L. 1236 listed, automatic, solid-state battery charger, 20 A (min.) current limited, $\pm 2\%$ voltage regulation, $\pm 10\%$ line voltage variation, automatic float equalizing system, DC voltmeter, and DC ammeter. Provide a Form C unpowered (dry) contact to indicate a low battery alarm condition.
- C. In addition, the engine shall be provided with an engine battery charging alternator that automatically charges the starting batteries during engine operation.

2.10 EXHAUST SILENCER

- A. Furnish and install an exhaust silencer. Silencers shall be of critical type and sized to produce a high degree of silencing. Reference the sound attenuation requirements specified herein.
- B. Connect the silencer to the engine exhaust manifold with a high corrosion and temperature resistant stainless steel flexible convoluted exhaust pipe. Use flange-type connections. Provide a taper-cut tail pipe complete with rain cap to exhaust the gases to the atmosphere.
- C. The silencer (if installed inside), exhaust piping, and expansion fittings, including collector box, shall be completely covered with a removable insulation blanket in order to protect operating personnel and to reduce noise. Insulation shall be of composite fiberglass and stainless steel construction capable of withstanding 1200°F continuously. The insulation blankets shall be tailored and custom fabricated to fit the contours of the manifolds. Average weight of the insulating blanket shall be 1.5 psf. Insulation shall conform to MIL-1-16411D, Type II and shall be custom fabricated to fit the contours of the components.

- D. The silencer system shall be designed, furnished, and installed to prevent moisture and condensation from corroding the silencer. All exterior components of the exhaust system shall be of 316 stainless steel.
- E. Silencer shall be mounted within or exterior to the generator enclosure dependent on generator size and manufacturer's standards. Silencers mounted on the outside of the enclosure shall be 316 stainless steel construction on its interior and exterior. Silencers mounted within the generator enclosure shall be painted steel.

2.11 WIRING

- A. Furnish and install internal wiring in the engine-generator set. All internal wiring between the generator and engine-generator control panel, the on-board power source and all accessories shall be provided.

2.12 WEATHERPROOF ENGINE - 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. 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, reinforced to be vibration free in the operating mode. 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. 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 piped to outside the unit to facilitate maintenance. Each drain line shall have a valve located near the fluid source.
- B. A "Skin-tight" housing shall be provided. No walk-around access is required within the enclosure; however, adequate working clearance shall be provided as required by the NEC. Alternatively, access doors may be provided so that when opened, adequate working clearance is achieved in front of electrical equipment.
- C. Enclosure shall be sound attenuated to provide sound level as specified herein.
- E. All hardware (nuts, bolts, screws, washers, etc.) that is installed on the exterior of the generator enclosure shall be stainless steel. Galvanized steel hardware is not acceptable.
- F. Conduit and wire shall be in accordance with Sections 16111 and 16123, respectively.
- G. 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 full load (maximum airflow) during rain events.

2.15 SOUND ATTENUATION

- A. Extreme care shall be exercised in providing equipment for and setting the engine-generator in place to guard against excessive noise transmission and vibrations. Fasten to the underside of the skids seismically-rated spring type isolators.
- B. The engine-generator enclosure shall be designed, furnished, and installed to reduce source noise to not more than 74 dB(A) as measured at seven (7) meters from the enclosure.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The standby generator system shall be furnished and installed as indicated on the Drawings and as recommended by the equipment manufacturer.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Witnessed Shop Tests
 - a. None required.
 - 2. Certified Shop Tests
 - a. Fully test the engine-generator set with all accessories in the manufacturer's plant before shipment. Tests shall be conducted through the use of balanced, three-phase, dry-type, resistive load banks.
 - b. Record complete test data for frequency, amperes, volts, power factor, exhaust temperature, coolant temperature, and oil pressure.
 - c. The manufacturer shall conduct a shop test run of at least two (2) consecutive hours for the set under the following conditions of load:
 - 2 hours - full load
 - d. Lubricants and other fluids as required for the shop tests shall be furnished by the manufacturer.
 - 2. Field Tests

- a. Field tests shall be performed by the generator manufacturer's technical representative. The Contractor shall obtain from the manufacturer and submit a detailed field test plan and procedures documenting the intended field test program.
- b. In the presence of a representative of the Engineer and/or Owner, the manufacturer's representative shall inspect, adjust, and test the entire system after installation and leave in good working order. Field tests specific to each generator shall be conducted after the entire engine-generator system is installed including, but not limited to, the following: exhaust silencer, radiators, enclosures, batteries, and all other equipment included in the complete system.
- c. Field test the generator enclosure to ensure the enclosure performs as specified herein. The generator enclosure field tests shall include water tests to confirm the enclosure does not leak and that the air intake louvers eliminate water intrusion to the interior of the generator enclosure when the generator is operating at its full load capacity (maximum airflow). A garden hose shall be used to simulate falling rain for this test. Water supply and garden hose will be provided by the Owner for this test.
- d. Field test, as far as practicable, all control, shutdown, and alarm circuits. Document the successful completion of these tests as witnessed by the Owner and the Engineer.
- e. Generator load tests shall be conducted through the use of balanced, three-phase, dry-type, load banks. Conduct a continuous run test using the load bank without shutdown for the engine-generator set under the following load conditions (in this specific order) and in the presence of the Owner and Engineer:
 - 2 hours, full loadRecord complete test data for frequency, amperes, volts, power factor, exhaust temperature, coolant temperature, and oil pressure every 15 minutes during the continuous run test. If any failures, malfunctions, and/or shutdowns occur during this test, the problems shall be fixed and the test shall be restarted. The test shall not be considered complete until the generator has operated for eight (8) consecutive hours without any shutdowns under the conditions listed above.
- f. After successful completion of the load bank tests, the generator system shall then be operated for a minimum of two (2) hours with plant loads during a time period when the plant is operating at average demand. The same data shall be recorded at 15 minute intervals for this load test as for the load bank test.

- g. The Contractor shall collect a sample of engine oil from each engine for analysis after the start-up and testing has been completed. The sampling method shall be of the atomic absorption spectrophotometry method and be accurate to within a fraction of one part per million for the following elements:

- Iron
- Chromium
- Copper
- Aluminum
- Silicon
- Lead

The sample shall also be tested for the presence of water and coolant.

The oil samples shall be analyzed at an independent laboratory that is not a part of the engine supplier's facility. Immediate notification of critical results shall be provided to the Owner when the analysis shows any critical reading.

- h. All lubricants and other fluids required to complete all field tests shall be paid for by the Contractor.

3.03 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified generator manufacturer's factory-trained technical representative who shall adequately supervise the installation and of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform all startup and field testing of the generator assembly as specified herein.
- C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for one (1) session of four (4) hours. Training shall not take place until after the generator has been installed and tested. Training shall be conducted at times coordinated with the Owner and shall occur during the same week as the training specified in Section 16496 – Automatic Transfer Switch.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
1. One (1) trip of one (1) working day to perform startup and testing of the engine-generator set (with an additional day if necessary to complete the required testing).

2. One (1) trip of one (1) working day to perform training as specified herein.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

- END OF SECTION -

SECTION 16670

LIGHTNING PROTECTION SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory operation a complete lightning protection system as specified herein. This is a performance specification. The Drawings do not show a complete lightning protection system design. The Contractor shall retain the services of a firm specializing in the design, installation, and testing of lightning protection systems.

1.02 CODES AND STANDARDS

- A. The system shall comply with the following codes and standards:
 - 1. Underwriters Laboratories, Inc. (U.L.):
 - a. U.L. 96 - Lightning System Components
 - b. U.L. 96A - Installation Requirements for Lightning Protection Systems
 - c. U.L. 467 – Grounding and Bonding Equipment
 - 2. National Fire Protection Association (NFPA):
 - a. ANSI/NFPA 780 - Lightning Protection Code
 - 3. Lightning Protection Institute (LPI):
 - a. LPI-175 - Standard of Practice

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Operation and Maintenance Manuals
 - 3. Spare Parts List
 - 4. Test Reports

5. UL Master Label Certification

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings for each lightning protection system shall include, but not be limited to:
 - 1. Product data sheets.
 - 2. Complete U.L. approved, full size layout and installation drawings/details with clearly marked dimensions. Drawings shall indicate the exact location of all system components. Drawings shall be signed by a full-time employee of the lightning protection system manufacturer who is in responsible charge of this project and has been engaged in the business for at least ten (10) years.
 - 3. Weights of major all components.
 - 4. Bill of material list for each lightning protection system.
 - 5. Manufacturer's installation instructions.
 - 6. Manufacturer's and installer's standard warranty.
 - 7. Evidence of the designer/installers UL listing.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:
 - 1. Instruction books and/or leaflets.
 - 2. Recommended spare parts list.
 - 3. Final as-built construction drawings included in the shop drawings incorporating all changes made during the installation.
 - 4. All other information that was included in the shop drawing submittal.

1.06 SPARE PARTS

- A. The lightning protection system shall be furnished with all spare parts as recommended by the equipment manufacturer.

In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following minimum spare parts for each structure provided with a lightning protection system under this Contract:

<u>No. Required</u>	<u>Descriptions</u>
2	Air Terminals
2	Point Tip Protectors

- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

- A. The lightning protection systems covered by this Specification shall be furnished using standard components of proven performance as manufactured by reputable concerns. The systems shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed.
- B. The lightning protection systems shall be furnished and installed by A-C Lightning Security, Inc., Thompson Lightning Protection, Inc, Lightning Elimination and Consultants, Modern Lightning Protection Company, Inc. or approved equal.
- C. System designer/supplier qualifications shall be as follows:
1. System components shall be manufactured by a company specializing in lightning protection equipment with a minimum of 5 years documented experience. Company shall be listed in the Section entitled "Lightning Conductor, Air Terminals and Fittings" of the U.L. "Electrical Construction Materials Directory" for at least 5 years previous to this Contract's bid opening date.

2. The system designer/installer shall be an authorized installer of manufacturer with a minimum of 5 years of documented experience. Designer/Installer shall be listed in the section entitled "Lightning Protection Installation" of the U.L. "Electrical Construction Materials Directory" for at least 5 years previous to this Contract's bid opening date.

2.02 LIGHTNING PROTECTION SYSTEMS

A. General

1. All components and parts of the lightning protection system shall be as specified herein. The materials used shall meet or exceed the material specification requirements of the Underwriters Laboratories, Inc. All materials shall be marked with a UL label or stamp.
2. The complete lightning protection system shall be inspected and included in the Master Label certification.

B. Conductors

1. Conductors shall be aluminum cable, consisting of a minimum of 24 strands of No. 14 AWG aluminum wire. Copper conductors shall be furnished and installed only where required and when in contact with the earth. Where termination of copper conductors is required to aluminum parts, suitable bi-metallic connectors approved for the purpose shall be furnished and installed.

C. Fittings

1. Fittings shall be the bolted type with stainless steel bolts, nuts, and washers. Fittings shall be of cast metal construction specifically designed for the application. Crimp-type fittings are not acceptable. Bi-metallic type fittings shall be furnished where required.

D. Fasteners

1. Fasteners shall be manufactured from non-corrosive material of ample strength and rigidity for the application.

E. Bases

1. Bases shall be bolted style provided with the model to suit the application (i.e. parapet, standing seam, etc.). Bolts, nuts, and washers shall be made of stainless steel. Bases shall be of aluminum or bronze construction, compatible with the material of the surface to which it is attached. Crimp-type bases are not acceptable.

F. Ground Rods

1. Ground rods shall be 3/4-inch by 10-foot 0-inch sectional type copper-clad steel rods; as specified in Section 16170, Grounding and Bonding; quantity as required. Ground rods and all associated hardware shall be UL 467 listed.

G. Air Terminals

1. Air terminals shall be solid aluminum. Air terminals shall be tapered or blunt tip type to suit the application and furnished with air terminal bases and safety tips (ball or bullet type) for impalement protection.

H. Thru-Roof Hardware

1. Thru-roof penetrations shall have stainless steel nuts, bolts, and washers. Sealing washers and sealing boots shall be provided as required and shall be compatible with the roofing material. Conductor connections to this roof hardware shall be by bolted connection. Crimp type connections are not acceptable.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The lightning protection system shall be furnished and installed in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the system components at time of shipment. The system components shall be suitably protected until accepted by the Owner.
- B. The equipment shall be installed in accordance with the manufacturer's recommendations. This shall include, but not be limited to the following:
 1. Course all main down conductors to maintain a downward or horizontal run free of pockets or sags. Maintain an eight-inch (8") minimum radius and make no bend greater than 90 degrees. Follow the most direct route with inductance bonding conductors maintaining the horizontal or downward course of the main conductor. Interconnect roof conductors to provide at least two paths to ground from each terminal and to form closed loops. Follow the most direct path possible with down conductors between roof conductors and ground terminals. All down conductors for new occupiable buildings shall be placed in a concealed manner. Down conductors for existing occupiable structures, tanks, basins, and other non-occupiable structures may be installed exposed.
 2. Install ground connections at no less than 60-foot intervals and at each down conductor on perimeter. If the structure has a ground grid, the ground rods from that grid may be used for connection to the down conductors. At each ground connection, determine the extent of the grounding arrangement according to the volume and type of soil encountered and the lowest expected moisture content. Have the Owner's representative observe each ground connection. Bond together all electrical service, telephone service, and lightning protection grounds to all underground metallic piping systems as required by Article 250 of the NEC.

3. The structural steel frame (where provided) may substitute for main down conductors provided the frame is electrically continuous and of adequate cross-section. Where the steel frame is utilized, connect the roof conductor to steel at least as often and at the same column as the ground connections. Make connections to steel with exothermic welds wherever possible. Provide bonding as required to make the entire metal frame continuous.
4. Bond all sizable metal objects within 6-feet of down, roof, or grounding conductors to the system. Use only approved fittings and conductors.
5. Wherever possible problems with corrosion are encountered, use substitute approved materials and/or provide corrosion protection. Use bimetallic or other specially designed and approved connectors where dissimilar metals are to be joined.
6. Install air terminals within 2-feet of the edge of structure and at intervals not greater than 20-feet along perimeter and peak. Provide additional terminals to limit spacing across roof to 50-feet maximum. Bond any exposed metallic object or surface to the roof conductor. Flash all terminal or conductor penetrations in the roof to conform to the roofer's requirements.
7. Record each ground connection location and mark up a reproducible copy of the approved shop drawings with their location. Also, indicate any substantial field modifications on these drawings. These drawings shall be included in the O&M manual.
8. Log all continuity tests of metal framing, ground grid connections, bonding, and similar connections. Indicate the location of tests or plans. Include test results in the O&M manual.
9. Retain U.L. to make an inspection of the completed installation and issue a Master Label Certification. Furnish a copy of the Certification to the Owner upon receipt.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 1. Certified Shop Tests and Reports
 - a. None Required.
 2. Field Tests
 - a. After installation, the lightning protection system shall be tested for continuity to the ground grid. The tests shall be made by the lightning protection system installer. Test shall be as follows:

- i. Record the resistance between each down conductor and the ground grid to ensure a suitable low-resistance connection. All resistance values shall be 1 ohm or less. Test shall be made after the ground grid has been installed and tested per the requirements of Section 16170, Grounding and Bonding.

-END OF SECTION-

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SECTION 16902

ELECTRIC CONTROLS AND RELAYS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.
- B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.
- C. Reference Section 16000, Basic Electrical Requirements and Section 16195, Electrical Identification.

1.02 CODES AND STANDARDS

- A. Products specified herein shall be in conformance with or listed to the following standards as applicable:
 - 1. NEMA 250 – Enclosures for Electrical Equipment
 - 2. UL 508A – Standard for Industrial Control Panels
 - 3. UL-1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
 - 4. ANSI/ISA 12.12.01-2013 – Nonincendive Electrical Equipment for use in Class I and II, Division II Hazardous (Classified) locations.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Spare Parts List
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. In addition to the manufacturer recommended spare parts, the following spare parts shall be provided for the local control stations:
 - 1. One (1) contact block of each type furnished on the project
 - 2. One (1) indicating light lens of each color furnished on the project
 - 3. One (1) LED lamp of each color furnished on the project
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

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:
 - i. Red - "Run", "On", "Open"
 - ii. Green - "Off", "Closed"
 - iii. Amber - "Alarm", "Fail"
 - iv. 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.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
All Outdoor Areas	NEMA 4X, Type 316 Stainless Steel

- D. In hazardous locations, local control stations 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.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Type 316 Stainless Steel
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

- E. 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.
- F. 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.
- G. Provide a nameplate on each local control station in accordance with Section 16195, 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. 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.
- B. 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.
- C. 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.
- D. Local control station covers shall be bonded to the local control station enclosure through the use of an insulated green bonding conductor.
- E. 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.
- F. Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors. Terminal strips, relays, timers, and similar devices shall not be installed on the side walls of panel/cabinet interiors without written permission from the Engineer.

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SECTION 17000

CONTROL AND INFORMATION SYSTEM SCOPE AND GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 SCOPE

- A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, components, system installation services, as well as required and specified ancillary services in connection with the Instrumentation, Control and Information System.
- B. The System includes materials, labor, tools, fees, charges, and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system.
- C. The system shall include measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, remote telemetry units, signal and data transmission systems, interconnecting wiring, and pertinent accessories.
- D. The scope of the work to be performed under this Division includes but is not limited to the following:
 - 1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.
 - 2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
 - 3. Furnish and install digital control system hardware and software as specified in Division 17. Coordinate with the Owner to incorporate the new facilities being constructed under this Contract into the Owner's existing SCADA system.
 - 4. Furnish, install and terminate special cables for devices (e.g., radios). Furnish and terminate control system communication network cables.
 - 5. Furnish and install surge protection devices for digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 16.
 - 6. Coordinate grounding requirements with the electrical subcontractor for digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division. Terminate grounding system cables at equipment provided under this Division.

7. Provide system testing, calibration, training and startup services as specified herein and as required to make systems fully operational. Coordinate all testing activities related to the existing SCADA system, including hardware software and radio communication systems, with the Owner.
- E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

- A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls, and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested, and calibrated as specified under other Divisions unless otherwise indicated.
- B. Additional and related work performed under Division 16 includes the following:
 1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for equipment, control panels and accessories furnished under this Contract.
 2. Conduit and raceways for instrumentation and control system signal wiring, grounding systems, special cables and radio communication cables.
 3. Instrumentation and control system signal wiring.
 4. Install control system radio communication cables.
 5. Furnish and install grounding systems for digital equipment, local control panels, remote telemetry units, and instrumentation. Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor. Termination of grounding systems for equipment furnished under other Divisions shall be performed by the electrical subcontractor.
 6. Termination of instrumentation and control system signal wiring at equipment furnished under other divisions of the Specifications.
 7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g., panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

- A. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment/systems and shall provide for the services of a qualified

installation engineer to supervise activities required to place the completed facility in stable operation under full digital control.

- B. The Contractor shall coordinate the efforts of each supplier to aid in interfacing systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.
- C. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

- A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water and wastewater facilities. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers/models of major hardware or software products (PLC, HMI software, network, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made.
- B. Acceptable instrumentation and control system subcontractors shall be MR Systems, Inc.

1.05 ENVIRONMENTAL CONDITIONS

- A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.
- B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (e.g., dust).
- C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.
- D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

PART 2 – PRODUCTS

(NOT USED)

PART 3 – EXECUTION

(NOT USED)

- - END OF SECTION - -

SECTION 17136

RADIO TELEMETRY SYSTEM (UNLICENSED)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the unlicensed (spread spectrum) radio telemetry equipment, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements

PART 2 -- PRODUCTS

2.01 GENERAL

- A. The Contractor shall provide a spread spectrum radio telemetry system that operates and is fully functional with no required FCC frequency license in the 902-928 MHz band.
- B. All communications equipment shall be installed in accordance with the manufacturer's recommendations, FCC rules and regulations, details on the Contract Drawings and as described below.

2.02 SCADA PARTS LIST

- A. Provide the equipment listed in the following table at the Thomas Island Regional PS:

Part	Manufacturer	Model No.	Qty	Units	Notes
LDF4-50A, HELIAX® Low Density Foam Coaxial Cable, corrugated copper, 1/2 in	CommScope	AND-LDF4-50A	As req'd	Feet	Amount determined by installation requirements
SureGround® Grounding Kit for 1/2" coaxial cable	CommScope	SG12-06B2A	2	Each	One at top + one at bottom
Weather Proofing Kit (for antenna)	CommScope	221213	1	Each	
Polyphaser, in-line lightning protection	CommScope	IS-B50LN-C2	1	Each	Installed at radio
Universal Stand-off Adapter (every 2 Feet)	CommScope	SA-38	3	Bag of 10	Wave guides shall be welded to pole.
SnapStak® Hanger for 1/2" coaxial cable	CommScope	SSH-12	3	Bag of 10	
890-960 Mhz, 10 DBD Gain, Yagi, N(F)	Kathrein Scala	SCA-TY-900	1	Each	
LMR-400 Jumper Cable, 24 inch	Hutton	ACM-400M-NMTM-24	1	Each	
Type N Male Positive Stop™ for 1/2" cable	CommScope	L4TNM-PSA	2	Each	
Antenna Mast, Galvanized or Aluminum 2" (conduit/pipe)		10'	1	Each	
4RF Aprisa SRi, Unlicensed 900 Mhz Spread Spectrum radio	4RF Aprisa Radio	APSI-N915-SSC-SO-22-C1AA	1	Each	Mounted in PS LCP Refer to Section 11130 East Coast VAR: MR Systems 1-678-325-2833
4RF Aprisa SRi Acc, Mounting, Bracket, DIN Rail	4RF Aprisa Radio	APSB-MBRK-DIN	1	Each	Mounted in PS LCP Refer to Section 11130 East Coast VAR: MR Systems 1-678-325-2833

2.03 ANTENNA SUPPORT STRUCTURE

- A. Support structures shall be designed to withstand earthquake, wind and ice loads in accordance with the Electronic Industries Association (EIA) Structural Standards for Steel Antenna Towers and Antenna Supporting Structures. Wind loads shall also be calculated in accordance with the State Building Code, except the basic wind speed used for calculating wind loads shall be 100 mph. The worst case loads from the EIA standards and the State Building Code shall be used for design. The shop drawing submittals shall include details of proposed antenna supporting systems.
- B. Antenna mast shall be a galvanized steel or aluminum pole with a height of 60 feet above ground level, with a 10-foot, 2-inch galvanized steel or aluminum mast mounted to the top. Antenna support poles shall be as manufactured by Valmont Structures, or equal.

- C. The Contractor shall submit for review by the Engineer shop drawings for the pole and its associated foundation signed and sealed by a professional structural engineer licensed in the State of South Carolina.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

- A. After the radios have been installed, the instrumentation subcontractor shall test the following items and make all necessary adjustments:
 - 1. Supply voltage (In keyed and de-keyed positions)
 - 2. Regulated voltage (In keyed and de-keyed positions)
 - 3. Lock voltage
 - 4. Signal strength
 - 5. Forward power
 - 6. Reverse power
 - 7. Standing wave ratio (SWR)
 - 8. Radio temperature
 - 9. Loop back code (if applicable)
 - 10. Software revision
 - 11. Hardware revision
 - 12. Time out timer setting
 - 13. Squelch tail eliminator
 - 14. Soft carrier de-key setting
 - 15. Push to test delay testing
- B. The instrumentation subcontractor shall test the integrity of the radio cable after installation to ensure that the insertion losses are not excessive. The lock voltage, regulated voltage, etc. shall be checked by keying and then de-keying the radio to ensure proper functioning of the radio hardware.
- C. Refer to Section 17000 for additional requirements.

- END OF SECTION -

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SECTION 17200

CONTROL AND INFORMATION SYSTEM SOFTWARE REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all control and information system software with all required programming and software appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements

PART 2 -- PRODUCTS

2.01 SOFTWARE REQUIREMENTS

- A. The Owner's existing SCADA (Human-Machine Interface or HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract.
- B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Contract Documents.

2.02 OVERALL SYSTEM CONFIGURATION

- A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel" of the Owner's existing system. Major HMI software scope of work shall include but shall not be limited to the following:
 - 1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.
 - 2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment, and create links to the new screens.
 - 3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.
 - 4. Modify existing reports to include the additional monitoring points specified under this Contract.
 - 5. Create new real-time and historical trends, and coordinate with the Owner appropriate grouping of the trend charts.

- 6. Update the system status display to include new hardware provided under this Contract.
- B. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

- A. Software design, implementation and checkout shall satisfy the requirements specified in the various Sections of Division 17.

- END OF SECTION -

SECTION 17560
SURGE PROTECTION DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install and place in satisfactory operation the surge protection devices (SPDs) as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements

1.03 GENERAL INFORMATION AND DESCRIPTION

- A. All surge protectors of each type provided under this Contract shall be furnished by a single manufacturer.

PART 2 -- PRODUCTS

2.01 SURGE PROTECTION, GENERAL

- A. 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.
- B. 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 Phoenix Contact, Edco, Transtector, Weidmuller, or equal.
- C. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.
- D. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.
- E. Device Locations: As a minimum, provide surge protection devices at the following locations:
 - 1. At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters.
 - 2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.

3. At both ends of all copper-based communication cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.
4. On all external telephone communication lines.

2.02 AC POWER PROTECTION

- A. 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, latest 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:
 - a. Maximum Continuous Operating Voltage: 150VAC
 - b. Maximum Operating Current: 20 amps
 - c. Ambient Temperature Range: -20 degrees C to +65 degrees C
 - d. Response Time: 5 nanoseconds

2.03 ANALOG SIGNAL CIRCUIT PROTECTION

- A. 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:
 - a. Maximum Continuous Operating Voltage: 28VDC
 - b. Ambient Temperature Range: -20 degrees C to +65 degrees C
 - c. Response Time (Line-to-Line): 5 ns

2.04 COMMUNICATION CIRCUIT PROTECTION

- A. 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:
 - a. IEC 60-1 / DIN VDE 0432 part 2
 - b. CCITT K17 / DIN VDE 0845 part 2
 - c. IEEE C62.31
 3. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
 4. Provide automatic recovery.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 17000 for additional requirements.

- END OF SECTION -

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SECTION 17698

INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.
- B. Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This Specification shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17700 – Powered Instruments, General
- C. Section 16902 – Electric Controls and Relays

1.03 SUBMITTALS

- A. Impulse piping layout and routing drawings
- B. Instrument assembly drawings.

PART 2 – PRODUCTS

2.01 PROCESS TUBING

- A. Process, impulse, or capillary tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with 37 degrees Type 316 stainless steel flared fittings or Swagelok or Parker-CPI flareless fittings.
- B. Piping for closely coupling instruments to process seals shall be standard stainless steel NPT threaded piping or NPT tapped mounting blocks.
- C. A nickel-based lubricant shall be used on threaded stainless steel piping connections to prevent galling.

2.02 POWER, CONTROL, AND SIGNAL CABLES

- A. Power, control and signal wiring shall be provided under Division 16 of the Specifications, unless otherwise indicated.

2.03 CHEMICAL DIAPHRAGM SEALS

- A. Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, all components shall be non-reactive with the process fluid in all cases. Refer to the Instrument Schedules for specific materials requirements.
- B. Seal shall have fill connection, 1/4-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements and shall be provided with 316 SS factory filled capillaries.
- C. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

2.04 ISOLATING RING SEALS

- A. For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).

1. Full Line Size Isolating Ring Seals

- a. Where indicated, the sensor body shall be full line size wafer design.
- b. Full line size isolating ring seals shall have 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. Gauge or readout shall be oriented for viewing.
- c. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Manufacturer shall furnish seals with a quick-disconnect-type fitting for field disassembly and reassembly, however, seal and instruments shall be factory assembled prior to arriving at the job site
- d. Isolating ring seals shall be RED Valve Series 40, Ronningen Petter Iso Ring, Moyno RKL Series W, Onyx Isolator Ring, or equal.

2. Tapped Isolating Ring Seals

- a. Where indicated, pressure shall be sensed via a minimum 1-1/2" diameter spool type isolating ring seal mounted on a 1-1/2" pipe nipple at 90 degrees from the process piping.

- b. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The factory assembled and filled pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally.
- c. Tapped isolating ring seals for solids service shall be Red Valve Series 42/742, Ronningen Petter Iso Spool, Onyx Isolator Ring, or equal.

2.05 FILLING MEDIUM:

- A. The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10 degrees F to +150 degrees F.
- B. Filling medium shall be silicone unless oxidizing agents, such as sodium hypochlorite, are present, then halocarbon shall be used.

2.06 TAMPER EVIDENT PAINT

- A. Piping and screwed/bolted connections of instrumentation containing the filling medium shall be marked with a small continuous tick mark of tamper evident paint over each piping/instrument joint. Tamper evident paint shall be applied prior to instrument assemblies arriving on the job site. Disturbance of the joint shall break the paint.
- B. Instrument assemblies with broken paint or missing paint shall not be accepted and shall be repaired or replaced at no additional cost to Owner. Paint shall be Dykem Cross-Check or equal.

2.07 ISOLATION VALVES

- A. Isolation valves shall be 1/2 inch diameter ball valves, unless otherwise indicated, with a Type 316 stainless steel body, Type 316 stainless steel ball. Where 316 stainless steel is not compatible with the process fluid, materials of construction shall be suitable for the associated process fluid (e.g., PVC for chemical service).

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 17700 of the Specifications.

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SECTION 17700

POWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The instrumentation subcontractor shall furnish, install, test and place in operation powered process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process control system as shown on the Drawings and as specified. Powered instruments are those instruments that require power (120 VAC or 24 VDC loop power) to operate. The Contractor may elect to install primary elements (flowmeters, etc.) on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.
- B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The instrumentation subcontractor shall supervise installation of equipment provided under this Division where installation is provided by others.
- C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17698 – Instrumentation and Control System Accessories
- C. Powered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

PART 2 -- PRODUCTS

2.01 GENERAL

- A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.
- B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.
- C. All field instrumentation for outdoor service shall be provided with enclosures which are suitable for outdoor service, as follows:
 - 1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.
 - 2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels unless otherwise specified herein or shown on the Drawings.
- D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.
- E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 (B) herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.
- F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper-free cast aluminum NEMA 4X construction.
- G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.
- H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

- I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.
- J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.
- L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

- 1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.
- 2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where the Contract Documents do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

- 1. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square by 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.
3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.
4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.
5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The instrumentation subcontractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.
2. The instrumentation subcontractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.
3. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

B. Field Instrument Calibration Requirements

1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.
2. If the manufacturer's recommendations require calibration, each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).
3. The instrumentation subcontractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.
4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.
5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.
6. After completion of instrumentation installation, the instrumentation subcontractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

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SECTION 17760

PRESSURE INDICATING TRANSMITTERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure indicating transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17700 – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 GAUGE PRESSURE INDICATING TRANSMITTERS

- A. Gauge pressure transmitters shall be of the capacitance type with a process-isolated diaphragm with silicone oil fill, microprocessor-based "smart" electronics, and a field adjustable rangeability of 100:1 input range. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.025 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits. Output shall be linear isolated 4-20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be -40 to 85 degrees Celsius at 0-100% relative humidity. Each transmitter shall have a stainless steel tag with calibration data attached to body.
- B. The piezoresistive silicon 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. 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. 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. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA output signal, with a remote interface device. Output signal

damping shall be provided, with an adjustable time constant of 0-36 seconds. Total long term stability (frequency of calibration) shall be not less than 0.20% URL for 15 years.

- C. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service.
- D. Gauge pressure indicating transmitters shall be Model 3051S1TG as manufactured by Emerson Process Management (Rosemount), or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 17700 of the Specifications.

- END OF SECTION -

APPENDIX A

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SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION
Encroachment Permit

Permit No : 228981

Permit Decision Date :

11/7/2019

Expiration Date : 11/7/2020

Type Permit :SEWER

Location:

<u>District</u>	<u>Work County</u>	<u>Type</u>	<u>Route</u>	<u>Aux</u>	<u>Begin MP</u>	<u>End MP</u>
6	Berkeley, SC	S-	33	None	8.258	8.366
6	Berkeley, SC	S-	33	None	8.590	8.590
6	Berkeley, SC	S-	913	None	0.067	0.067

Contact Information

Applicant: CharlestonWaterSystem

Phone:

Contact: Christopher E.
Troutman, P.E.

Address: 103 St Philip Street,

City: Charleston

State: SC

Zip: 29403

Comments

Along Clements Ferry Rd below I-526; see attached plans

Special Provisions:

9999 - See Attached for Additional Special Provisions

Customer Agreement

3. The undersigned applicant hereby requests the SCDOT to permit encroachment on the SCDOT right of way as described herein. It is expressly understood that the encroachment, if and when constructed, shall be installed in accordance with the sketch attached hereto and made a part hereof. The applicant agrees to comply with and be bound by the SCDOT's "A Policy for Accommodating Utilities on Highways Rights of way", "Standard Specifications for Highway Construction", the "General Provisions" and "Special Provisions", attached hereto or made a part hereof by reference, during the installation, operation and maintenance of said encroachment within the SCDOT's Right of Way. **DISCHARGES OF STORM WATER AND NON-STORM WATER:** Work within State Highway right-of-way shall be conducted in compliance with all applicable requirements of the National Pollutant Discharge Elimination System (NPDES) permit(s) issued to the Department of Transportation (Department), to govern the discharge of storm water and non-storm water from its properties. Work shall also be in compliance with all other applicable Federal, State and Local laws and regulations, and with the Department's Encroachment Permits Manual and encroachment permit. The encroachment permit will not be issued until the applicant has received an NPDES construction permit from SC Department of Health and Environmental Control.

The applicant agrees to comply with all current SCDOT Standards Specifications for Highway Construction including all Supplemental Technical Specifications. The applicant hereby further agrees, and binds his/her/its heirs, personal representatives, successors, assigns, to assume any and all liability for accidents or injuries to persons, or damage to property, including the highway, that may be caused by the construction, maintenance, use, moving or removing of the physical appurtenances contemplated herein.

Applicant's Name: Christopher E. Troutman, PE Date: 10/03/2019

(Please print or type)

Applicant's Sig:  Title: Asst. Director of Engineering

For Office Use Only

For Office Use Only

In accordance with your request and subject to all the provisions, terms, conditions, and restrictions stated in the application and the general and special provisions attached hereto, the SCDOT hereby approves your application for an encroachment permit. This permit shall become null and void unless the work contemplated herein shall have been completed prior to:

- ☐ See Attached Special Provision and/or Permit Requirements

	NPDES Permit No:	
		11-7-19
(Date received by res. Maint. Engr.)	(SCDOT Approval)	(Date)

9999 SPECIAL PROVISIONS

Sewer

The South Carolina Department of Transportation reserves the right to impose additional conditions, provisions, and/or requirements on this permit to respond to any unforeseen, specific problems that might arise during the life of this permit, and to take any enforcement action necessary to ensure compliance with SCDOT specifications, standards, or policies.

If in the future the proposed utility work to be performed under this permit is requested to be removed by the SCDOT because of roadway improvements and the facilities are left in place by the permittee, and the improvements are made and the facilities are then located under new pavement or construction, any future access, taps, ties, or maintenance on the covered facilities may be denied by SCDOT.

All of the following provisions may not apply to work being performed under this permit. Any provision listed below along with those stated on the application form, and any other provision added to and made part of this permit, will be required to be executed to the extent expressed in these provisions.

The permittee fully understands and agrees with all conditions, requirements, provisions, and specifications associated with or listed on this permit with the start of any construction described or shown on this permit.

This permit has been approved with one year life duration; all work shown or detailed on this permit must be completed and accepted in that time frame. If all of the work is not finished the permit will be considered in noncompliance and the permittee will be legally responsible for any actions which may result from the construction deficiencies.

Approval of this permit is for the installation of a 12" PVC sewer main within the right-of-way of Clements Ferry Road (S-8-33 & S-8-913) and St. Thomas Island Drive (S-8-33). Project will include the installation of a 45' of 24" steel casing, 100' of 24" steel casing, 715' of 12" PVC sewer main, 190' of 8" PVC sewer main, and (6) SSMH. Installation method will be jack and bore and trenching. All shown fully on the plans.

The contractor is to confirm all existing utilities' location and depth prior to construction. Contractor shall notify CWS and SCDOT Berkeley Maintenance of any location and elevation discrepancies that differ from the plans.

No lane closures or traffic disruptions will be allowed without prior permission. Any work requiring a traffic disruption or lane closure will be done at night between the hours of 9:00 PM and 5:00 AM with all traffic control removed from the roadway at that time. Any closure will require notifying SCDOT and all required media outlets and all emergency agencies a minimum of one week prior to the implementation of the closure.

Any SCDOT assets damaged during the installation of this sewer line must be repaired/replaced by the permittee to SCDOT standards and specifications immediately.

- Let it be known that this utility company will need to coordinate with other utilities that may be in the vicinity. This concurrence does not relieve them of conflicts with other utilities. They will also need to make sure that they will be underneath our storm drain and all minimum vertical and horizontal clearances are met per standard. In addition, they need to ensure that the proposed driveway elevations align with all the improvements which includes but limited to sidewalk, roadway, curb and gutter.

All driveways cut during installation of utility lines will be restored and completely patched immediately to ensure property owner's access, and shall meet all South Carolina Department of Transportation specifications that apply. Each driveway will be patched with the same material used in the construction of the driveway. Concrete driveways will be cut at an existing joint or at a location that will not leave small areas of less than 4'-0" between patch edge and existing joint or edge of pavement.

- If any settlement occurs within the open cut driveways, the permittee shall repair the settled area and provide an overlay of asphalt covering the entire driveway.
- Backfilling of trenches is to be accomplished immediately after placement of pipe.

OPEN CUT(S) AND POTHOLING (If required)

1. This office must be contacted a minimum of 48 hours before project is to begin to schedule an SCDOT Inspector (if available) to be on site when open cut is performed
2. The open cut repairs to any portion of the roadway shall include the following: milling 2" deep on each side of open cut to extend 5' beyond each side of open cut the entire width of all travel lanes affected. Entire depth of open cut(s) shall be flowable filled and steel plated with steel plate secured to the road surface. Once setup then top four inches of flowable fill removed and patched with a minimum of 4" hot asphalt surface course and/or the thickness and type of existing asphalt, whichever is greater. Milled area shall be replaced with 220 lbs/sy asphalt surface course Type B.
3. Steel plate ahead signs shall be placed approx. 500' before the excavation in both directions
4. If any settlement occurs within the open cut(s), the permittee shall repair the settled area and provide an overlay of asphalt covering the entire repair and any additional area to be determined by SCDOT at that time.
5. The open cut(s), potholing, repairs to the road structure, and the final mill and overlay of the travel lanes will be performed at night between the hours of 9:00 pm and 5:00 am with all traffic control removed from the roadway at that time. Any closure will require notifying all required

media outlets, SCDOT, and emergency agencies a minimum of one week prior to the implementation of the closure.

This office must be contacted a minimum of 48 hours before project is to begin to schedule an SCDOT Inspector (if available) to be on site when any open cut is performed.

If any settlement occurs within the open cut(s), the permittee shall repair the settled area and provide an overlay of asphalt covering the entire repair and any additional area to be determined by SCDOT at that time.

- The South Carolina Department of Transportation reserves the right to impose additional conditions, provisions, and/or requirements on this permit to respond to any unforeseen, specific problems that might arise during the life of this permit, and to take any enforcement action necessary to ensure compliance with SCDOT specifications, standards, or policies.
- If in the future the facilities left in place by the permittee and the facilities are located under new pavement or construction, any future access, taps, ties, or maintenance on the covered facilities may be denied by SCDOT.
- All of the following provisions may not apply to work being performed under this permit. Any provision listed below along with those stated on the application form, and any other provision added to and made part of this permit, will be required to be executed to the extent expressed in these provisions.
- The permittee fully understands and agrees with all conditions, requirements, provisions, and specifications associated with or listed on this permit with the start of any construction described or shown on this permit.
- **Prior to the start of any work shown on this permit the permittee, the contractor, and SCDOT will meet on site to discuss proposed work, these provisions, and all required safety requirements and signage pertaining to this permit.**
- All construction signage is to be placed and maintained during the construction of this project until SCDOT final approval of work is given for all work shown on this permit. All signage is the responsibility of the permittee.
- Any boring operation being made on this project shall be made by method shown in permit and in such a manner as not to disturb the existing pavement. Notice will be given to the South Carolina Department of Transportation a minimum of 48 hours prior to the start of the boring operation, and immediately if the bore turns and damages the existing roadway pavement or shoulders in any way.
- At all locations of jack and bore crossings, casing will extend from right-of-way line to right-of-way line.

- All ingress and egress from and to the work area must be made from a safe location providing adequate and safe sight distance for the workers and motorists.
- Traffic Control to follow SCDOT Standard Drawing 610-005-00 for a Flagging Operation.
- Traffic Control to follow SCDOT Standard Drawing 610-205-00 for a Shoulder Closure.
- This office is to be notified a minimum of 24 hours prior to any work inside SCDOT rights-of-way being started by calling, faxing or emailing the Permit Construction Notification form or by immediately calling if an accident should occur during this construction. (843) 761-8481
- Any installation of this water/sewer main between the ditch line and edge of pavement must have a cover depth of 42 inches below the top of pavement.
- Any installation of this water/sewer main between the ditch line and right-of-way line must have a minimum cover depth of 36 inches.
- The utility company to the extent required by law shall hold harmless the Department, its employees, contractors and agents, from any damages caused to the utility installations by routine maintenance operations. The utility company shall be responsible for any damages it causes to other utility installations on the Department right-of-way.
- All work shown on attached drawings to be done by Chas. Water Systems.
- All pavement markings (edge line and/or center line) shall be restored to SCDOT standards and specifications.
- Any existing pavement markings or traffic signage altered during the installation of this permitted construction will be replaced by the permittee to their original condition as soon as possible. All existing and required construction signage will be maintained at all times during this permit.
- **No trenches or open excavations are to be left open overnight.**
- All areas disturbed inside SCDOT rights-of-way are to be compacted, graded and grassed as soon as possible to prevent any erosion or sedimentation in the drainage system.
- The open cut repairs to any portion of the roadway shall include the following: milling 2" deep on each side of open cut to extend 5' beyond each side of open cut. Entire depth of open cut shall be flowable filled and steel plated then secured to allow setup then top four inches of flowable fill removed and patched with a minimum of 4" hot asphalt surface course and/or the thickness and type of existing asphalt, whichever is greater. Milled area shall be replaced with 220 lbs/sy asphalt surface course Type B.
- The open cut(s) in the roadway is/are to be patched by backfilling with SCDOT approved flowable fill, plated and when setup
- **Any sidewalk or curbing damaged or removed during construction must be replaced by the permittee to SCDOT standards and specifications.**
- All construction signage is to be placed and maintained during the construction of this project until SCDOT final approval of work is given for all work shown on this permit. All signage is the responsibility of the permittee.
- No excavated material is to be placed or let accumulate on roadway surface during the construction of this project. All material is to be removed from roadway as soon as possible.

- **Any excavation within 5' of the edge of pavement will be backfilled entirely with flowable fill. The excavated area will be backfilled entirely with flowable fill.**
- **Any boring operation being made on this project shall be made by method shown in permit and in such a manner as not to disturb the existing pavement. The bore pit must not be any closer than five to six feet from the edge of pavement and constructed as shown. **The cover over the casing shall not be less than 48 inches at any point in the casing length from the lowest point of the roadway cross sections to the top of the casing.** Notice will be given to the South Carolina Department of Transportation a minimum of 24 hours prior to the start of the boring operation, and immediately if the bore turns and damages the existing roadway pavement or shoulders in any way.**
- **Bore pits shall be closed immediately after installation. Disturbed area will be backfilled in 6" lifts, compacted as required, graded to provide positive drainage, raked, and cleared of all debris, then grassed as required.**
- **This office is to be notified 24 hours prior to the start of any boring or open roadway cut operation is to begin. All necessary equipment and materials needed to accomplish these tasks are to be on site, and inspected by SCDOT inspector prior to the start of each operation. This also includes all traffic control devices and signage. Call (843) 761-8481**

UTILITY LINE CONSTRUCTION PROVISIONS

- 1.) All work to be performed under this permit will be in accordance with South Carolina Department of Transportation manual "A Policy for Accommodating Utilities on Highway Right-of-way", latest edition.
- 2.) All underground utility lines are to be placed as indicated on attached drawings or detailed in the permit. The line is to be placed in a uniform distance either off edge of roadway or right-of-way lines with the least amount of defluctive changes as possible. All lines are to be buried with a minimum cover as shown on drawings or indicated in the permit.
- 3.) Contractor will maintain access to all property owners at all times during construction, and until final inspection, and approval is obtained. If in the course of construction driveways are to be cut and access impaired the contractor will be responsible to inform each resident of the inconvenience and the time, date and length of the work to be done.
- 4.) All utility valves, meters, vaults, air release valves, manholes, and others utility structures are to be installed outside existing or proposed roadway surface, flush with the existing ground, and behind ditches if at all possible, and/or 3'-0" inside the right-of-way lines.
- 5.) Any existing pavement markings or traffic signage altered during the installation of this permitted construction will be replaced by the permittee to their original condition as soon as possible. All existing and required construction signage will be maintained at all times during this permit. Some new construction will require new pavement markings and permanent signage, see permit for details.
- 6.) Any request for a final inspection of a utility project will be made by either sending this office a letter or email requesting final inspection or by calling and requesting the inspection.

UTILITY LINE BORING PROVISIONS

- 7.) Any boring operation being made on this project shall be made by method shown in permit and in such a manner as not to disturb the existing pavement. The bore pit must not be

any closer than five to six feet from the edge of pavement and constructed as detailed in provision number 8. The cover over the casing shall not be less than 48 inches at any point in the casing length from the lowest point of the roadway structure to the top of the casing. Notice will be given to the South Carolina Department of Transportation a minimum of 24 hours prior to the start of the boring operation, and immediately if the bore turns and damages the existing roadway pavement or shoulders in any way.

- 8.) At all locations of jack and bore crossings, casing will extend from right-of-way line to right-of-way line. Boring pit location will be determined by the depth of boring, i.e. the distance from edge of pavement to the front edge of the pit will be the same or greater than the depth of line crossing, minimum of five or six feet.
- 9.) Bore pits shall be closed immediately after installation. Disturbed area will be backfilled in 6" lifts, compacted as required, graded to provide positive drainage, raked, and cleared of all debris, then grassed as required.
- 10.) This office is to be notified 24 hours prior to the start of any boring or open roadway cut operation is to begin. All necessary equipment and materials needed to accomplish these tasks are to be on site, and inspected by SCDOT inspector prior to the start of each operation. This also includes all traffic control devices and signage. Call (843) 761-8481

PAVEMENT PROVISIONS

- 11.) Any pavement to be used in the construction shown on this permit is to be placed as specified and in accordance with the South Carolina Department of Transportation standard specifications for highway construction (latest edition), whichever is greater. The pavement structure listed or shown will be used in all areas where asphalt is to be placed inside SCDOT right-of-way unless indicated differently on the permit.
- 12.) Any existing roadway pavement damaged or removed in connection with this work will be replaced, using the same thickness and type of material destroyed, or according to specifications called for in the South Carolina Department of Transportation construction manual (latest edition), whichever is greater.
- 13.) Where pavement is cut and replaced, the contractor shall cut the edges to a straight and even line before removing the pavement. No ragged edges will be allowed or accepted. All patches and repairs will have squared corners. Prior to placing new asphalt all existing edges are to be tacked as per current SCDOT specifications. In some cases an asphalt surface overlay may be required to smooth riding surface of roadway at patch, see permit for details.
- 14.) Where roadway pavement is cut and is to be replaced, the trench is to be backfilled with SCDOT approved flowable fill from top of pipe to riding surface, and steel plating is to be placed over cut and secured as required. Then maintained until backfill has setup and then surface treatment can be placed. The top two inches (minimum) of flowable fill is to be removed and the equivalent amount and type of existing roadway asphalt (minimum two inches) is to be placed in patch.

EXCAVATION PROVISIONS

- 15.) Any required excavation or mucking in connection with this work, will be backfilled in six inch layers, and thoroughly compacted in a manner satisfactory to the South Carolina Department of Transportation specifications. Density tests may be required with the

results to be furnished to the departments utility inspector on a weekly basis during construction, see permit for details.

- 16.) Compaction requirements in these provisions apply to crosscuts and longitudinal trench cuts from shoulder break to shoulder break. If compaction tests are required the maximum distance between tests shall be 500 feet. In some cases additional tests may be required, see permit for details.
- 17.) If unsuitable material is excavated, it will not be put back in the excavation, and will be removed from the right-of-way as soon as possible. The material will be replaced with suitable approved backfill, and be in compliance with the South Carolina Department of Transportation specifications for backfill.
- 18.) There shall be no excavation of soil nearer than two feet from any public utility pole or appurtenant facility without the written consent of the owner thereof. Special permission of the South Carolina Department of Transportation after an opportunity to be heard is given the owner of such pole or appurtenant facility may be given.
- 19.) If the side of the trench, pit, or any excavation is less than 3'-0" from the existing edge of pavement, the excavated area will be backfilled entirely with flowable fill to an elevation 6 inches from the existing ground elevation. Then brought to grade with suitable topsoil, compacted, graded, and grassed as required to eliminate any erosion.
- 20.) Existing ditch slopes, if excavated, shall be backfilled in six inch layers and well tamped with a mechanical tamp to 95% density (standard proctor). These lifts will be benched into the existing embankment as required. The new slopes will then be graded to match existing typical roadway cross section.
- 21.) No excavated material or spoil is to be placed on the pavement without the permission of the South Carolina Department of Transportation, and if permission is granted, this material must be removed daily, as soon as possible. The roadway is to be cleaned of all material in a manner as to protect the existing pavement. Any pavement destroyed, or marked by this operation will be removed and replaced as required.
- 22.) When shoulders and ditch slopes are reshaped and graded to a typical section, the section will match existing road section. Where the existing section is less than state standards (6' wide shoulder @ 12:1, front slope of ditch @ 4:1, ditch bottom as required to accommodate existing runoff, and back slope of ditch min. 3:1 or to right-of-way line) the section will be upgraded to the standard. In either case positive drainage must be established and approved by SCDOT.
- 23.) Contractor will maintain positive drainage at all times during construction and until final inspection and approval from South Carolina Department of Transportation is obtained.
- 24.) No excavation located between the edge of roadway pavement and the center of sideline ditch or 15'0" where no ditch is present is to be left open overnight. The excavation is to be either temporarily backfilled or a steel plate is to be secured over hole. In either case reflective traffic cones are to be placed around the area of the excavation until the excavation has been permanently backfilled as required and graded.

CONSTRUCTION CLEANUP PROVISIONS

- 25.) All areas in SCDOT right-of-way disturbed during construction are to be restored to original condition as soon as possible and maintained during entire length of project,

- 26.) All disturbed areas inside SCDOT rights-of-way will be seeded with a mixture of grass seed as specified in the South Carolina Department of Transportation standard specifications for highway construction, section 109b2, or latest edition. No rye grass will be allowed inside SCDOT rights-of-way. A satisfactory stand of grass will be required, prior to any acceptance or final approval is granted on this permit.
- 27.) All rocks, pebbles, boards, other debris along with any spoil material will be kept clear of roadway at all times as the work progresses.

TRAFFIC CONTROL PROVISIONS

- 28.) The permittee, owner, and/or contractor will be responsible for all required traffic control for this construction. SCDOT will be available for any questions concerning the required signage, types, size and placement.
- 29.) Any time personnel or equipment is required to be inside right-of-way. Signs are to be covered or removed each night or if no activity is present inside right-of-way.
- 30.) All men working in the SCDOT right-of-way will wear approved safety vests as required.
- 31.) **Traffic control, lights, signs, and flagmen will be furnished by the permittee and/or contractor and will conform to “Manual on Uniform Traffic Control Devices”, latest edition. All devices and signs will be maintained during all phases of construction. Signs not in use will be removed or covered as required.**

GENERAL PROVISIONS

- 32.) All work to be performed under this permit will be in accordance with South Carolina Department of Transportation specifications, latest edition.
- 33.) All work indicated on this permit is to be completed within one (1) year of the approval date of the permit. All utility line construction is to include the surface treatment and all shoulder and ditch stabilization required.
- 34.) All roadway and work performed in the SCDOT right-of-way under this permit including any utility installations will be the responsibility of the owner for the life of the utility placed. If for any reason the utility line fails, this office is to be notified immediately. If in the construction of the project detailed on the permit, the roadway or right-of-way construction or any part of that construction is performed in a manner not specified in the permit or according to SCDOT standards or specifications shall be corrected immediately.
- 35.) Appropriate South Carolina Department of Transportation officials will be notified as of the start of any construction on this project, 24 hours prior to the start, and be kept informed of the progress during construction, and when a final inspection is wanted at the completion of the project.
- 36.) A reliable, properly insured, and licensed contractor will perform this construction.
- 37.) Any construction materials or equipment to be stored or parked alongside of roadway or in the right-of-way will be placed a minimum of 30' from the edge of pavement, or have warning devices as required and approved by this office.
- 38.) Field changes, if necessary must be submitted in writing and approved prior to the start of any actual construction on proposed change. An as-built set of plans will be required upon completion of the project reflecting any and all changes to the original plans.
- 39.) If a time extension or a revision to an approved permit is required, a written request along with any drawings required is to be submitted to this department for review and approval. No work is to be performed on any item not indicated on the permit, either shown in a sketch or indicated in a description, prior to an amended permit being issued.

- 40.) The permittee shall be responsible for any and all damages that occur as a direct result of this installation.
- 41.) A copy of this approved permit will be made available to the South Carolina Department of Transportation at the work site at all times.



Permit Construction Notification

Submit To: Encroachment Permit Manager
SCDOT Berkeley Encroachment Permit Office
Email: Carswelljs@scdot.org Fax: 843-761-5100

This notification is to inform the Department of the upcoming construction commencement of the following permitted work:

Permit Number:

Road Name/Number:

Project Name:

Name of Permittee:

Contractor Name & Contact:

Contractor Office & Mobile Phone No:

Proposed Preconstruction Date:

Estimated Project Completion Time:

Notes:

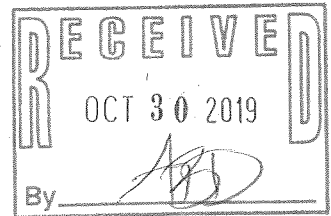
❖ Upon completion of all work you must contact the SCDOT-Berkeley Maintenance Permit Office at (843) 761-8481 to schedule a final inspection.

❖ Once work has been satisfactorily completed SCDOT will issue a Letter of Compliance.

APPENDIX B

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BERKELEY COUNTY DEPARTMENT OF ROADS AND BRIDGES
P.O. Box 6122
MONCK'S CORNER, SC 29461-6120
719-4129 723-3800 567-3136
FAX - 719-4974



APPLICATION FOR ENCROACHMENT PERMIT

APPLICANT NAME: Charleston Water System
MAILING ADDRESS: 103 St. Philip Street, Charleston SC 29403
SITE ADDRESS: Along Old Clements Ferry Road
TELEPHONE: (83) 727-6876 SUBDIVISION: Shell Ring
EMAIL: benjamind@charlestoncpw.com

1. The undersigned applicant hereby applies to the Berkeley County Roads and Bridges Department for a permit for encroachment on the County right-of-way or easement as shown and described below:
2. Type of encroachment:

<input type="checkbox"/> Driveway	<input type="checkbox"/> Pipe Drainage Easement	<input type="checkbox"/> Landscaping
<input type="checkbox"/> Fence	<input checked="" type="checkbox"/> Other (Describe) <u>Utility (12-inch gravity sewer)</u>	
3. Description and details of proposed installation: (Attach drawings showing the encroachment on the right-of-way or easement)
4. The undersigned applicant hereby requests the Berkeley County Roads and Bridges Department to permit encroachment on the County's right-of-way or easement as described herein. It is expressly understood that the encroachment shall be installed in accordance with the description and details attached hereto and made a part hereof, including the General Provisions and Special Provisions. The applicant agrees to assume any and all liability that may be caused by the construction, maintenance, use, moving or removing, of the physical appurtenances contemplated herein and agrees to indemnify Berkeley County from any liability incurred or injury or damage sustained by reason of the past, present, or future existence of said appurtenances.

Applicant Name: Don Benjamin, P.E. Date: 10/23/19
(Print or Type Name)

Applicant(s) Signature: [Signature] Title: Dir. of Engineering & Construction

Area Below For Office Use Only:

In compliance with your request and subject to all the provisions, terms, conditions and restrictions stated in the application and special provisions below or attached hereto, the Department approves the request. This permit is valid for a period of 12 months from the date of approval.

SPECIAL PROVISIONS: This is Not an SCDOT Permit.

This is Not an approval for unpaved/gravel section of
Old Clements Ferry RD. See Drawings #s C204, C206-C208

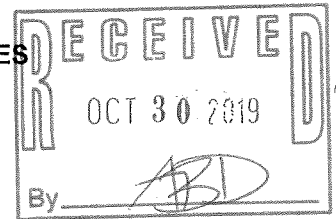
Approved by: [Signature] Date: 11/22/19

Title: Encroachment Inspection Supervisor PLEN #: See attached documents.

Revised August 24, 2015

Any questions, please call
Ashley Holley
(843) 719-4132

BERKELEY COUNTY DEPARTMENT OF ROADS AND BRIDGES
P.O. Box 6122
MONCK'S CORNER, SC 29461-6120
719-4129 723-3800 567-3136
FAX - 719-4974



APPLICATION FOR ENCROACHMENT PERMIT

APPLICANT NAME: Charleston Water System
MAILING ADDRESS: 103 St. Philip Street, Charleston SC 29403
SITE ADDRESS: Along Clouter Creek (near 118 Clouter Creek Drive)
TELEPHONE: (83) 727-6876 SUBDIVISION: Shell Ring
EMAIL: benjamind@charlestoncpw.com

- The undersigned applicant hereby applies to the Berkeley County Roads and Bridges Department for a permit for encroachment on the County right-of-way or easement as shown and described below:
- Type of encroachment:
☒ Driveway ☐ Pipe Drainage Easement ☐ Landscaping
☐ Fence ☐ Other (Describe) _____
- Description and details of proposed installation: (Attach drawings showing the encroachment on the right-of-way or easement)
- The undersigned applicant hereby requests the Berkeley County Roads and Bridges Department to permit encroachment on the County's right-of-way or easement as described herein. It is expressly understood that the encroachment shall be installed in accordance with the description and details attached hereto and made a part hereof, including the General Provisions and Special Provisions. The applicant agrees to assume any and all liability that may be caused by the construction, maintenance, use, moving or removing, of the physical appurtenances contemplated herein and agrees to indemnify Berkeley County from any liability incurred or injury or damage sustained by reason of the past, present, or future existence of said appurtenances.

Applicant Name: Don Benjamin, P.E. Date: 10/25/17
(Print or Type Name)

Applicant(s) Signature: [Signature] Title: Dir. of Engineering & Construction

Area Below For Office Use Only:

In compliance with your request and subject to all the provisions, terms, conditions and restrictions stated in the application and special provisions below or attached hereto, the Department approves the request. This permit is valid for a period of 12 months from the date of approval.

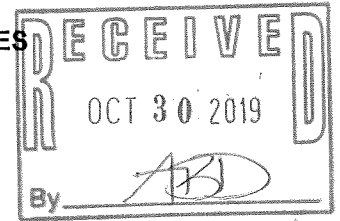
SPECIAL PROVISIONS: This is Not an SCDOT Permit.
This is Not an approval For unpaved/Gravel Section
of old CLEMENTS FERRY RD, Drawing #s C201-C206-C208

Approved by: Ashley Holley Date: 11/20/19
Title: Encroachment-Inspection Supervisor PLEN #: See attached documents.

Revised August 24, 2015

Any questions, please call
Ashley Holley
(843) 719-4132

BERKELEY COUNTY DEPARTMENT OF ROADS AND BRIDGES
P.O. Box 6122
MONCK'S CORNER, SC 29461-6120
719-4129 723-3800 567-3136
FAX - 719-4974



APPLICATION FOR ENCROACHMENT PERMIT

APPLICANT NAME: Charleston Water System
MAILING ADDRESS: 103 St. Philip Street, Charleston SC 29403
SITE ADDRESS: Along Clouter Creek (near 118 Clouter Creek Drive)
TELEPHONE: (83) 727-6876 SUBDIVISION: Shell Ring
EMAIL: benjamind@charlestoncpw.com

- The undersigned applicant hereby applies to the Berkeley County Roads and Bridges Department for a permit for encroachment on the County right-of-way or easement as shown and described below:
- Type of encroachment:

<input type="checkbox"/> Driveway	<input type="checkbox"/> Pipe Drainage Easement	<input type="checkbox"/> Landscaping
<input type="checkbox"/> Fence	<input checked="" type="checkbox"/> Other (Describe) <u>Utility (8-inch force main)</u>	
- Description and details of proposed installation: (Attach drawings showing the encroachment on the right-of-way or easement)
- The undersigned applicant hereby requests the Berkeley County Roads and Bridges Department to permit encroachment on the County's right-of-way or easement as described herein. It is expressly understood that the encroachment shall be installed in accordance with the description and details attached hereto and made a part hereof, including the General Provisions and Special Provisions. The applicant agrees to assume any and all liability that may be caused by the construction, maintenance, use, moving or removing, of the physical appurtenances contemplated herein and agrees to indemnify Berkeley County from any liability incurred or injury or damage sustained by reason of the past, present, or future existence of said appurtenances.

Applicant Name: Don Benjamin, P.E. Date: 10/25/19
(Print or Type Name)

Applicant(s) Signature:  Title: Dir. of Engineering & Construction

Area Below For Office Use Only:

In compliance with your request and subject to all the provisions, terms, conditions and restrictions stated in the application and special provisions below or attached hereto, the Department approves the request. This permit is valid for a period of 12 months from the date of approval.

SPECIAL PROVISIONS: This is not an SCDOT Permit.
This is not an approval for unpaved/gravel section
of old Clements Ferry RD. See Drawings #s C201, C206-C208

Approved by:  Date: 11/22/19

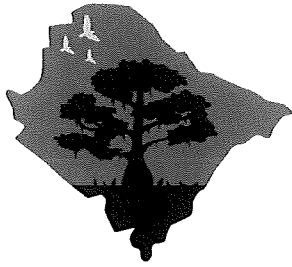
Title: Encroachment-Inspection PLEN #: See attached documents.
Supervisor

Revised August 24, 2015

Any questions, please call
Ashley Holley
(843) 719-4132

ENCROACHMENT PERMIT GENERAL PROVISIONS

1. **NOTICE PRIOR TO STARTING WORK:** Before starting the work contemplated, the Department shall be notified 24 hours in advance so that a representative may be present while the work is underway.
2. **PERMIT SUBJECT TO INSPECTION:** This permit shall be kept at the site of the work at all times while said work is underway and must be shown to any representative of the Department or law enforcement officer on demand.
3. **PROTECTION OF PUBLIC:** Adequate provisions shall be made for the protection of the public at all times. Where applicable, necessary detours, barricades, warning signs, and flagmen shall be provided by and at the expense of the permit tee and shall be in accordance with the South Carolina Manual on Uniform Traffic Control Devices. The work shall be planned and carried out so that there will be the least possible inconvenience to the public. The permit tee agrees to observe all rules and regulations of the Department while carrying on the work contemplated herein and take all other precautions that circumstances warrant.
4. **STANDARDS OF CONSTRUCTION:** All work shall conform to approved plans and recognized standards of construction and shall be performed in a workmanlike manner. Adequate provisions shall be made for maintaining proper drainage. All work shall be subject to the supervision and satisfaction of the Department.
5. **FUTURE MOVING OF PHYSICAL APPURTENANCES:** If, in the opinion of the Department Director, it should ever become necessary to move or remove the physical appurtenances, or any part thereof contemplated herein, on account of repair of drainage facilities, change in location of the roadway, widening of the roadway, or for any other sufficient reason, such relocation shall be done on demand of the Department at the expense of the permit tee.
6. **RESTORATION OF ROADWAY AND/OR FACILITIES UPON MOVING OR REMOVING OF PHYSICAL APPURTENANCES:** If, and when, the physical appurtenances contemplated herein shall be moved or removed, either on the demand of the Department or at the option of the permit tee, the roadway and/or facilities shall immediately be restored to their original condition at the expense of the permit tee.
7. **COSTS:** All work in connection with the construction, maintenance, moving or removing of the physical appurtenances contemplated herein shall be done by and at the expense of the permit tee.
8. **PERMITTEE:** The word "Permit tee" used herein shall mean the name of the person, firm, corporation, or public utility to whom this permit is addressed, as well as his/her/its, heirs, successors and assigns.
9. **PERMISSION OF ABUTTING PROPERTY OWNERS:** It is distinctly understood that this permit does not in any wise grant or release any rights lawfully possessed by the abutting property owners. Any such rights necessary shall be secured from said abutting property owners by the permit tee.
10. **UTILITY WORK:**
 - a) Work shall be performed in accordance with the SCDOT's "A Policy for Accommodating Utilities on Highway Rights-of-Way."
 - b) Poles/posts shall be placed at the distance from the centerline of right of way or easement as specifically stipulated herein.
 - c) All tunneling, boring, or jacking shall be done in such a way as not to disturb the roadway surfacing.
 - d) No pavement shall be cut unless specifically authorized herein.
 - e) No excavation shall be nearer than three feet to the edge of pavement unless specifically authorized herein.
 - f) Underground facilities will be located at minimum depths as defined in the Utility Accommodations Manual for the surfaces – 30 inches minimum for power and communication lines and 36 inches for all other facilities.
 - g) Service and other small diameter pipes shall be jacked, driven or otherwise forced underneath the pavements on any
 - h) Warning tape shall be placed directly over all water lines, sewer lines, force mains, power lines, and fiber optic lines at a depth of 18 inches below the finish surface grade.
 - i) No road may be closed unless specifically authorized herein.
11. For the purpose of this permit, the word "Department" shall mean the Berkeley County Department of Roads and Bridges.
12. The permit tee shall be responsible for obtaining any other approvals or permits necessary for installation.
13. Permit tee is responsible for maintaining reasonable access to private driveways during construction.
14. **BEAUTIFICATION WORK:**
 - a) All trees, plants, flowers, etc., shall be placed in accordance with the provisions specifically stipulated herein.
 - b) All trees, plants, flowers, etc., shall be cared for by and at the expense of the permittee and the provisions of this permit shall become null and void if and when the permittee ceases to properly care for said trees, plants, flowers, etc.
15. There shall be no excavation of soil nearer than two feet of any public utility line or appurtenant facility except with the consent of the owner thereof, or except upon special permission of this Department after an opportunity to be heard is given the owner of such line or appurtenant facility.
16. Privacy fences must be a minimum of 3" above finished grade and at least 3 feet from drainage structures within easements.



**BERKELEY
COUNTY SC**

RICH HISTORY.
BRIGHT FUTURE.

One Berkeley

**BERKELEY COUNTY
Roads & Bridges**

**Special Provisions
Utilities**

SOUTH CLEMENTS FERRY RD.

THOMAS ISLAND CWS REGIONAL PUMP STATION & INTERSEPTER SYSTEM

- This is not an SCDOT permit.
- This permit is not an approval for work in the gravel section of Old Clements Ferry RD. from SAT.# 7+20 – SAT.# 12+60. See drawings C201- C202, & C206 – C208 CWS PLANS, THOMAS ISLAND REGIONAL PUMP STATION & INTERCEPTOR. HAZEN # 30533-008.
- Conduits must not cut into or cut through any drainage structures.
- All road boring, will be at a minimum of 36” under the road surface, basins, pipe lines and under ditch flow lines.
- Unless preplanned and approved by Berkeley County, all open cuts and excavation in the road bed will be compacted in 4” lifts, flowable filled before base, repaved and crack sealed.
- Poles and any attachments must be in the back of the right-of way and not obstruct line of sight or traffic movement.
- Any damages to drainage structures; ditches, pipes, basin, curb or asphalt is to be made safe and reported to Berkeley County Roads & Bridges office in a timely manner and to be properly repaired and or replaced by permit holder or its contractors or sub-contractors.
- Excavation within 36” of edge of asphalt, under curb and sidewalk must be sealed with flowable fill.
- Bore and excavation work must not damage or clog any existing drainage structures.
- Bore pits and any other excavations or any soil disturbances will be filled, compacted, repaired to proper grade and re-sodded by applicant or applicant’s contractors or sub-contractors.
- No pipes, conduits, wire, or any other utilities shall intrude into or conflict in any way with drainage basin, pipes or ditches.
- Conduit stub-outs must be a minimum of 36” from edge of asphalt.
- Berkeley County is not responsible for altered surfaces made dangerous by broken, leaking, unmaintained or improperly installed systems.
- Berkeley County is not responsible for any trash or waste associated with permitted work and cleanup is the responsibility of applicant or applicant’s contractors or sub-contractors.



BERKELEY COUNTY SC

Construction Entrance

RICH HISTORY.
BRIGHT FUTURE.

One Berkeley

I. Design

- I. Thickness = 6-inches
- II. Width of entrance area = 24-feet Minimum
- III. Length = 100-feet or required length for 10 tire revolutions
- IV. Material consist of stone with a D50 diameter ranging from 2--3 in
- V. Non-woven geotextile fabric is required to underlie the stone.

2. Installation

- VI. Remove all vegetation from the foundation area.
- VII. Divert all surface runoff to a sediment trap or basin.
- VIII. Install an entrance pipe when needed to provide positive drainage.

3. Inspection & Maintenance

- IX. Inspect every 7 calendar days and within 24-hours after each rainfall.
- X. Inspect and clean sediment traps immediately following each rainfall.
- XI. Wash & reshape the stone as needed for drainage control
- XII. Wash or replace the stone in the entrance whenever the entrance fails to reduce mud being carried off site by vehicles
- XIII. Remove as soon as they are no longer needed to provide access to the site.

- **Follow All Berkeley County Approved Plans; Provisions, Ordinances and Regulations.**
- **Follow All Storm Water Regulations and Practices**



Hazen and Sawyer
735 Johnnie Dodds Blvd., Suite 102
Mount Pleasant, SC 29464 • 843.414.1402

October 29, 2019

Ashley Holley
Maintenance Support Supervisor
Department of Roads and Bridges
Berkeley County
P.O. Box 6122
Moncks Corner, SC 29461-6120

Re: Thomas Island Regional Pump Station and Interceptor

Dear Mr. Holley:

Please find the following attached to this letter:

- Three (3) Encroachment Permit Application forms:
 - Driveway Encroachment along Clouter Creek
 - Force Main Encroachment along Clouter Creek
 - Force Main Encroachment along Clements Ferry Road
- Two (2) copies of Signed and Sealed Plans (1 – Full Size and 1 – Half-Size)

If any additional information is required, please feel free to contact me at (843) 414-1408 or email me at cragos@hazenandsawyer.com.

Thank you,

Carl Ragos, PE
Associate



BERKELEY COUNTY SC

Construction Entrance

RICH HISTORY.
BRIGHT FUTURE.

One Berkeley

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BERKELEY
COUNTY SC

BERKELEY COUNTY
Roads & Bridges

RICH HISTORY.
BRIGHT FUTURE.

One Berkeley

Special Provisions
Utilities

SOUTH CLEMENTS FERRY RD.

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- Excavation within 36” of edge of asphalt, under curb and sidewalk must be sealed with flowable fill.
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- Bore pits and any other excavations or any soil disturbances will be filled, compacted, repaired to proper grade and re-sodded by applicant or applicant’s contractors or sub-contractors.
- No pipes, conduits, wire, or any other utilities shall intrude into or conflict in any way with drainage basin, pipes or ditches.
- Conduit stub-outs must be a minimum of 36” from edge of asphalt.
- Berkeley County is not responsible for altered surfaces made dangerous by broken, leaking, unmaintained or improperly installed systems.
- Berkeley County is not responsible for any trash or waste associated with permitted work and cleanup is the responsibility of applicant or applicant’s contractors or sub-contractors.

PO Box 6122, Moncks Corner, SC 29461-3707
223 N. Live Oak Drive Moncks Corner, SC 29461
(843) 719-4129 • **Fax** (843) 719-4974

APPENDIX C

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Geotechnical Engineering Report
Thomas Island Pump Station and Interceptor
Charleston, South Carolina

July 28, 2017

Terracon Project No. EN175139

Prepared for:

Hazen and Sawyer
Charleston, South Carolina

Prepared by:

Terracon Consultants, Inc.
North Charleston, South Carolina

terracon.com

Terracon

Environmental



Facilities



Geotechnical



Materials

July 28, 2017



Hazen and Sawyer
1 Poston Road, Suite 320
Charleston, South Carolina 29407

Attn: Mr. Jared M. Hartwig, P.E.
P: (843) 744-6467
E: jhartwig@hazenandsawyer.com

Re: Geotechnical Engineering Report
Thomas Island Pump Station and Interceptor
Charleston, South Carolina
Terracon Project No. EN175139

Dear Mr. Hartwig:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Hazen and Sawyer contract # 30533-008 dated June 13, 2017. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

A handwritten signature in black ink, appearing to read "Yulian A. Kebede".

Yulian A. Kebede
Geotechnical Project Manager

A handwritten signature in black ink, appearing to read "William B. Wright".

William B. Wright, P.E.,
Authorized Project Reviewer



A handwritten signature in black ink, appearing to read "Jonathan N. Ard".

Jonathan N. Ard, P.E.
Senior Geotechnical Engineer



Terracon Consultants, Inc. 1450 Fifth Street West North Charleston, South Carolina 29405

P [843] 884 1234 F [843] 884 9234 terracon.com

Environmental

Facilities

Geotechnical

Materials

REPORT TOPICS

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GEOTECHNICAL SEISMIC CONSIDERATIONS	5
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ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLAN
EXPLORATION RESULTS (In Situ Testing Logs)
SUPPORTING INFORMATION (General Notes)

GEOTECHNICAL OVERVIEW

This report provides recommendations for foundation options, seismic considerations, site preparation, and the other geotechnical related conditions that might affect the proposed construction. The following geotechnical considerations were identified during our investigation:

- Deep excavations will require fully sloping, shielding, or combination of both methods. Open cut excavation with slopes no greater than 2H: 1V (horizontal: vertical) can be utilized.
- Due to the shallow groundwater depth, a dewatering program will be necessary to provide a stable work environment below the groundwater table.
- Based on procedures outlined in IBC 2015 and ASCE 7-10, and the results of our field testing, the project site will classify as Seismic Site Class D. However, the structural engineer should verify that the site class exemption provided by ASCE 7-10 Section 20.3.1 is available for the proposed facility.
- We estimate that unmitigated total liquefaction-induced settlements from the design seismic event may range from **1 to 2 ½ inches** with differential settlement ranging from 50% to 75% of the total.
- With proper site preparation, the proposed pump station can be supported on a mat foundation with an estimated static settlement on the order of **1 inch** and differential settlements up to ½ inch over 50 feet.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT

Thomas Island Pump Station and Interceptor

Charleston, South Carolina

Terracon Project No. EN175139

July 28, 2017

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed pump station and sewer line to be located on Clements Ferry Road in Charleston, South Carolina. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- site preparation and earthwork
- lateral earth pressures
- foundation design and construction
- excavation considerations
- seismic site classification per IBC
- other geotechnical considerations

We explored the pump station site with two Cone Penetration Tests (CPTs) and the sewer line locations with five Cone Penetration Tests (CPTs) to depths ranging from approximately 30 to 40 feet. Adjacent to the in situ tests, we also conducted a Hand Auger Boring (HAB) to 4 feet below existing ground surface. In situ tests were performed on Monday, June 26 and Friday, June 30, 2017.

Maps showing the site and boring locations are presented in the **Site Location** and **Exploration Plan** sections, respectively. The boring logs are located in the **Exploration Results** section of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel information	The project is located at Clements Ferry Road in Charleston, South Carolina. Latitude: 32.8712° Longitude: -79.9333° See Site Location
Existing improvements	There is an existing right of way with utilities and roadway.
Current ground cover	Small trees, brush, and grass
Existing topography	Relatively flat lying

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information provided	The client has provided areal drawings and preliminary plans showing the location of the pump station, wet well, and sewer force main. The client also provided the in situ test locations.
Project description	Pump station that has a wet well bearing approximately 20.5 feet below the existing ground surface. The sewer line will be embedded at varying depths between 1 to 20.5 feet below the existing grade.
Finished floor elevation	Based on the preliminary plan drawings provided by Hazen and Sawyer, the FFE for the pump station is at Elevation 8.5 feet. The proposed wet well is located at Elevation -12.50 feet. Existing ground surface is located at Elevation 8.0 feet.
Maximum loads	The following structural loads were assumed by Terracon. ■ Matt Foundation: 1,500 pounds per square foot If final loads vary from these assumptions, further review will be necessary.
Grading/slopes	We are assuming 1 foot or less of fill may be required to develop final grade.

Geotechnical Engineering Report

Thomas Island Pump Station and Interceptor ■ Charleston, South Carolina

July 28, 2017 ■ Terracon Project No. EN175139



Item	Description
Below Grade Structures	Proposed wet well to be located at 20.5 feet below existing grade.
Pavements	Asphalt pads will be constructed at the pump station location.
Estimated start of construction	Unknown

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting. The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Generalized soil profile at the pump station and sewer line locations

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description ^{1,4}	Consistency/Density	OSHA Soil Classification
1	4 to 8 inches	Topsoil	N/A	N/A
2	10 feet	Sandy clay with interbedded sand layers	Very soft to soft	Type C
3	23 feet	Silty sand with interbedded clay layers	Medium dense to dense	Type B
4	40 feet ²	Cooper Marl Formation ³	Medium stiff	Type B

1. Material descriptions are based on visual classification from HAB samples and correlations with in situ data.

2. Termination of deepest testing.

3. The Cooper Marl Formation is a well-studied and uniform soil stratum consisting of clayey to sandy silt approximately 100 to 200 feet thick in the greater Charleston area. This soil stratum is a typical bearing layer for deep foundations as well as the basis for earthquake modeling in the Charleston area.

4. In situ testing at CPT-3 location showed sandy soils throughout the top 30 feet of the subsurface profile.

Geotechnical Engineering Report

Thomas Island Pump Station and Interceptor ■ Charleston, South Carolina

July 28, 2017 ■ Terracon Project No. EN175139



Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized below.

Boring number	Date Performed	Approximate depth to groundwater after drilling (feet) ¹	Estimated Depth to Groundwater based on CPT Pore Pressure Data (feet) ¹
CPT-1	06/30/2017	4.5 ft.	4.5 ft.
CPT-2	06/26/2017	5 ft.	5 ft.
CPT-3	06/30/2017	4 ft.	4 ft.
CPT-4	06/30/2017	5 ft.	5 ft.
CPT-5	06/30/2017	5 ft.	5 ft.
CPT-6	06/30/2017	7.5 ft.	7.5 ft.
CPT-7	06/26/2017	5 ft.	5 ft.

¹. Below ground surface

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

There is a possibility of a perched groundwater table within the top 10 feet of the subsurface soils due to the presence of clayey soils near the surface in some areas of the project site. The groundwater surface should be checked prior to construction to assess its effect on site work and other construction activities. Refer to the table below for groundwater depth at each in situ test location.

GEOTECHNICAL SEISMIC CONSIDERATIONS

According to the International Building Code 2015 edition (IBC 2015), structures are required to avoid collapse during a design earthquake event. The design earthquake has a 50 year exposure period with a 2% probability of exceedance (i.e. a 2500 year design earthquake). The 2500 year design earthquake has a Moment Magnitude (M_w) of 7.3 and a design Peak Ground Acceleration (PGA_M) of **0.81 g**, as determined by data provided by the IBC 2015 Code and ASCE 7-10. The seismic evaluation of the site identified potentially liquefiable soils. According to the IBC (2015) and ASCE 7-10, this potential for liquefaction classifies the site as Site Class F.

ASCE 7-10 (Section 20.3.1) provides an exception to the Site Class recommendation for structure(s) with a fundamental period equal to or less than 0.5 seconds. This exception states that a site can be classified without considering liquefaction to determine spectral accelerations for structural design. The structural engineer should verify this exception. If the proposed structures meet the requirements of the exception, Seismic Site Class D would be applicable and the following seismic design parameters can be used for the site:

Code Used	Site Classification
2015 International Building Code (IBC) ¹	D ²
Seismic Design Parameter	Value
F_a	1.01
F_v	1.62
F_{PGA}	1.00
S_{DS}	0.82 g
S_{D1}	0.42 g
PGA_M ³	0.81 g

1. In general accordance with the 2015 International Building Code and ASCE 7-10 Table 20.3-1.
2. Based upon the fundamental period exception outlined in ASCE 7-10 Section 20.3.1.
3. Based on procedures outlined in ASCE 7-10 for geotechnical hazards

LIQUEFACTION

Due to the high seismicity of the Coastal Plain of South Carolina, we performed a liquefaction potential analysis to evaluate the stability of the soils. Ground shaking at the foundation of structures and liquefaction of the soil under the foundation are the principal seismic hazards identified for the design of earthquake-resistant structures. Liquefaction occurs when a rapid buildup in water pressure, caused by the ground motion, pushes sand particles apart, resulting in a loss of strength and later densification as the water pressure dissipates. This loss of strength can cause bearing capacity failure while the densification can cause excessive settlement.

While the amount of settlement is dependent on the magnitude and distance from a seismic event, and geologic age of the soil deposit, we estimate that settlements from the design earthquake may range from **1 to 2 ½ inches**. Differential settlement may range from 50% to 75% of the total settlement depending on depth and amount of liquefaction, and location relative to a seismic event epicenter. Design under the IBC allows for buildings to sustain damage during the design earthquake event, but they must remain standing. Therefore, our liquefaction settlement estimate should be reviewed from the standpoint of risk of total collapse of the structure. While the project structural engineer should review our estimates, in our experience, liquefaction mitigation is not typically required for this amount of liquefaction settlement.

RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

The recommendations presented herein have been developed on the basis of the subsurface conditions encountered during field investigation and our understanding of the proposed construction.

Deep Excavations

Sloping, shielding consisting of steel sheeting, or a combination of both will be necessary for deep excavation and construction of the pump station and sewer line. We understand these excavations may reach depths of 20.5 feet or more below the existing ground surface. Open cut excavation with slopes no greater than 2H:1V (horizontal: vertical) can be utilized. If site constraints will not allow slopes of that size, shielding consisting of steel sheeting can be used, or a combination of both sloping and shielding. At a minimum, sheeting should extend past the anticipated bottom depth of the excavation by a minimum of 5 feet below Cooper Marl Formation to minimize the potential for bottom heave and limit groundwater inflow. If side slopes or open cut excavations are considered, a slope stability analysis will be necessary. The slope stability analysis should account for the potential for groundwater inflow, including steady state conditions and storm events. Dewatering will be required at the pump station and deeper sewer line location due to the shallow groundwater table.

Depending on the stability of the excavation bottom encountered at time of construction, it may be necessary to increase the excavation depth by several feet below what is necessary to construct the pump station and backfilled with free draining No. 57 stone or similar material. The stone will aid in dewatering using sump pumps and provide a stable working surface during construction. A nonwoven geotextile fabric should be placed between the stone and underlying native soils to limit the migration of fines into the stone and should meet SCDOT specifications.

Shallow Utility Excavations

Shallower excavations for installation of the sewer line can be sloped back per OSHA soil types or shielding with trench boxes. Dewatering will be required for excavations deeper than 5 feet. Due to the presence of fine grained soils to depths of 10 feet below existing ground surface, a bridge lift of No. 57 stones may be necessary to provide a stable working platform.

Lateral Earth Pressure

Walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Appropriate earth pressures should be used for wall restraint conditions. Active pressure can be used when the top of wall can move

Geotechnical Engineering Report

Thomas Island Pump Station and Interceptor ■ Charleston, South Carolina

July 28, 2017 ■ Terracon Project No. EN175139



0.002H to 0.004H. At rest earth pressure is used when there is no wall movement. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.

Estimated soil parameters and lateral earth pressure coefficients

Stratum	Depth (ft.)	Estimated Soil Properties					
		Total/Effective Unit Weight (pcf)	Friction Angle (ϕ)	Cohesion (psf)	Earth Pressure Coeff.		
					Active K_a	At Rest K_o	Passive K_p
1	0 to 10	110/47.6	N/A	500	1	1	1
2	10 to 40	120/57.6	30	N/A	0.33	0.50	3.00

Depending on the section modulus of sheeting selected, the sheeting system may require supplemental bracing to maintain stability. The ground support system (with or without slopes) should conform to OSHA Standard 29 CFR 1926. The design of the shielding system should be based on the soils within the study area and parameters provided in the previous table. The contractor is solely responsible for designing and maintaining a stable excavation and all excavations should comply with applicable local, state, and OSHA standards.

Excavation and Dewatering

Groundwater was encountered at an average depth of 5 feet below the ground surface therefore dewatering will be necessary to provide a stable work environment. The groundwater should be kept 2 feet below excavations to provide a stable work area. Dewatering can be accomplished with trench drains (2 feet deep) filled with #57 stone be installed at the toe of the slopes to allow groundwater to be pumped from the excavation. Alternatively, sanded well points can also be utilized to dewater the excavation. Dewatering system should be undertaken concurrently with the excavation support. The dewatering design should be undertaken by an engineer registered in the State of South Carolina, employed by the contractor and is familiar with this type of operation. The shallow utility excavations can be dewatered sloping the bottom of the trench to a sump areas and pumping the water with sump pumps or whistlers.

We recommend surface stormwater runoff be prevented from entering the open excavation with either a berm and swale system constructed around the perimeter of the excavation. Soils used to construct the berm may consist of the less permeable clayey soils removed from the excavation.

General Excavation Notes

We expect the excavation of the pump station and sewer lines can be accomplished with a trackhoe and typical excavation bucket. Unless accounted for and allowed by the shielding design, soils removed from the excavation should not be placed closer than 30 feet from the edge of the excavation to prevent surcharge loading on the shielding system and to prevent spillage of spoil material back into the excavation.

OSHA standards require daily inspections of excavations, their surrounding areas, and protective systems by a geotechnical engineer or other competent person. Daily inspections are to be conducted prior to the start of work in the excavation, after each storm event or other hazard-increasing occurrence and as needed throughout the workday. These inspections search for evidence of situations that could result in possible cave-ins, indications of failure of the protective systems, or other hazardous conditions. Safety guidelines concerning means of egress into and out of the excavation, worker protection from falling loads, and other issues as outlined in OSHA Standard 29 CFR Part 1926 should be followed at all times.

Site Preparation

The initial step in site preparation is to strip and clear the upper topsoil, existing slab/pavements, existing utilities, and other deleterious material from within the proposed construction area footprint. Once the subgrade is exposed, a construction drainage plan should be established to carry surface water away from the structural areas. After a construction drainage plan is established the excavation of the wet well can commence. Once the wet well is constructed and backfilled, the asphalt pad area should be proofrolled to aid in locating loose or soft areas. Proofrolling can be performed with a loaded tandem axle dump truck and should be monitored by the geotechnical engineer. Loose, soft, and/or wet soils that pump or rut excessively while proofrolling should be removed and replaced with controlled fill or reworked and compacted in-place as described in the following paragraphs.

Fill Material Types

We recommend that Controlled Fill be used to backfill the pump station excavation. Controlled Fill should meet the following material property requirements:

Fill Type ¹	USCS Classification	Acceptable Parameters (for Structural Fill)
Controlled/Imported Fill	SP, SP-SM, GP, GW, SW, SC, SM (Passing #200<15%)	All locations and elevations
Onsite Soil	SC, SM (Passing #200<25%)	All locations and elevations

Geotechnical Engineering Report

Thomas Island Pump Station and Interceptor ■ Charleston, South Carolina

July 28, 2017 ■ Terracon Project No. EN175139



Fill Type ¹	USCS Classification	Acceptable Parameters (for Structural Fill)
Onsite Soil ²	SC, SM, CL, CH, ML, MH (Passing #200>25%)	Non-structural areas

1. Structural and general fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. Clayey or silty soils with fine content greater than 25% should not be used within 5 feet of finished grade in building area and 1 foot below finished grade in all other structural fill areas.

We understand that excavations with approximately 20.5 feet in depth or more will require backfilling during this project. Sands encountered below the upper 10 feet of the subsurface soils at the location of the pump station, may meet the criteria in the above table. However, before these materials are used as Controlled Fill, laboratory testing should be performed to ensure the requirements of this section are met. If material encountered does not meet the criteria of this section, it should not be used as Controlled Fill, however, it may be used as general fill in non-structural areas.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill
Fill lift thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum compaction requirements ^{1, 2, 3}	Pavement Base Course: 100% of the material's maximum Modified Proctor dry density (ASTM D1557) Controlled Fill: 95% of the material's maximum Modified Proctor dry density ASTM D1557)
Water content range ¹	Within the range of $\pm 2\%$ of optimum moisture content value as determined by the Modified Proctor test.

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D 1557).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate.
3. We recommend that Controlled Fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

Utility Pipe Bedding

Pipe bedding for gravity utility lines will be required in areas that are below the groundwater. We recommend a minimum of 6 inches of pipe bedding but contractor should carry contingency for additional bedding mat.

Uplift Resistance Mat Foundation Recommendations

The new pump station may be constructed on a monolithic mat foundation with an allowable contact pressure of **1,500 psf**. Long-term post construction static settlements are expected to be 1 inch or less. The weight of the structure can be used to resist the buoyancy (uplift) forces experienced by the wet well. If additional uplift resistance is needed, the designers may consider extending the perimeter of the mat beyond the edge of the walls to further resist the buoyant forces. For this case, the volume of the soil mass available for uplift restraint includes the mass directly above the edge of the mat plus that contained within the wedge bounded by a vertical line and a line projected at a 15° angle with the vertical, both originating from the top outside edge of the mat. The unit weight of 120 pcf and 150 pcf can be used for the soil and concrete, respectively, in calculating the vertical restraint. These values should be reduced by the unit weight of water (62.4 pcf) below the groundwater level. We recommend designing the structure for a groundwater level at a depth of 5 feet below ground surface. If surface drainage conditions are expected to be poor in the area of the wet well area, full buoyant conditions should be resisted.

Asphalt Pad

The asphalt pad should not be placed until after completion of the wet well and all equipment is installed. The subgrade soils for the asphalt pad area should be prepared as described in the above sections. Traffic patterns and anticipated loading conditions were not available at the time that this report was prepared. However, we anticipate that traffic loads will be produced primarily by service trucks. If the asphalt pad traffic loads are expected to be greater than occasional service trucks the pad should be determined using expected traffic volumes, vehicle types, and vehicle loads and should be in accordance with local, city or county ordinances.

Traffic Area	AC Surface Course ¹	Graded Aggregate Base Course	Total Thickness
Pad around wet well	2.0 Inches	6.0 Inches	8.0 inches

1. AC: Asphalt Concrete

GENERAL COMMENTS

Our work is conducted with the understanding of the project as described in the proposal, and will incorporate collaboration with the design team as we complete our services to verify assumptions. Revision of our understanding to reflect actual conditions important to our work will be based on these verifications and will be reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the geotechnical conditions in the area, the data obtained from our site exploration and from our understanding of the project. Variations will occur between exploration point locations, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations. Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes only. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made. Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

SITE LOCATION AND EXPLORATION PLANS

SITE LOCATION

Thomas Island Pumpstation and Interceptor ■ Charleston, SC

July 18, 2017 ■ Terracon Project No. EN175139

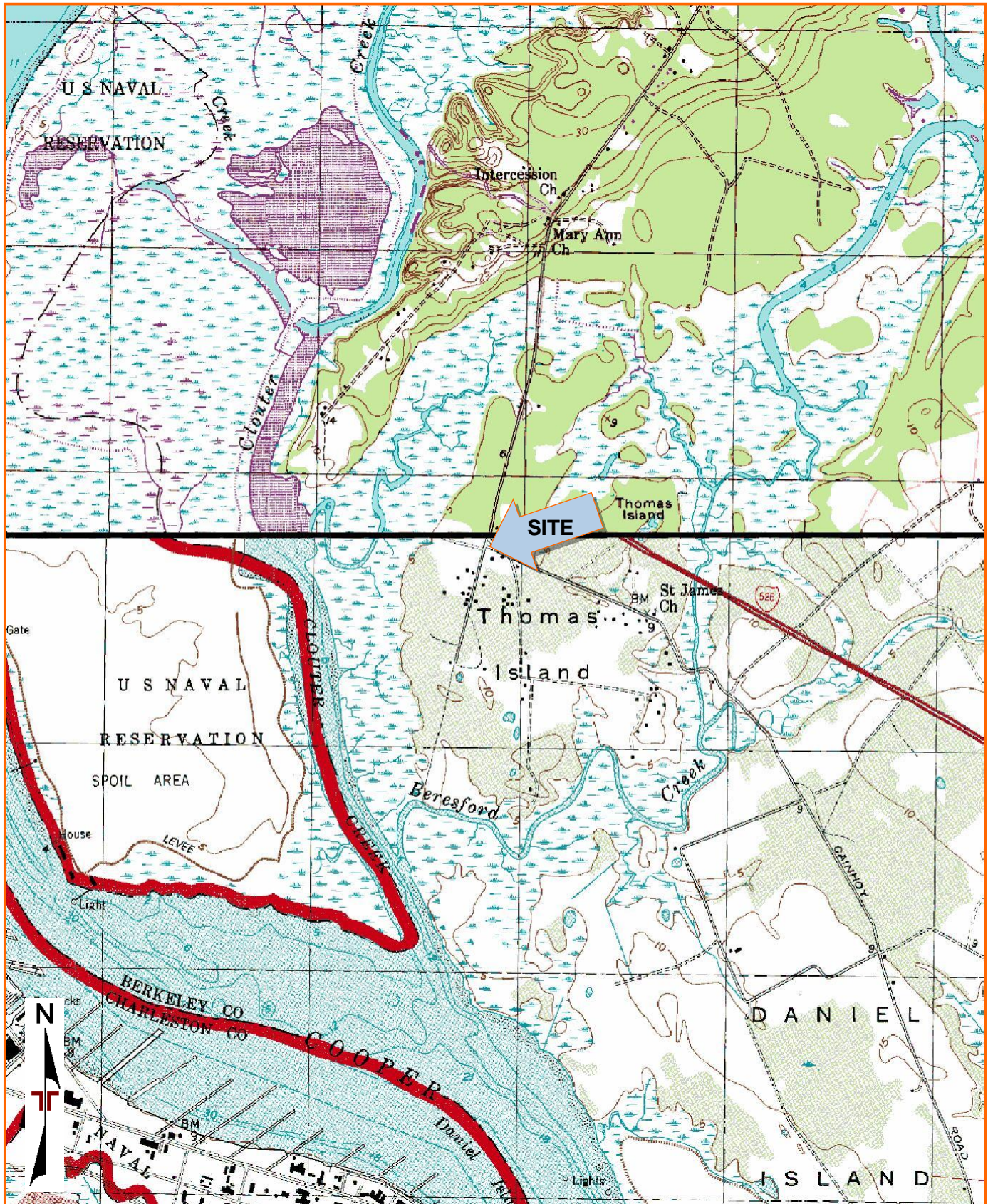


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: NORTH CHARLESTON, SC (1/1/1998) and CHARLESTON, SC (1/1/1994).

EXPLORATION PLAN

Thomas Island Pumpstation and Interceptor ■ Charleston, SC
July 18, 2017 ■ Terracon Project No. EN175139

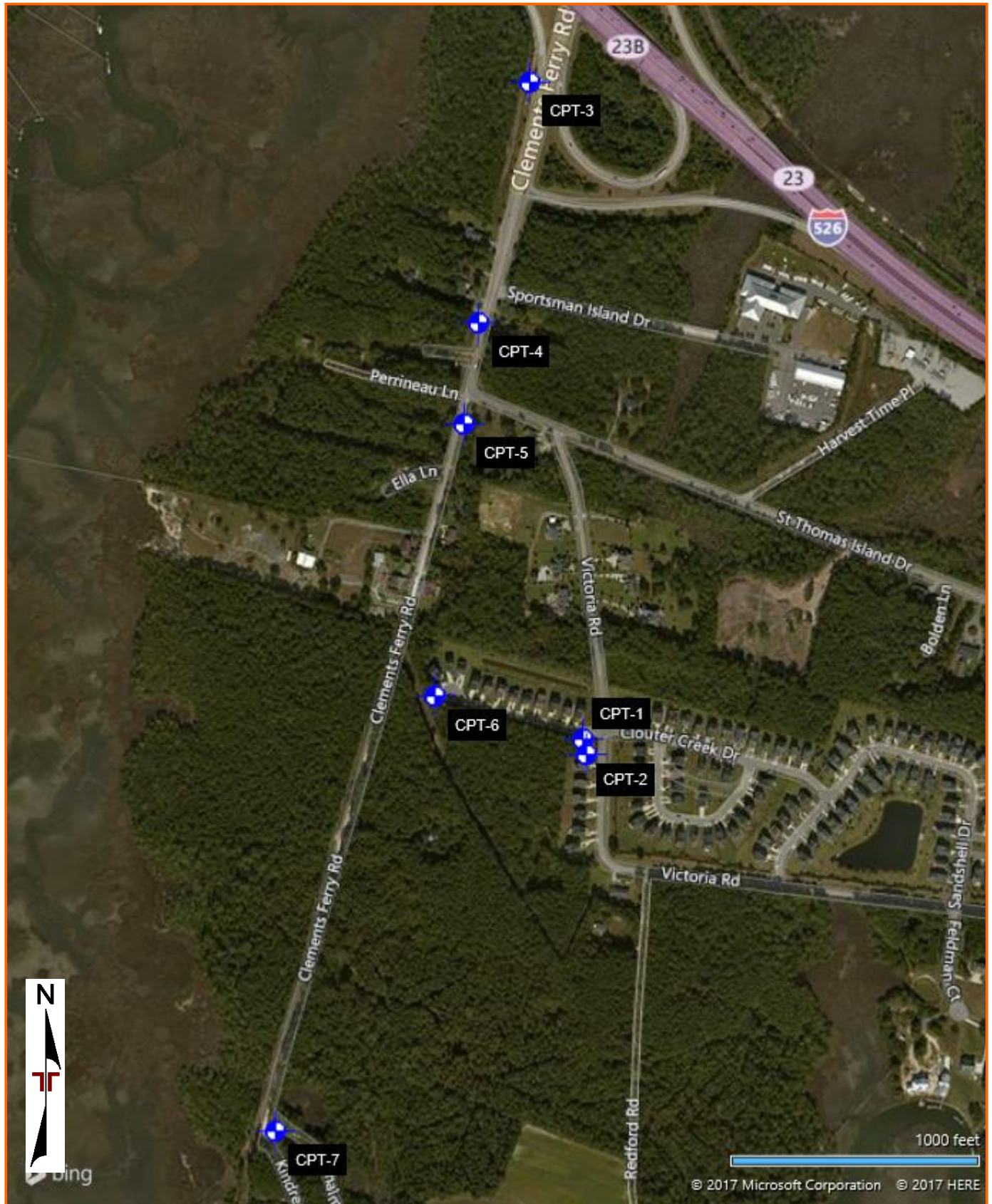


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS
NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED
BY MICROSOFT BING MAPS

EXPLORATION AND TESTING PROCEDURES

We explored the pump station site with two Cone Penetration Tests (CPTs) and the sewer line locations with five Cone Penetration Tests (CPTs) to depths ranging from approximately 30 to 40 feet. Adjacent to the in situ tests, we also conducted a Hand Auger Boring (HAB) to 4 feet below existing ground surface. In situ tests were performed on Monday, June 26 and Friday, June 30, 2017.

The test locations were selected by Terracon personnel and located in the field utilizing aerial drawings, existing landmarks, a tape measure, and hand held a GPS device that is accurate to 20 feet. The locations as shown in the exploration plan should be considered accurate only to the degree implied by the means and methods used to define them.

The driller's logs were compiled and reviewed by the geotechnical engineer in order to produce the logs. The in situ tests and HAB logs are presented in the **Attachments**. General notes and soil classification procedures for soundings are presented in Appendix B.

Unless otherwise specified on the logs or in the report, all groundwater measurements are collected during or immediately after drilling. Groundwater levels are measured using the following criteria:

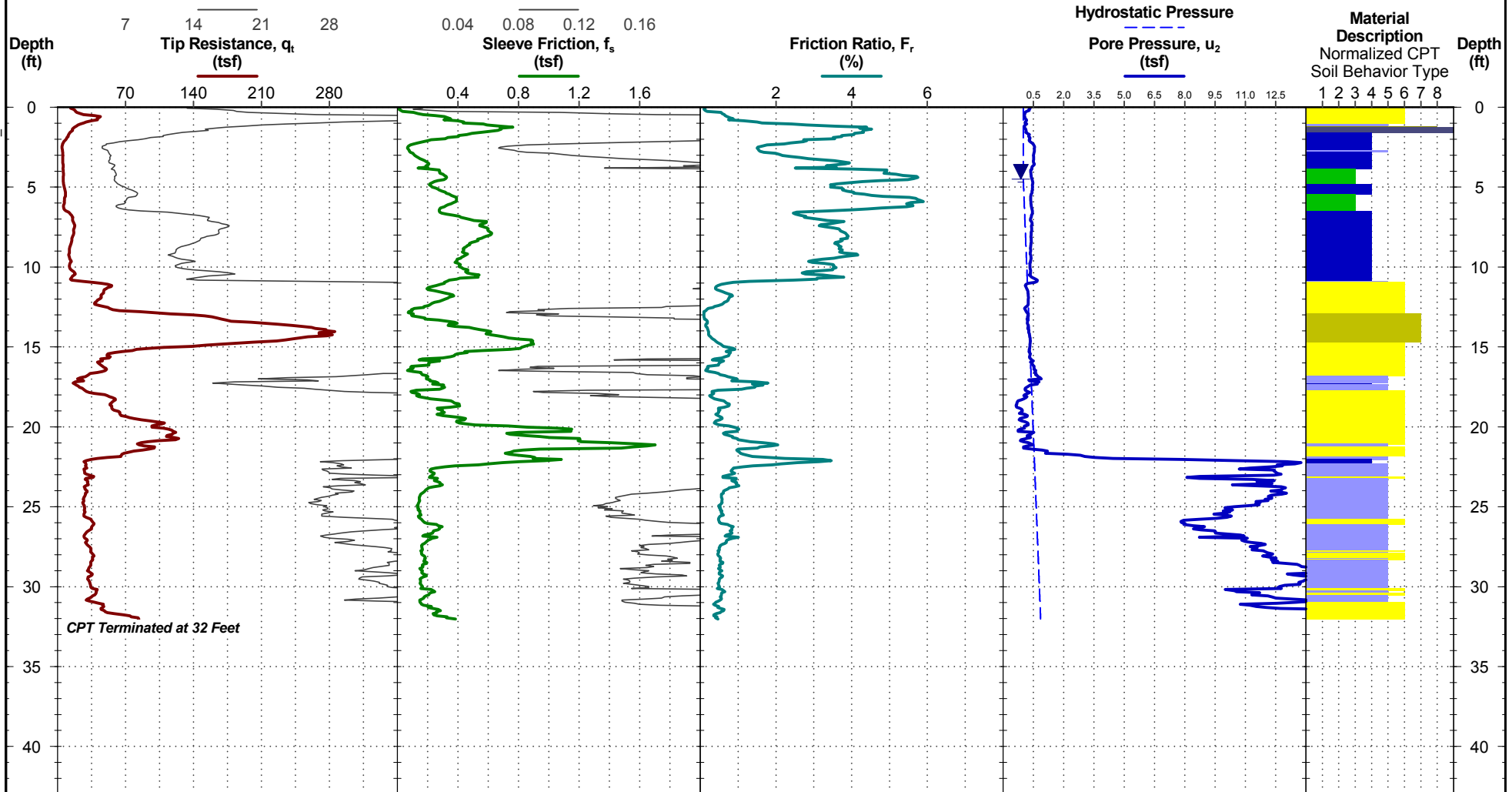
- Physical observation within hand auger borings (HABs) or Cone Penetration Testing (CPT) hole depths.
- Where not physically encountered in HABs or CPT soundings, groundwater levels are measured using a groundwater probe within the voids left by cone penetration (CPT) soundings.
- Where hole-collapse does not allow for measurement within CPT voids, groundwater levels are estimated using the hydrostatic line (height of water below the ground surface) on the CPT Porewater pressure (U) graph shown on the CPT logs.

IN SITU TEST RESULTS

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/18/17

CPT LOG NO. CPT-1

PROJECT: Thomas Island Pumpstation and Interceptor	CLIENT: Hazen and Sawyer PC Charleston, SC	TEST LOCATION: See Exploration Plan
SITE: Clements Ferry Road Charleston, SC		Latitude: 32.870731° Longitude: -79.931317°



See Terracon's CPT General Notes for explanation of symbols and abbreviations.

Auger anchors used as reaction force.
CPT sensor calibration reports available upon request.

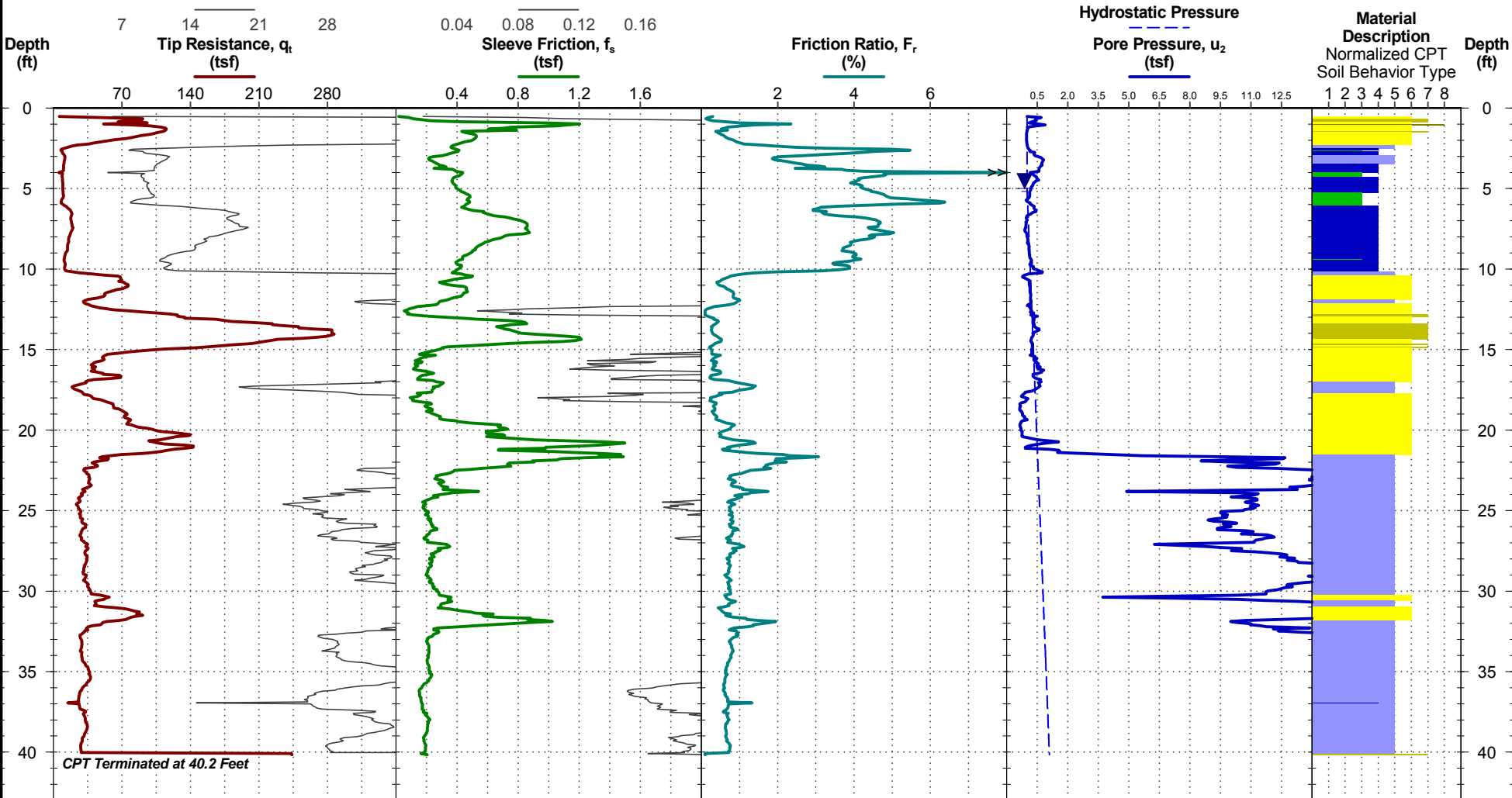
- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

WATER LEVEL OBSERVATION 4.5 ft measured water depth (used in normalizations and correlations)	Probe no. 7522 with net area ratio of 0.84 U2 pore pressure transducer location Manufactured by Geotech A.B.; calibrated 8/15/2014 Tip and sleeve areas of 10 cm ² and 150 cm ² Ring friction reducer with O.D. of 1.875 in	Terracon 1450 Fifth St W North Charleston, SC	CPT Started: 6/30/2017 Rig: Pagani TG73-200 Project No.: EN175139	CPT Completed: 6/30/2017 Operator: B. Rozier
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THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/18/17

CPT LOG NO. CPT-2

PROJECT: Thomas Island Pumpstation and Interceptor	CLIENT: Hazen and Sawyer PC Charleston, SC	TEST LOCATION: See Exploration Plan
SITE: Clements Ferry Road Charleston, SC		Latitude: 32.870561° Longitude: -79.93127°



See Terracon's CPT General Notes for explanation of symbols and abbreviations.

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

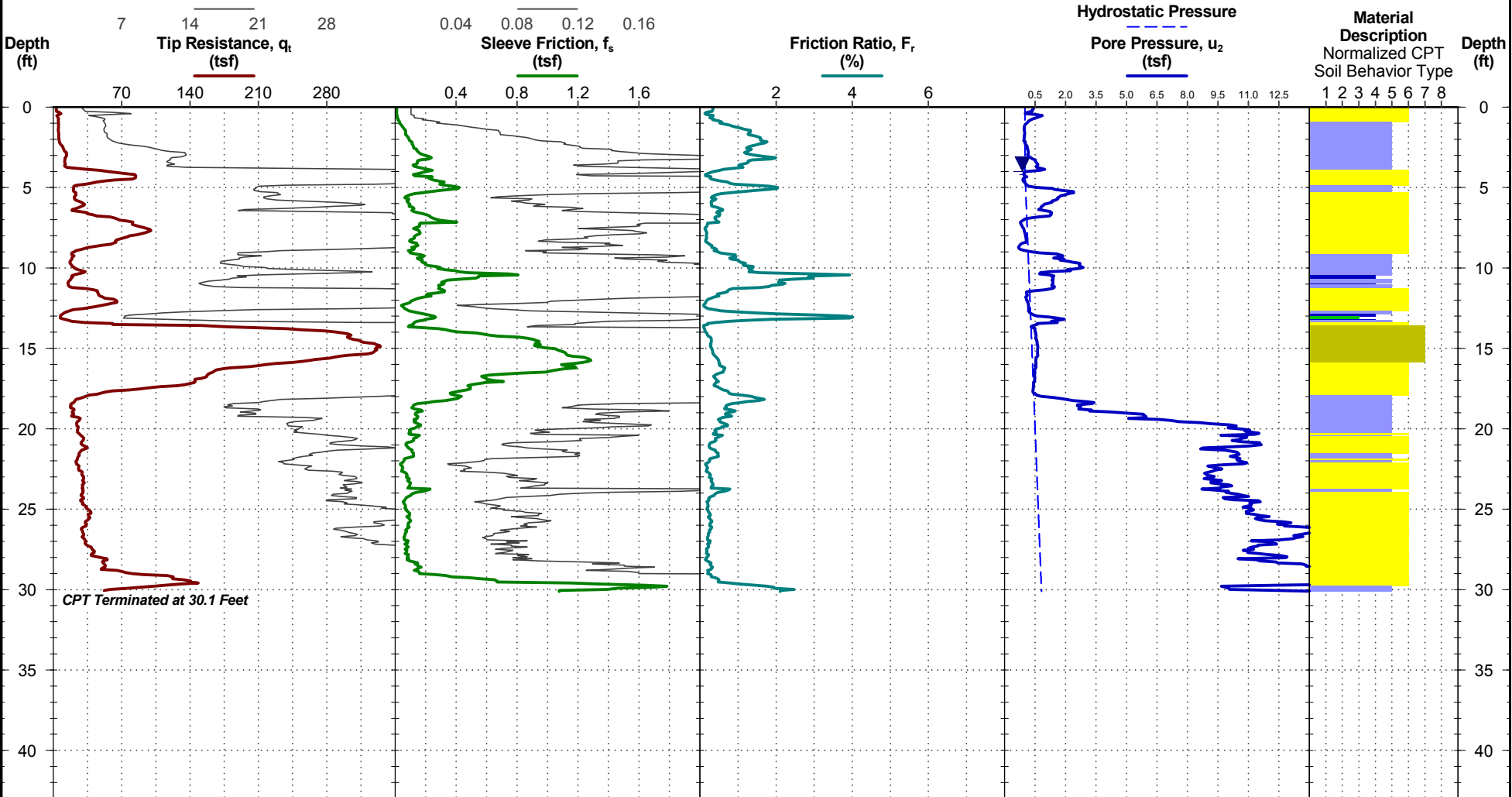
- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

WATER LEVEL OBSERVATION 5 ft measured water depth (used in normalizations and correlations)	Probe no. 7522 with net area ratio of 0.84 U2 pore pressure transducer location Manufactured by Geotech A.B.; calibrated 8/15/2014 Tip and sleeve areas of 10 cm ² and 150 cm ² Ring friction reducer with O.D. of 1.875 in	Terracon 1450 Fifth St W North Charleston, SC	CPT Started: 6/26/2017 Rig: Pagani TG73-200 Project No.: EN175139	CPT Completed: 6/26/2017 Operator: B. Rozier
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THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/18/17

CPT LOG NO. CPT-3

PROJECT: Thomas Island Pumpstation and Interceptor	CLIENT: Hazen and Sawyer PC Charleston, SC	TEST LOCATION: See Exploration Plan
SITE: Clements Ferry Road Charleston, SC		Latitude: 32.878004° Longitude: -79.932017°



See Terracon's CPT General Notes for explanation of symbols and abbreviations.

Auger anchors used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION 4 ft measured water depth (used in normalizations and correlations)	Probe no. 7522 with net area ratio of 0.84 U2 pore pressure transducer location Manufactured by Geotech A.B.; calibrated 8/15/2014 Tip and sleeve areas of 10 cm ² and 150 cm ² Ring friction reducer with O.D. of 1.875 in	Terracon 1450 Fifth St W North Charleston, SC	CPT Started: 6/30/2017 Rig: Pagani TG73-200 Project No.: EN175139	CPT Completed: 6/30/2017 Operator: B. Rozier
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THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/18/17

CPT LOG NO. CPT-4

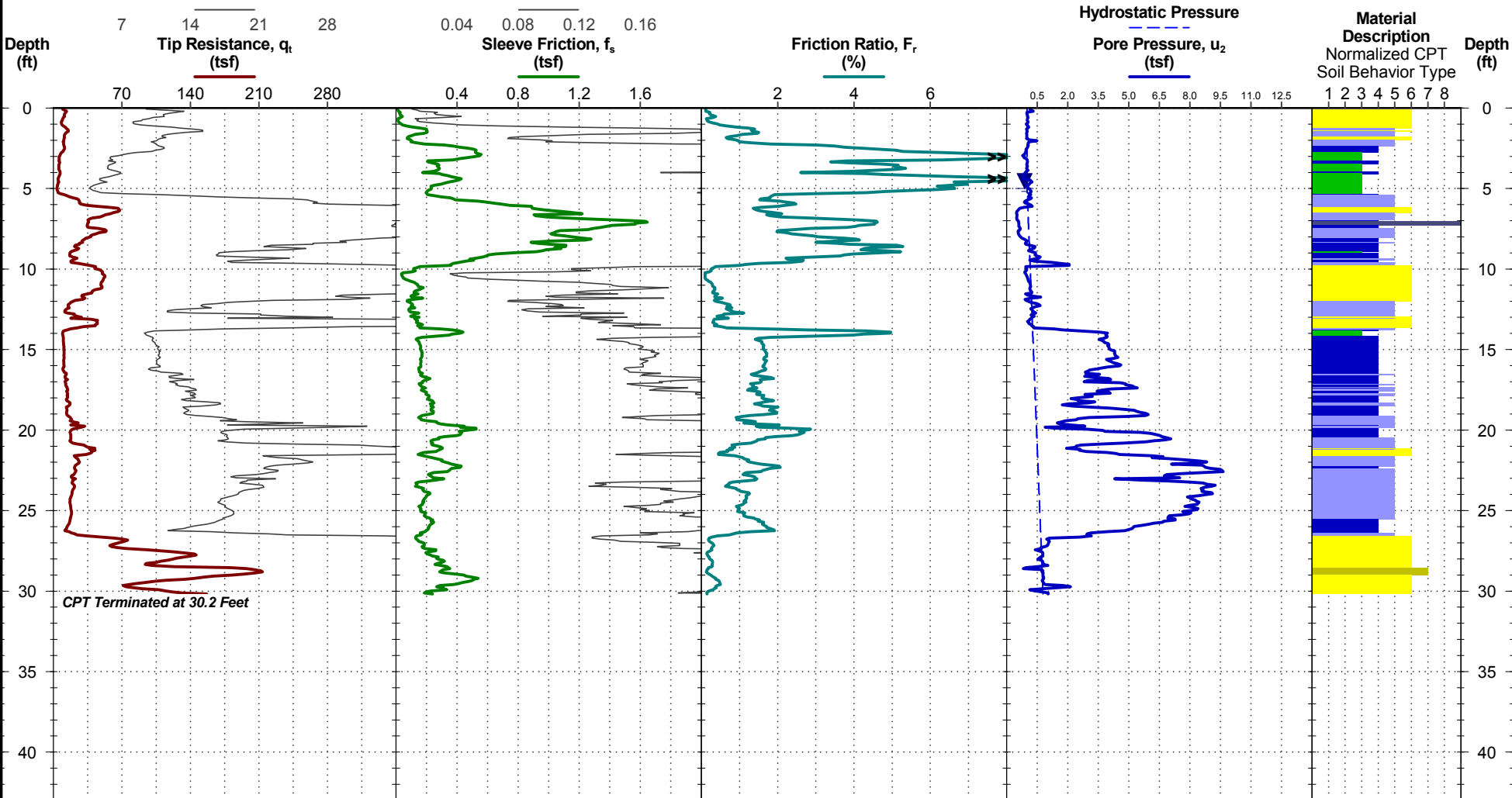
PROJECT: Thomas Island Pumpstation and
Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

TEST LOCATION: See Exploration Plan

SITE: Clements Ferry Road
Charleston, SC

Latitude: 32.875341°
Longitude: -79.932691°



See Terracon's CPT General Notes for
explanation of symbols and abbreviations.

Auger anchors used as reaction force.
CPT sensor calibration reports available upon request.

- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

WATER LEVEL OBSERVATION

5 ft measured water depth
(used in normalizations and correlations)

Probe no. 7522 with net area ratio of 0.84
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 8/15/2014
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 Fifth St W
North Charleston, SC

CPT Started: 6/30/2017

Rig: Pagani TG73-200

Project No.: EN175139

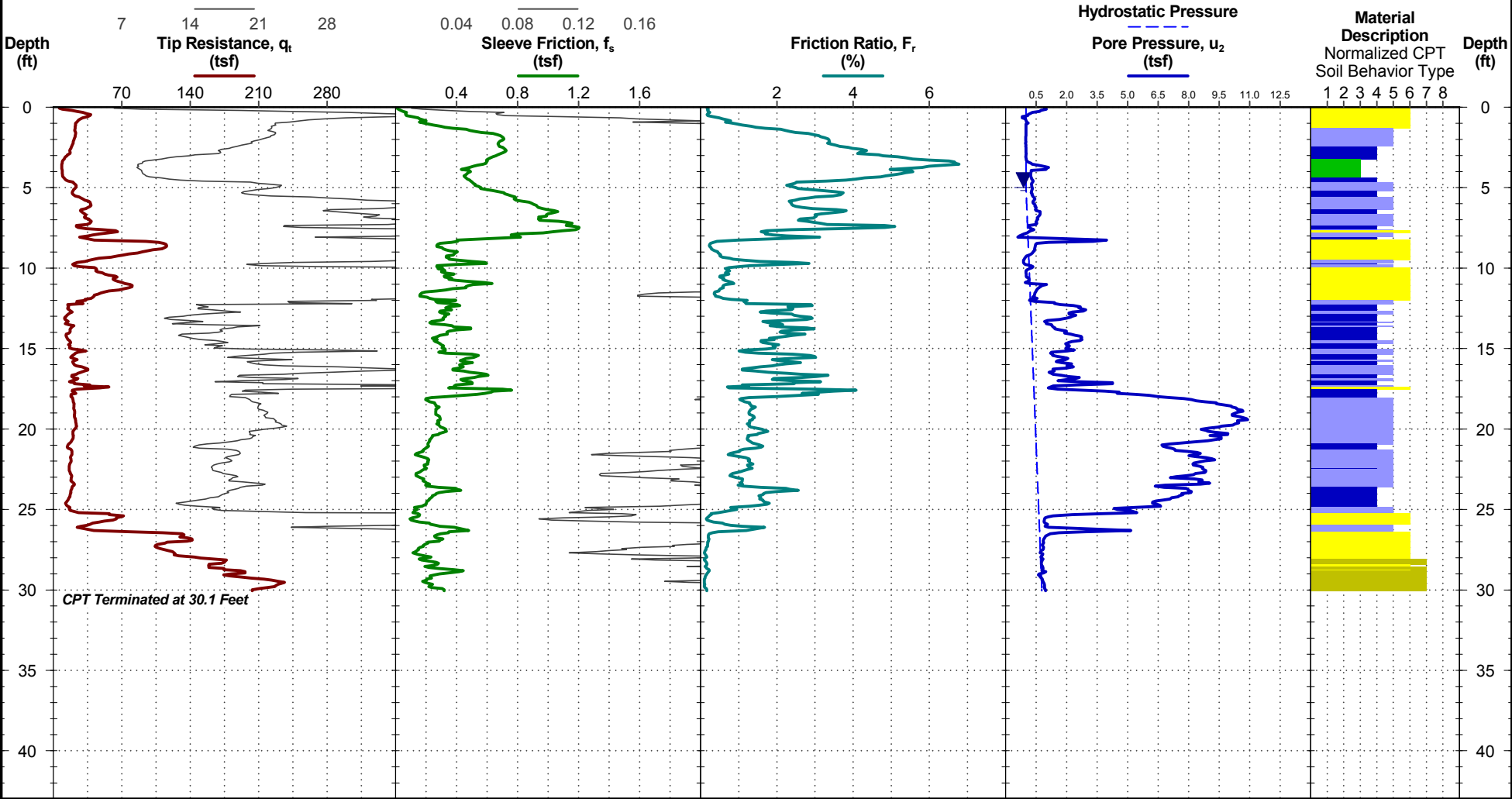
CPT Completed: 6/30/2017

Operator: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/18/17

CPT LOG NO. CPT-5

PROJECT: Thomas Island Pumpstation and Interceptor	CLIENT: Hazen and Sawyer PC Charleston, SC	TEST LOCATION: See Exploration Plan
SITE: Clements Ferry Road Charleston, SC		Latitude: 32.874221° Longitude: -79.932883°



See Terracon's CPT General Notes for explanation of symbols and abbreviations.

Auger anchors used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION 5 ft measured water depth (used in normalizations and correlations)	Probe no. 7522 with net area ratio of 0.84 U2 pore pressure transducer location Manufactured by Geotech A.B.; calibrated 8/15/2014 Tip and sleeve areas of 10 cm ² and 150 cm ² Ring friction reducer with O.D. of 1.875 in	Terracon 1450 Fifth St W North Charleston, SC	CPT Started: 6/30/2017 Rig: Pagani TG73-200 Project No.: EN175139	CPT Completed: 6/30/2017 Operator: B. Rozier
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THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/18/17

CPT LOG NO. CPT-6

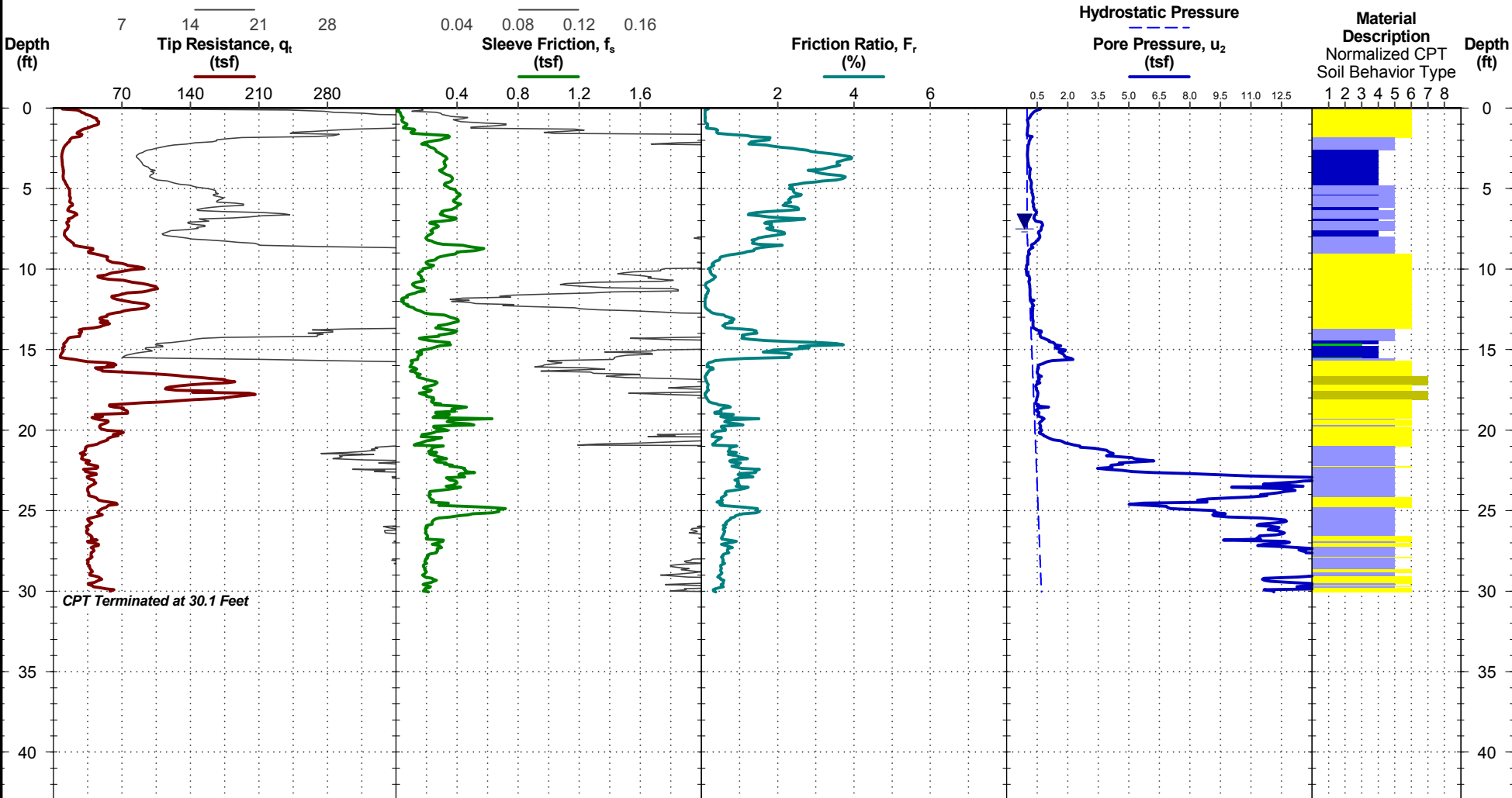
PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

TEST LOCATION: See Exploration Plan

SITE: Clements Ferry Road
Charleston, SC

Latitude: 32.871207°
Longitude: -79.933266°



See Terracon's CPT General Notes for explanation of symbols and abbreviations.

Auger anchors used as reaction force.
CPT sensor calibration reports available upon request.

- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

WATER LEVEL OBSERVATION

7.5 ft measured water depth
(used in normalizations and correlations)

Probe no. 7522 with net area ratio of 0.84
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 8/15/2014
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 Fifth St W
North Charleston, SC

CPT Started: 6/30/2017

Rig: Pagani TG73-200

Project No.: EN175139

CPT Completed: 6/30/2017

Operator: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/18/17

CPT LOG NO. CPT-7

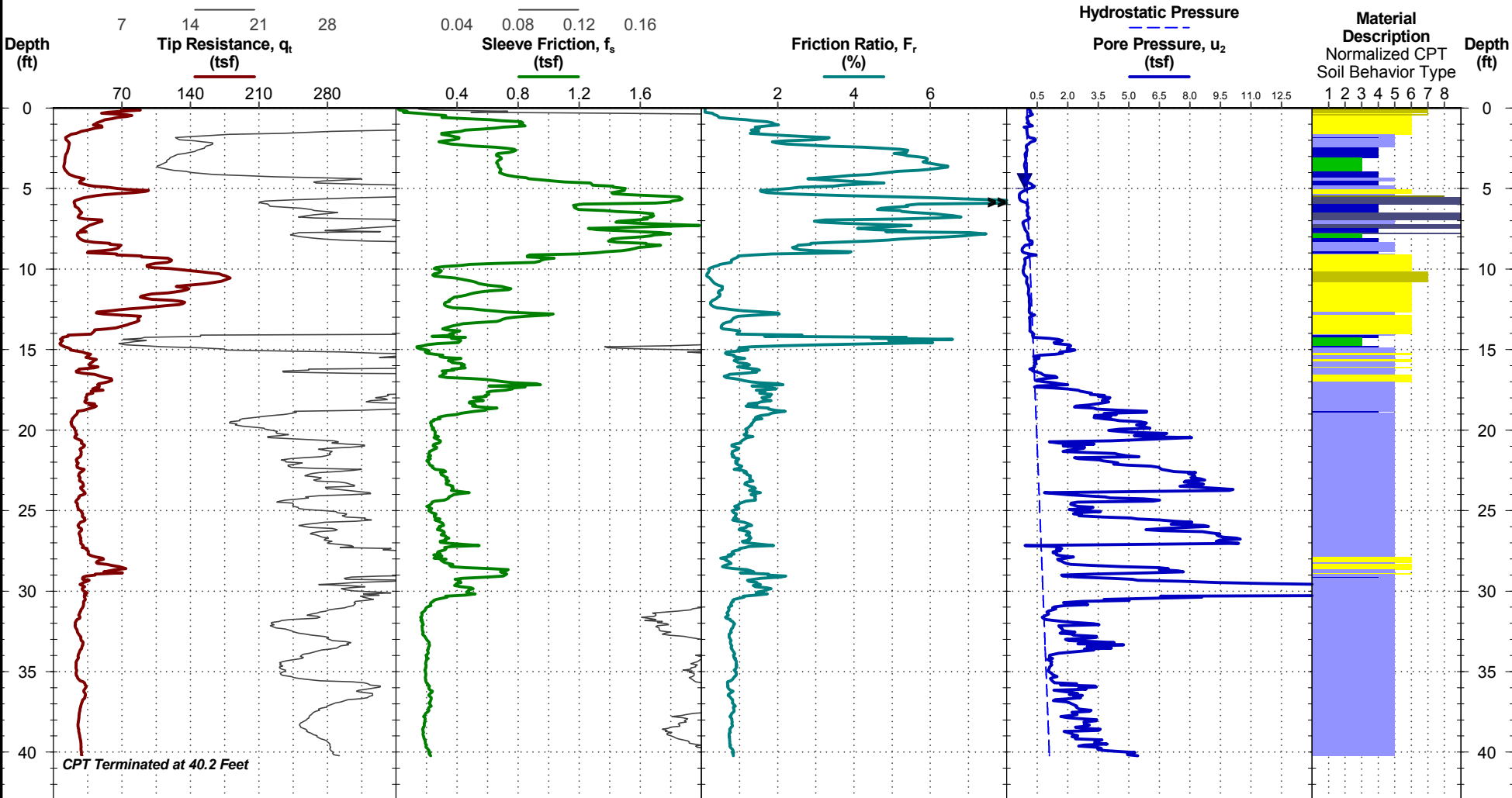
PROJECT: Thomas Island Pumpstation and
Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

TEST LOCATION: See Exploration Plan

SITE: Clements Ferry Road
Charleston, SC

Latitude: 32.86639°
Longitude: -79.935367°



See Terracon's CPT General Notes for
explanation of symbols and abbreviations.

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

WATER LEVEL OBSERVATION

5 ft measured water depth
(used in normalizations and correlations)

Probe no. 7522 with net area ratio of 0.84
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 8/15/2014
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 Fifth St W
North Charleston, SC

CPT Started: 6/26/2017

Rig: Pagani TG73-200

Project No.: EN175139

CPT Completed: 6/26/2017

Operator: B. Rozier


BORING LOG NO. HAB @ CPT-1

Page 1 of 1

PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

SITE: Clements Ferry Road
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	Latitude: 32.870731° Longitude: -79.931317°			
	DEPTH			
	TOPSOIL			
0.7	SANDY LEAN CLAY (CL) , tan to gray			
4.0	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: N/A

Advancement Method:
Manual Hand Auger

Abandonment Method:
Backfilled with Auger Cuttings

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon

1450 Fifth St W
North Charleston, SC

Boring Started: 6/30/2017

Drill Rig: N/A

Project No.: EN175139

Boring Completed: 6/30/2017

Driller: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATATEMPLATE.GDT 7/11/17

Page 1 of 1

CLIENT: Hazen and Sawyer PC
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	Latitude: 32.878004° Longitude: -79.932017°			
DEPTH				

0.2	<u>TC</u>
-----	-----------

SANDY LEAN CLAY (CL), tan to light brown

WATER LEVEL
OBSERVATIONS

SAMPLE I YP

4.0

Hammer Type: N/A

 While drilling

Project No.: EN175139

Driller: B. Rozier



THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA\TEMPLATE.GDT 7/11/17



BORING LOG NO. HAB @ CPT-4

Page 1 of 1

PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

SITE: Clements Ferry Road
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	Latitude: 32.875341° Longitude: -79.932691°			
	DEPTH			
	TOPSOIL			
	0.7 CLAYEY SAND (SC) , tan to light brown			
	4.0 Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: N/A

Advancement Method:
Manual Hand Auger

Abandonment Method:
Backfilled with Auger Cuttings

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon

1450 Fifth St W
North Charleston, SC

Boring Started: 6/30/2017

Drill Rig: N/A

Project No.: EN175139

Boring Completed: 6/30/2017

Driller: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATATEMPLATE.GDT 7/11/17



BORING LOG NO. HAB @ CPT-5

Page 1 of 1

PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

SITE: Clements Ferry Road
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	Latitude: 32.874221° Longitude: -79.932883°			
	DEPTH			
	TOPSOIL			
	0.3			
	SANDY LEAN CLAY (CL) , tan to light brown			
	4.0			
	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: N/A

Advancement Method:
Manual Hand Auger

Notes:

Abandonment Method:
Backfilled with Auger Cuttings

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon

1450 Fifth St W
North Charleston, SC

Boring Started: 6/30/2017

Boring Completed: 6/30/2017

Drill Rig: N/A

Driller: B. Rozier

Project No.: EN175139

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATATEMPLATE.GDT 7/11/17


BORING LOG NO. HAB @ CPT-6

Page 1 of 1

PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

SITE: Clements Ferry Road
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	Latitude: 32.871207° Longitude: -79.933266°			
	DEPTH			
	TOPSOIL			
	0.5			
	SILTY SAND (SM) , tan to gray			
	1.0			
	SANDY LEAN CLAY (CL) , tan to light brown			
	4.0			
	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: N/A

Advancement Method:
Manual Hand Auger

Abandonment Method:
Backfilled with Auger Cuttings

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon

1450 Fifth St W
North Charleston, SC

Boring Started: 6/30/2017

Drill Rig: N/A

Project No.: EN175139

Boring Completed: 6/30/2017

Driller: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATATEMPLATE.GDT 7/11/17

BORING LOG NO. HAB @ CPT- 7

Page 1 of 1

PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

SITE: Clements Ferry Road
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	Latitude: 32.86639° Longitude: -79.935367°			
	DEPTH			
	SILTY SAND (SM) , tan to brown			
	1.0			
	SANDY LEAN CLAY (CL) , tan to light brown			
	4.0			
	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: N/A

Advancement Method:
Manual Hand Auger

Abandonment Method:
Backfilled with Auger Cuttings

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon

1450 Fifth St W
North Charleston, SC

Boring Started: 6/26/2017

Drill Rig: N/A

Project No.: EN175139

Boring Completed: 6/26/2017

Driller: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATATEMPLATE.GDT 7/11/17

SUPPORTING INFORMATION

CPT GENERAL NOTES

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
 $q_t = q_c + u_2(1 - a)$

Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, u
Pore pressure measured during penetration
 u_1 - sensor on the face of the cone
 u_2 - sensor on the shoulder (more common)

Sleeve Friction, f_s
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, F_r
The ratio as a percentage of f_s to q_t , accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, V_s
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_{tn}

$$Q_{tn} = ((q_t - \sigma_{v0})/P_a)(P_a/\sigma'_{v0})^n$$

$$n = 0.381(I_c) + 0.05(\sigma'_{v0}/P_a) - 0.15$$

Over Consolidation Ratio, OCR

$$OCR(1) = 0.25(Q_{tn})^{1.25}$$

$$OCR(2) = 0.33(Q_{tn})$$

Undrained Shear Strength, S_u

$$S_u = Q_{tn} \times \sigma'_{v0}/N_{kt}$$

N_{kt} is a soil-specific factor (shown on S_u plot)

Sensitivity, S_t

$$S_t = (q_t - \sigma_{v0}/N_{kt}) \times (1/f_s)$$

Effective Friction Angle, ϕ'

$$\phi'(1) = \tan^{-1}(0.373[\log(q_t/\sigma'_{v0}) + 0.29])$$

$$\phi'(2) = 17.6 + 11[\log(Q_{tn})]$$

Unit Weight, γ

$$\gamma = (0.27[\log(F_r)] + 0.36[\log(q_t/atm)] + 1.236) \times \gamma_{water}$$

σ_{v0} is taken as the incremental sum of the unit weights

Small Strain Shear Modulus, G_0

$$G_0(1) = \rho V_s^2$$

$$G_0(2) = 0.015 \times 10^{(0.55I_c + 1.68)}(q_t - \sigma_{v0})$$

Soil Behavior Type Index, I_c

$$I_c = [(3.47 - \log(Q_{tn}))^2 + (\log(F_r) + 1.22)^2]^{0.5}$$

SPT N_{60}

$$N_{60} = (q_t/atm) / 10^{(1.268 - 0.2817I_c)}$$

Elastic Modulus, E_s (assumes $q/q_{ultimate} \sim 0.3$, i.e. FS = 3)

$$E_s(1) = 2.6\psi G_0 \text{ where } \psi = 0.56 - 0.33\log Q_{tn, \text{clean sand}}$$

$$E_s(2) = G_0$$

$$E_s(3) = 0.015 \times 10^{(0.55I_c + 1.68)}(q_t - \sigma_{v0})$$

$$E_s(4) = 2.5q_t$$

Constrained Modulus, M

$$M = \alpha_M(q_t - \sigma_{v0})$$

For $I_c > 2.2$ (fine-grained soils)

$$\alpha_M = Q_{tn} \text{ with maximum of } 14$$

For $I_c < 2.2$ (coarse-grained soils)

$$\alpha_M = 0.0188 \times 10^{(0.55I_c + 1.68)}$$

Hydraulic Conductivity, k

$$\text{For } 1.0 < I_c < 3.27 \quad k = 10^{(0.952 - 3.04I_c)}$$

$$\text{For } 3.27 < I_c < 4.0 \quad k = 10^{(-4.52 - 1.37I_c)}$$

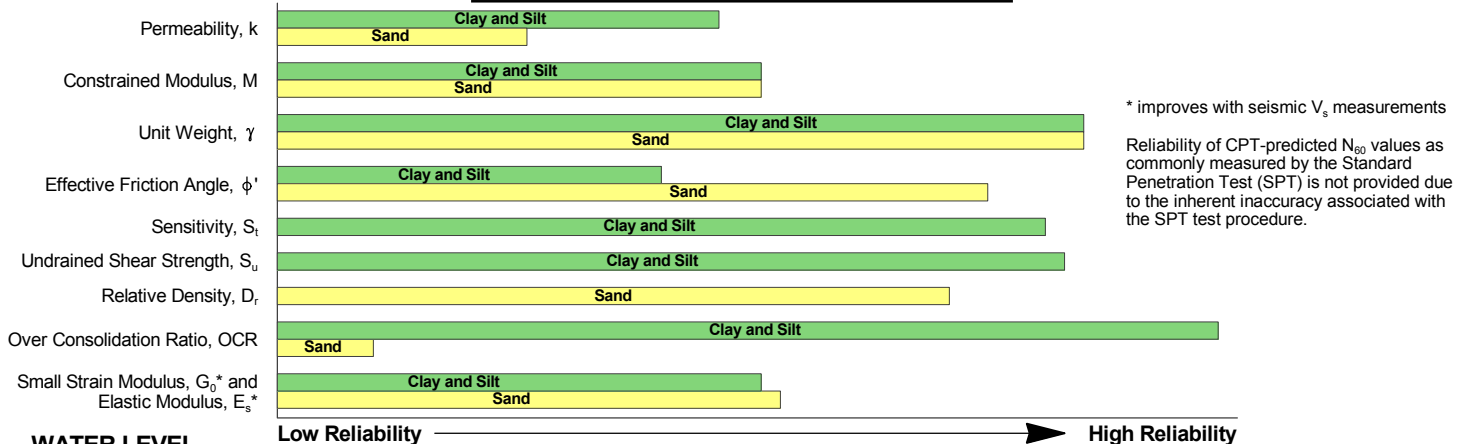
Relative Density, D_r

$$D_r = (Q_{tn} / 350)^{0.5} \times 100$$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include q_t , f_s , and u . Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. To this end, more than one correlation to a given parameter may be provided. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated":

Measured - Depth to water directly measured in the field

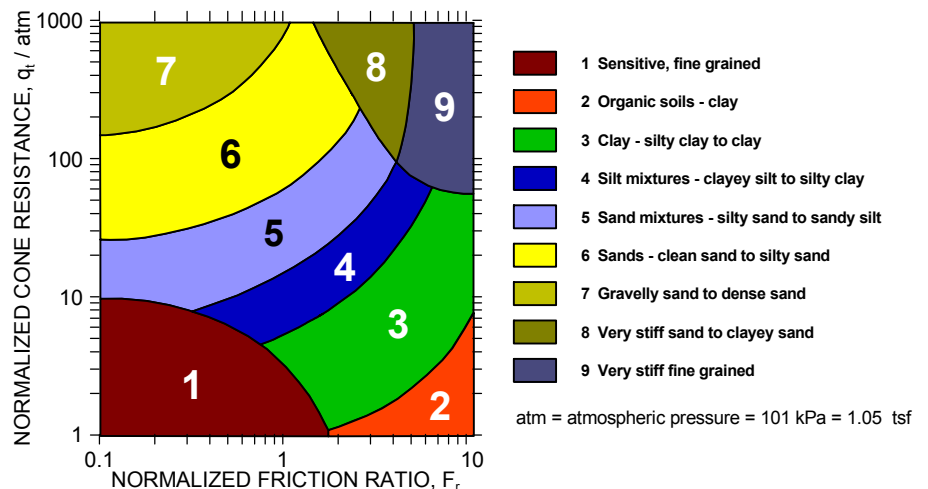
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (f_s), and porewater pressure (u_2). The normalized friction ratio (F_r) is used to classify the soil behavior type.

Typically, silts and clays have high F_r values and generate large excess penetration porewater pressures; sands have lower F_r 's and do not generate excess penetration porewater pressures. The adjacent graph (Robertson *et al.*) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



REFERENCES

- Kulhavy, F.H., Mayne, P.W., (1997). "Manual on Estimating Soil Properties for Foundation Design," Electric Power Research Institute, Palo Alto, CA.
- Mayne, P.W., (2013). "Geotechnical Site Exploration in the Year 2013," Georgia Institute of Technology, Atlanta, GA.
- Robertson, P.K., Cabal, K.L. (2012). "Guide to Cone Penetration Testing for Geotechnical Engineering," Signal Hill, CA.
- Schmertmann, J.H., (1970). "Static Cone to Compute Static Settlement over Sand," *Journal of the Soil Mechanics and Foundations Division*, 96(SM3), 1011-1043.

UNIFIED SOIL CLASSIFICATION SYSTEM

Thomas Island Pump Station And Interceptor ■ Charleston, South Carolina

July 26, 2017 ■ Terracon Project No. EN175139



Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A					Soil Classification	
					Group Symbol	Group Name ^B
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	Cu ≥ 4 and 1 ≤ Cc ≤ 3 ^E		GW	Well-graded gravel ^F
			Cu < 4 and/or 1 > Cc > 3 ^E		GP	Poorly graded gravel ^F
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH		GM	Silty gravel ^{F,G,H}
			Fines classify as CL or CH		GC	Clayey gravel ^{F,G,H}
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Cu ≥ 6 and 1 ≤ Cc ≤ 3 ^E		SW	Well-graded sand ^I
			Cu < 6 and/or 1 > Cc > 3 ^E		SP	Poorly graded sand ^I
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH		SM	Silty sand ^{G,H,I}
			Fines classify as CL or CH		SC	Clayey sand ^{G,H,I}
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	PI > 7 and plots on or above “A” line		CL	Lean clay ^{K,L,M}
			PI < 4 or plots below “A” line ^J		ML	Silt ^{K,L,M}
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K,L,M,N}
			Liquid limit - not dried		Organic silt ^{K,L,M,O}	
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above “A” line		CH	Fat clay ^{K,L,M}
			PI plots below “A” line		MH	Elastic Silt ^{K,L,M}
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K,L,M,P}
			Liquid limit - not dried		Organic silt ^{K,L,M,Q}	
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

^A Based on the material passing the 3-inch (75-mm) sieve

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

$$E \quad Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

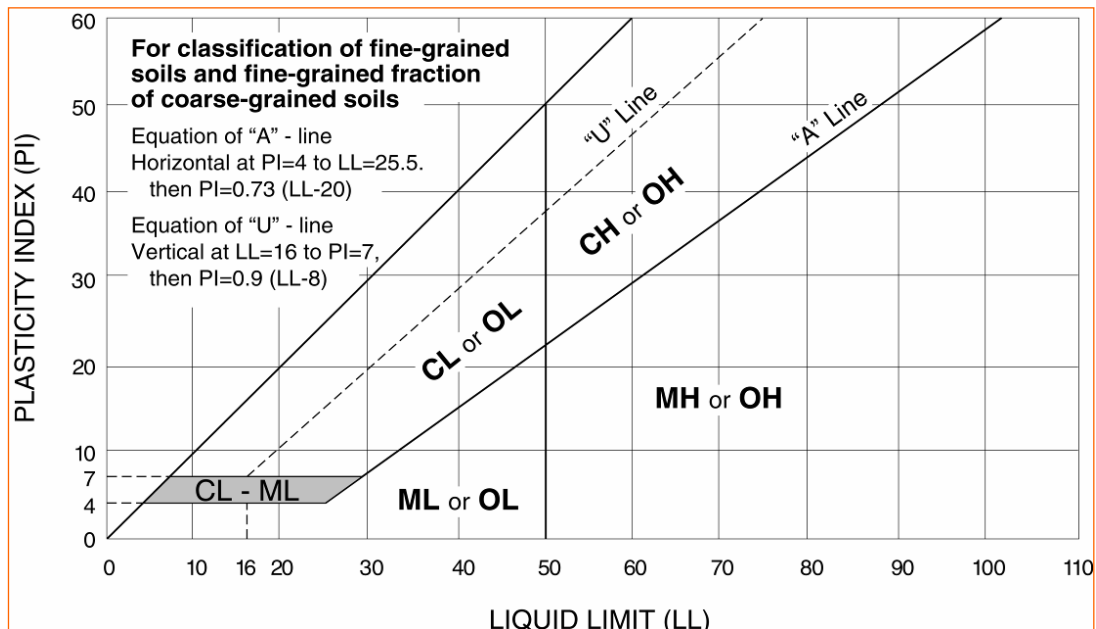
^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



April 2, 2019



Hazen and Sawyer
1 Poston Road, Suite 320
Charleston, South Carolina 29407

Attn: Mr. Jared M. Hartwig, P.E.
P: (843) 744-6467
E jhartwig@hazenandsawyer.com

Re: Addendum to the Geotechnical Engineering Report – Additional Sewer Lines
Thomas Island Pump Station and Interceptor
Charleston, South Carolina
Terracon Project No. EN175139

Dear Mr. Hartwig:

We understand that additional sewer lines will be added to Sportsman Island Drive, Harvest Time Place, and St. Thomas Island Drive. Terracon performed 2 additional cone penetration tests (CPTs) with adjacent hand auger borings (HABs) in order to evaluate soil conditions of the additional lines.

Soil conditions encountered at the additional test locations consisted of 5 to 6 inches of topsoil, followed by very soft to soft sandy clay to a depth of 4 to 5 feet below existing ground surface (BEGS). Beneath the clay was silty sand to clayey sand with interbedded layers of clay to the termination depth of 15 feet BEGS.

Groundwater was encountered in the voids left from our cone penetration testing between 4 and 4.5 feet BEGS and was not encountered in the hand auger borings. Please see attached logs for specific soil and groundwater conditions encountered at each additional location.

Shallow utility installation can be performed per the recommendations outlined in the geotechnical report dated July 28, 2017. However, groundwater was encountered between 4 and 4.5 feet BEGS and dewatering may be required to a depth of 4 feet.



Terracon Consultants, Inc. 1450 Fifth Street West North Charleston, South Carolina 29405
P [843] 884 1234 F [843] 884 9234 terracon.com

Geotechnical



Environmental



Construction Materials



Facilities

Addendum to the Geotechnical Engineering Report

Thomas Island Pump Station and Interceptor ■ Charleston, South Carolina

April 2, 2019 ■ Terracon Project No. EN175139



If you have any questions concerning this addendum, or if we may be of further service, please feel free to contact us at your convenience.

Sincerely,

Terracon Consultants, Inc.



A handwritten signature in blue ink, appearing to read "L.P. Van Brunt".

Leonard P. Van Brunt, E.I.T.
Project Manager

A handwritten signature in blue ink, appearing to read "Jonathan N. Ard".

Jonathan N. Ard, P.E.
Geotechnical Department Manager
SC Registration No. 30886

SITE LOCATION

Thomas Island Pumpstation and Interceptor ■ Charleston, SC

April 2, 2019 ■ Terracon Project No. EN175139

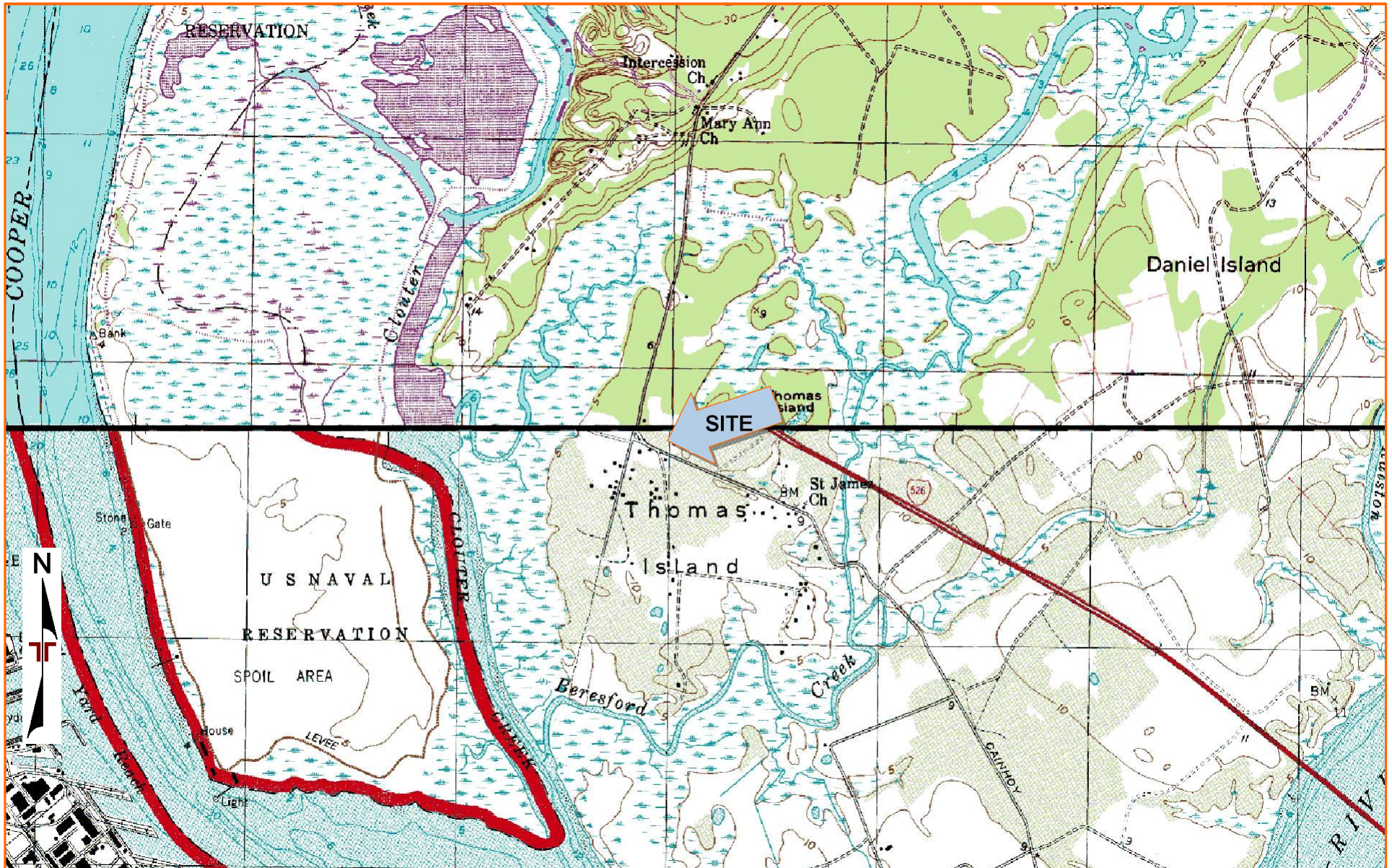


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT
INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: NORTH CHARLESTON, SC (1/1/1998) and CHARLESTON,
SC (1/1/1994).

EXPLORATION PLAN

Thomas Island Pumpstation and Interceptor ■ Charleston, SC
April 2, 2019 ■ Terracon Project No. EN175139

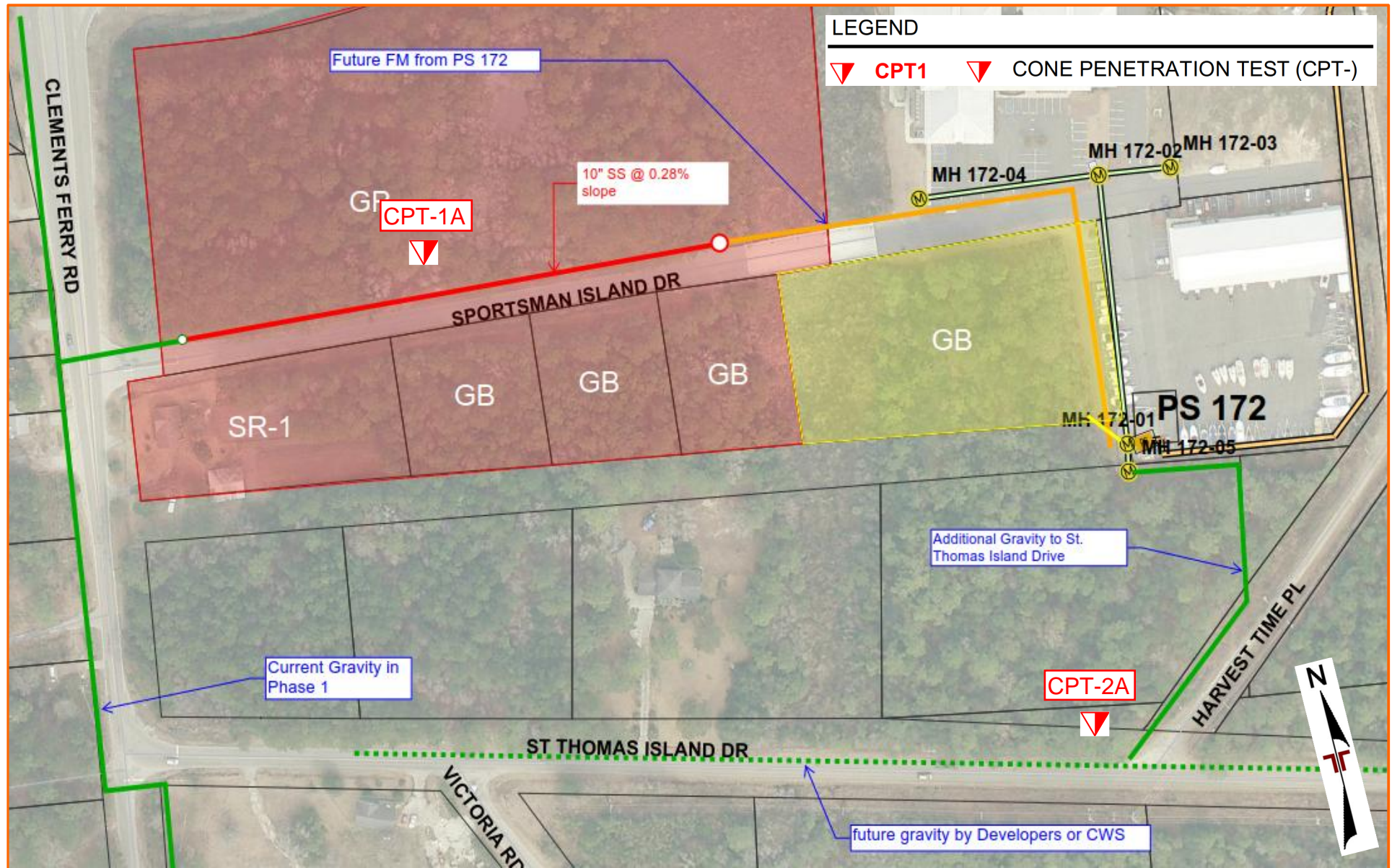


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT
INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY
MICROSOFT BING MAPS

CPT LOG NO. CPT-1A

Page 1 of 1

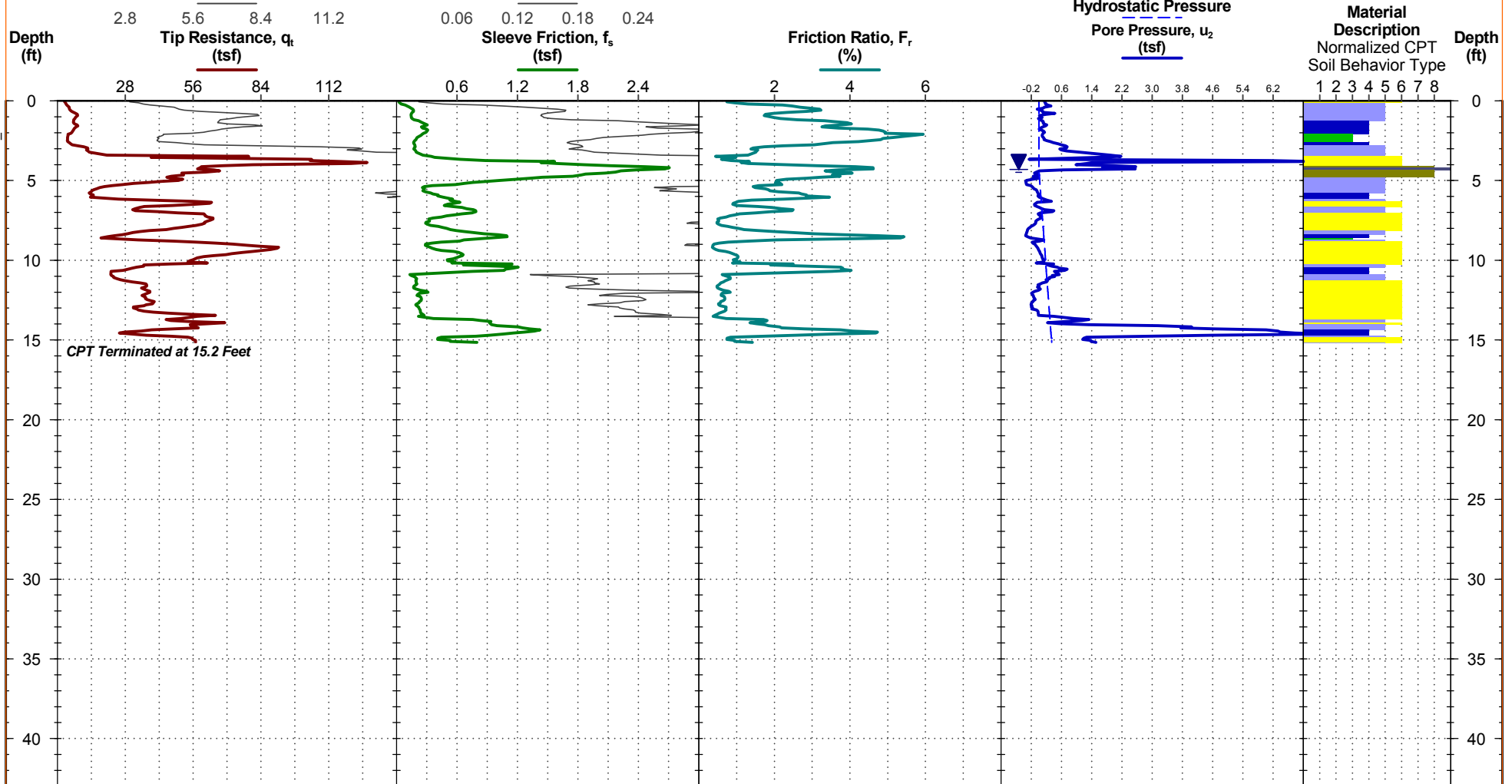
PROJECT: Thomas Island Pumpstation and
Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

TEST LOCATION: See [Exploration Plan](#)

SITE: Clements Ferry Road
Charleston, SC

Latitude: 32.875689°
Longitude: -79.931273°



CPT sensor calibration reports available upon request.

- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

WATER LEVEL OBSERVATION

4.3 ft measured water depth
(used in normalizations and correlations)

Probe no. 4815 with net area ratio of 0.88
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 2/20/2017
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 Fifth St W
North Charleston, SC

CPT Started: 4/1/2019

Rig: Pagani TG73-200

Project No.: EN175139

CPT Completed: 4/1/2019

Operator: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA TEMPLATE.GDT 4/2/19

CPT LOG NO. CPT-2A

Page 1 of 1

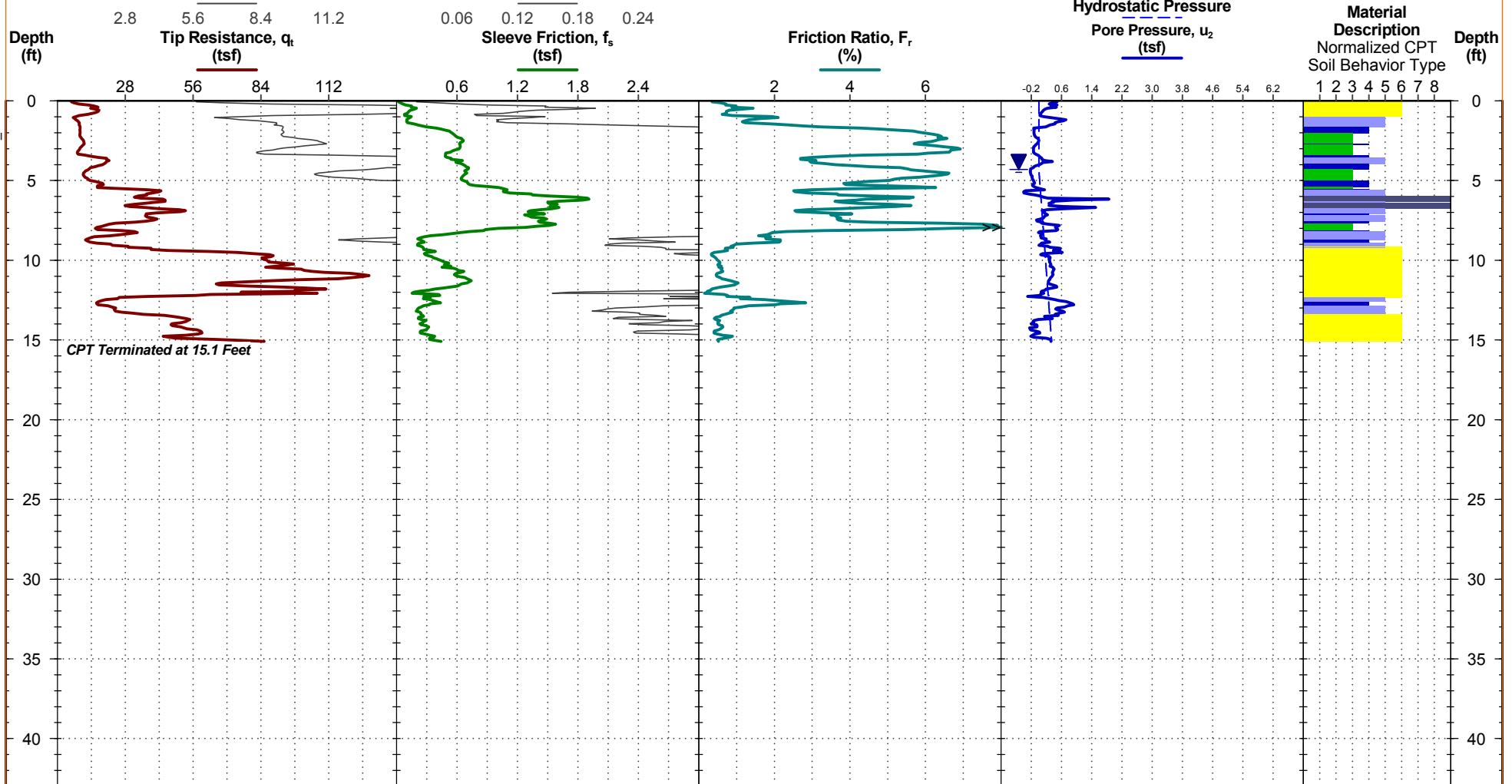
PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

TEST LOCATION: See [Exploration Plan](#)

SITE: Clements Ferry Road
Charleston, SC

Latitude: 32.873553°
Longitude: -79.929301°



CPT sensor calibration reports available upon request.

- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

WATER LEVEL OBSERVATION

4.3 ft measured water depth
(used in normalizations and correlations)

Probe no. 4815 with net area ratio of 0.88
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 2/20/2017
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 1.875 in

Terracon
1450 Fifth St W
North Charleston, SC

CPT Started: 4/1/2019

Rig: Pagani TG73-200

Project No.: EN175139

CPT Completed: 4/1/2019

Operator: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT EN175139 THOMAS ISLAND PUM.GPJ TERRACON_DATA TEMPLATE.GDT 4/2/19


BORING LOG NO. HAB AT CPT-1A

Page 1 of 1

PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

SITE: Clements Ferry Road
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.875689° Longitude: -79.931273°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	DEPTH			
	TOPSOIL			
	0.4 SANDY LEAN CLAY (CL) , brown to gray			
	4.0 Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: N/A

Advancement Method:
Manual Hand Auger

Abandonment Method:
Backfilled with Auger Cuttings

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
1450 Fifth St W
North Charleston, SC

Boring Started: 04-01-2019

Drill Rig: N/A

Project No.: EN175139

Boring Completed: 04-01-2019

Driller: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON.DATATEMPLATE.GDT 4/2/19




BORING LOG NO. HAB AT CPT-2A

Page 1 of 1

PROJECT: Thomas Island Pumpstation and Interceptor

CLIENT: Hazen and Sawyer PC
Charleston, SC

SITE: Clements Ferry Road
Charleston, SC

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.873553° Longitude: -79.929301°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	DEPTH			
	TOPSOIL			
	0.5			
	CLAYEY SAND (SC) , tan to brown			
	1.7			
	SANDY LEAN CLAY (CL) , tan to brown			
	4.0			
	Boring Terminated at 4 Feet			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: N/A

Advancement Method:
Manual Hand Auger

Abandonment Method:
Backfilled with Auger Cuttings

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
1450 Fifth St W
North Charleston, SC

Boring Started: 04-01-2019

Drill Rig: N/A

Project No.: EN175139

Boring Completed: 04-01-2019

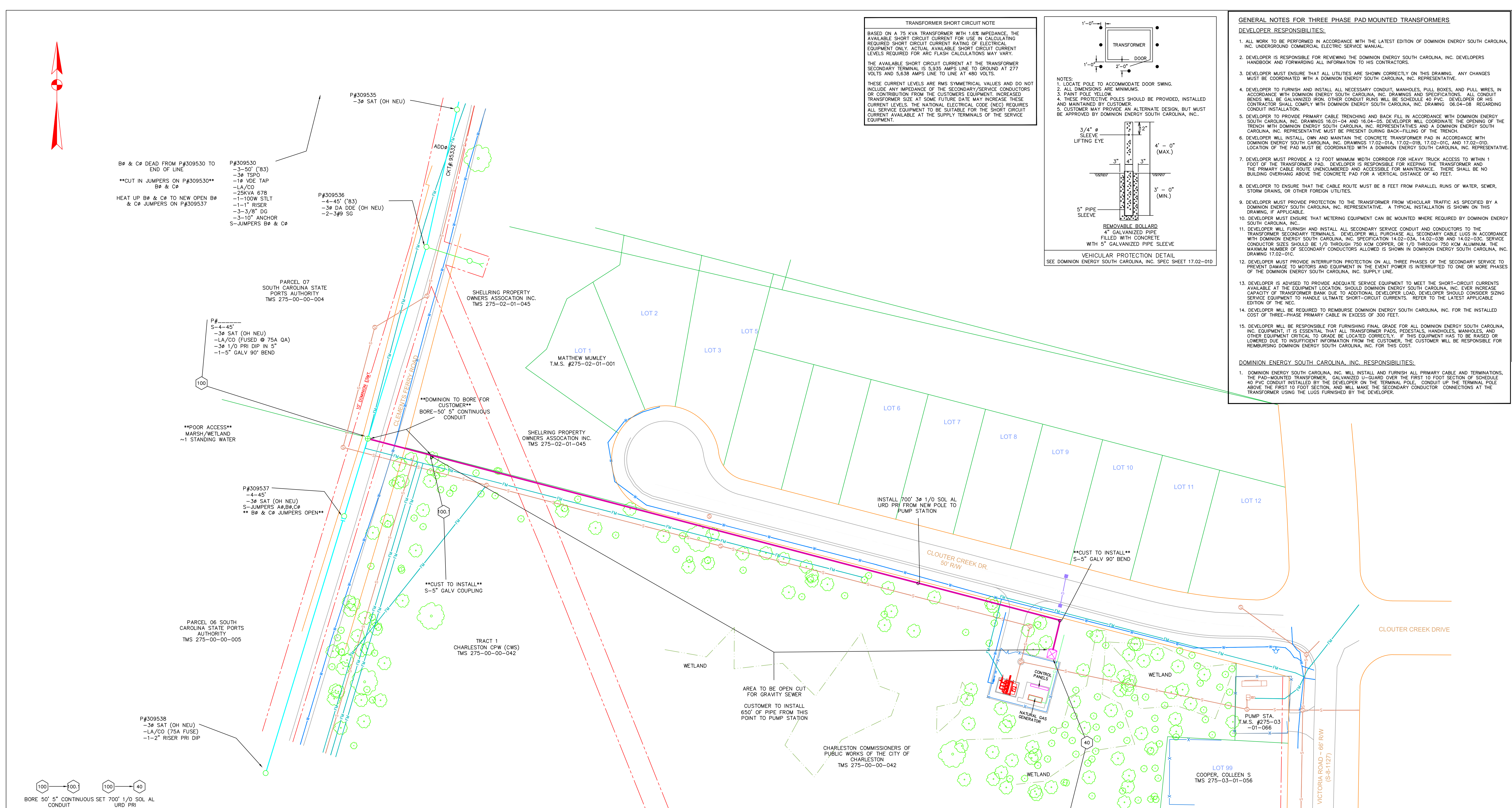
Driller: B. Rozier

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL EN175139 THOMAS ISLAND PUM.GPJ TERRACON.DATATEMPLATE.GDT 4/2/19

APPENDIX D

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\\sc001\server\apps\gish\SCAMCAD\Drawings\Electric\Construction\083444-01.dwg, Scale=40, Plotted By: 04/05/2019, Printed: Aug 14, 2019 - 8:47am, REV. 2 (03/25/19) - CHANGED DWTITLE STANDARDIZED ON COOP PAD



3Ø PAD MOUNT TRANSFORMER CONCRETE PAD NOTES

BY: MWC

DATE: 03-26-19

REV: 2

17.02-01A

NOTES:

1. SEE DRAWING 06.04-08 FOR CUSTOMER REQUIREMENTS.

2. SEE DRAWING 17.02-01B FOR CONCRETE PAD DETAILS.

3. PAD LOCATION IS TO BE SPOTTED BY COMPANY REPRESENTATIVE BEFORE FORMING OR POURING CONCRETE. SEE DRAWING 17.02-01D FOR CLEARANCE AND ACCESS REQUIREMENTS.

4. PAD MUST BE BUILT TO DIMENSIONS GIVEN AND CONDUITS MUST BE INSTALLED CORRECTLY.

5. FOR RADIAL FEED TRANSFORMERS, THE CENTER OF THE RADIAL PRIMARY CONDUIT SHALL BE POSITIONED 18" FROM THE LEFT EDGE OF THE CONDUIT WINDOW AND THE FRONT OF THE CONDUIT SHALL BE POSITIONED 6" FROM THE FRONT EDGE OF THE CONDUIT WINDOW AS SHOWN ON DRAWING 17.02-01B.

6. FOR LOOP FEED TRANSFORMERS, THE CENTER OF THE LEFT LOOP PRIMARY CONDUIT SHALL BE POSITIONED 9" FROM THE LEFT EDGE OF THE CONDUIT WINDOW; THE CENTER OF THE RIGHT LOOP PRIMARY CONDUIT SHALL BE POSITIONED 27" FROM THE LEFT EDGE OF THE CONDUIT WINDOW; THE FRONT OF BOTH CONDUITS SHALL BE POSITIONED 6" FROM THE FRONT EDGE OF THE CONDUIT WINDOW AS SHOWN ON DRAWING 17.02-01B.

7. PAD FOUNDATION MUST SUPPORT THE WEIGHT OF THE TRANSFORMER (SEE DRAWING 17.02-01C). IF SOIL CONDITION WILL NOT SUPPORT THE WEIGHT (POUNDS PER SQUARE FOOT AS INDICATED ON DRAWING 17.02-01C), THEN THE AREA THE OF PAD MUST BE INCREASED OR PILINGS INSTALLED TO MEET THE WEIGHT REQUIREMENT.

8. STEEL REINFORCING REBAR SHALL BE INTERMEDIATE GRADE BILLET STEEL WITH 40,000 PSI MINIMUM YIELD STRENGTH, CONFORMING TO ASTM A615 GRADE 40.

9. CONCRETE OF PAD TO CONFORM TO CLASS A STRUCTURAL CONCRETE AND SHALL HAVE 28 DAY STRENGTH OF 4000 PSI. CONTAIN NO MORE THAN 6 PERCENT ENTRAINED AIR AND HAVE NO LARGER THAN 1 INCH AGGREGATE MIXTURE.

10. LIMESTONE AGGREGATE IS NOT ACCEPTABLE. ALL OTHER CONCRETE MATERIALS SHALL BE IN ACCORDANCE WITH PORTLAND CEMENT STANDARD ASTM C150.

11. IF PAD IS LOCATED IN AREA SUBJECT TO FLOODING, IT MUST BE ELEVATED ABOVE WATER LINE.

12. ALL CONDUITS MUST BE FLUSH OR UP TO 1 INCH ABOVE FINISHED PAD.

13. SECONDARY CONDUIT(S) MUST NOT BE INSTALLED MORE THAN 20 INCHES FROM RIGHT EDGE OF WINDOW. CONDUIT(S) EDGE SHALL BE MINIMUM OF 2 INCHES FROM EDGE OF WINDOW OPENING.

14. CUSTOMER MUST PROVIDE AND MARK TWO (2) SUITABLE LOCATIONS WITHIN THE CONDUIT WINDOW FOR INSTALLATION OF TWO (2) 10 FOOT GROUND RODS. ONE SHALL BE LOCATED ON THE PRIMARY SIDE AND ONE SHALL BE LOCATED ON THE SECONDARY SIDE.

15. CONDUIT WINDOW MUST BE OPEN (NO REBAR, FORMS OR CONCRETE ALLOWED).

16. SEE DRAWING 17.02-01C FOR MAXIMUM ALLOWABLE SECONDARY RUNS AND OTHER PAD INFORMATION.

DISTRIBUTION CONSTRUCTION STANDARD

DOMINION ENERGY SOUTH CAROLINA, INC.

3Ø PAD MOUNT TRANSFORMER CONCRETE PAD DETAIL

BY: MWC

DATE: 03-26-19

REV: 2

17.02-01B

NOTES:

1. SEE DRAWING 17.02-01A FOR GENERAL INFORMATION AND NOTES.

DISTRIBUTION CONSTRUCTION STANDARD

DOMINION ENERGY SOUTH CAROLINA, INC.

TRANSFORMER SHORT CIRCUIT NOTE

BASED ON A 75 KVA TRANSFORMER WITH 1.6% IMPEDANCE, THE AVAILABLE SHORT CIRCUIT CURRENT FOR USE IN CALCULATING REQUIRED SHORT CIRCUIT CURRENT RATING OF ELECTRICAL EQUIPMENT ONLY. ACTUAL AVAILABLE SHORT CIRCUIT CURRENT LEVELS REQUIRED FOR ARC FLASH CALCULATIONS MAY VARY.

THE AVAILABLE SHORT CIRCUIT CURRENT AT THE TRANSFORMER SECONDARY TERMINAL IS 5,935 AMPS LINE TO GROUND AT 277 VOLTS AND 5,935 AMPS LINE TO LINE AT 480 VOLTS.

THESE CURRENT LEVELS ARE RMS SYMMETRICAL VALUES AND DO NOT INCLUDE ANY IMPEDANCE OF THE SECONDARY/SERVICE CONDUCTORS OR CONTRIBUTION FROM THE CUSTOMER EQUIPMENT. INCREASED TRANSFORMER SIZE AT SOME FUTURE DATE MAY INCREASE THESE CURRENT LEVELS. THE NATIONAL ELECTRICAL CODE (NEC) REQUIRES ALL SERVICE EQUIPMENT TO BE SUITABLE FOR THE SHORT CIRCUIT CURRENT AVAILABLE AT THE SUPPLY TERMINALS OF THE SERVICE EQUIPMENT.

1. LOCATE POLE TO ACCOMMODATE DOOR SWING.

2. ALL DIMENSIONS ARE MINIMUMS.

3. PAINT POLE YELLOW.

4. THESE PROTECTIVE POLES SHOULD BE PROVIDED, INSTALLED AND MAINTAINED BY CUSTOMER.

5. CUSTOMER MAY PROVIDE AN ALTERNATE DESIGN, BUT MUST BE APPROVED BY DOMINION ENERGY SOUTH CAROLINA, INC.

1'-0"

1'-0"

2'-0"

1

TRANSFORMER

DOOR

NOTES:

1. LOCATE POLE TO ACCOMMODATE DOOR SWING.

2. ALL DIMENSIONS ARE MINIMUMS.

3. PAINT POLE YELLOW.

4. THESE PROTECTIVE POLES SHOULD BE PROVIDED, INSTALLED AND MAINTAINED BY CUSTOMER.

5. CUSTOMER MAY PROVIDE AN ALTERNATE DESIGN, BUT MUST BE APPROVED BY DOMINION ENERGY SOUTH CAROLINA, INC.

3/4" Ø SLEEVE

LIFTING EYE

3"

3"

4' - 0" (MAX.)

3' - 0" (MIN.)

5" PIPE SLEEVE

REMOVABLE BOLLARD

4" GALVANIZED PIPE FILLED WITH CONCRETE WITH 5" GALVANIZED PIPE SLEEVE

VEHICULAR PROTECTION DETAIL

SEE DOMINION ENERGY SOUTH CAROLINA, INC. SPEC SHEET 17.02-01D

TRANSFORMER PROPERTIES

TRANSFORMER KVA	MAXIMUM CONDUCTORS PER PHASE		APPROXIMATE WEIGHT (LBS)	APPROXIMATE LBS/FT ²
	VOLTAGE 120 / 208 Y	VOLTAGE 277 / 480 Y		
150	16	14	4,000	150
225	16	14	4,500	150
300	16	14	5,000	300
500	16	14	6,000	300
750	16	14	10,000	400
1000	-	14	10,000	400
1500	-	14	12,000	500
2000	-	16	14,500	500
2500	-	18	15,000	500

GENERAL NOTES FOR THREE PHASE PAD MOUNTED TRANSFORMERS

DEVELOPER RESPONSIBILITIES:

1. ALL WORK TO BE PERFORMED IN ACCORDANCE WITH THE LATEST EDITION OF DOMINION ENERGY SOUTH CAROLINA, INC. UNDERGROUND COMMERCIAL ELECTRIC SERVICE MANUAL.

2. DEVELOPER IS RESPONSIBLE FOR REVIEWING THE DOMINION ENERGY SOUTH CAROLINA, INC. DEVELOPERS HANDBOOK AND FURNISHING ALL INFORMATION TO HIS CONTRACTORS.

3. DEVELOPER MUST ENSURE THAT ALL UTILITIES ARE SHOWN CORRECTLY ON THIS DRAWING. ANY CHANGES MUST BE COORDINATED WITH A DOMINION ENERGY SOUTH CAROLINA, INC. REPRESENTATIVE.

4. DEVELOPER TO FURNISH AND INSTALL ALL NECESSARY CONDUIT, MANHOLES, PULL BOXES, AND PULL WIRES, IN ACCORDANCE WITH DOMINION ENERGY SOUTH CAROLINA, INC. DRAWINGS AND SPECIFICATIONS. ALL CONDUIT BENDS WILL BE GALVANIZED IRON. OTHER CONDUIT RUNS WILL BE SCHEDULE 40 PVC. DEVELOPER OR HIS CONTRACTOR SHALL COMPLY WITH DOMINION ENERGY SOUTH CAROLINA, INC. DRAWING 06.04-08 REGARDING CONDUIT INSTALLATION.

5. DEVELOPER TO PROVIDE PRIMARY CABLE TRENCHING AND BACK FILL IN ACCORDANCE WITH DOMINION ENERGY SOUTH CAROLINA, INC. DRAWINGS 16.01-04 AND 16.04-05. DEVELOPER WILL COORDINATE THE OPENING OF THE TRENCH WITH DOMINION ENERGY SOUTH CAROLINA, INC. REPRESENTATIVES AND A DOMINION ENERGY SOUTH CAROLINA, INC. REPRESENTATIVE MUST BE PRESENT DURING BACK-FILLING OF THE TRENCH.

6. DEVELOPER WILL INSTALL, OWN AND MAINTAIN THE CONCRETE TRANSFORMER PAD IN ACCORDANCE WITH DOMINION ENERGY SOUTH CAROLINA, INC. DRAWINGS 17.02-01A, 17.02-01B, 17.02-01C, AND 17.02-01D. LOCATION OF THE PAD MUST BE COORDINATED WITH A DOMINION ENERGY SOUTH CAROLINA, INC. REPRESENTATIVE.

7. DEVELOPER MUST PROVIDE A 12 FOOT MINIMUM WIDTH CORRIDOR FOR HEAVY TRUCK ACCESS TO WITHIN 1 FOOT OF THE TRANSFORMER PAD. DEVELOPER IS RESPONSIBLE FOR KEEPING THE TRANSFORMER AND THE PRIMARY CABLE ROUTE UNOBSTRUCTED AND ACCESSIBLE FOR MAINTENANCE. THERE SHALL BE NO BUILDING OVERHANG ABOVE THE CONCRETE PAD FOR A VERTICAL DISTANCE OF 40 FEET.

8. DEVELOPER TO ENSURE THAT THE CABLE ROUTE MUST BE 8 FEET FROM PARALLEL RUNS OF WATER, SEWER, STORM DRAINS, OR OTHER FOREIGN UTILITIES.

9. DEVELOPER MUST PROVIDE PROTECTION TO THE TRANSFORMER FROM VEHICULAR TRAFFIC AS SPECIFIED BY A DOMINION ENERGY SOUTH CAROLINA, INC. REPRESENTATIVE. A TYPICAL INSTALLATION IS SHOWN ON THIS DRAWING, IF APPLICABLE.

10. DEVELOPER MUST ENSURE THAT METERING EQUIPMENT CAN BE MOUNTED WHERE REQUIRED BY DOMINION ENERGY SOUTH CAROLINA, INC.

11. DEVELOPER WILL FURNISH AND INSTALL ALL SECONDARY SERVICE CONDUIT AND CONDUCTORS TO THE TRANSFORMER SECONDARY TERMINALS. DEVELOPER WILL PURCHASE ALL SECONDARY CABLE LUGS IN ACCORDANCE WITH DOMINION ENERGY SOUTH CAROLINA, INC. SPECIFICATION 14.02-03A, 14.02-03B AND 14.02-03C. SERVICE CONDUCTOR SIZES SHOULD BE 1/0 THROUGH 750 KCM COPPER, OR 1/0 THROUGH 750 KCM ALUMINUM. THE MAXIMUM NUMBER OF SECONDARY CONDUCTORS ALLOWED IS SHOWN IN DOMINION ENERGY SOUTH CAROLINA, INC. DRAWING 17.02-01C.

12. DEVELOPER MUST PROVIDE INTERRUPTION PROTECTION ON ALL THREE PHASES OF THE SECONDARY SERVICE TO PREVENT DAMAGE TO MOTORS AND EQUIPMENT IN THE EVENT POWER IS INTERRUPTED TO ONE OR MORE PHASES OF THE DOMINION ENERGY SOUTH CAROLINA, INC. SUPPLY LINE.

13. DEVELOPER IS ADVISED TO PROVIDE ADEQUATE SERVICE EQUIPMENT TO MEET THE SHORT-CIRCUIT CURRENTS AVAILABLE AT THE EQUIPMENT LOCATION. SHOULD DOMINION ENERGY SOUTH CAROLINA, INC. EVER INCREASE CAPACITY OF TRANSFORMER BANK DUE TO ADDITIONAL DEVELOPER LOAD, DEVELOPER SHOULD CONSIDER SIZING SERVICE EQUIPMENT TO HANDLE ULTIMATE SHORT-CIRCUIT CURRENTS. REFER TO THE LATEST APPLICABLE EDITION OF THE NEC.

14. DEVELOPER WILL BE REQUIRED TO REIMBURSE DOMINION ENERGY SOUTH CAROLINA, INC. FOR THE INSTALLED COST OF THREE-PHASE PRIMARY CABLE IN EXCESS OF 300 FEET.

15. DEVELOPER WILL BE RESPONSIBLE FOR FURNISHING FINAL GRADE FOR ALL DOMINION ENERGY SOUTH CAROLINA, INC. EQUIPMENT. IT IS ESSENTIAL THAT ALL TRANSFORMER PADS, PRECASTS, HANDHOLES, MANHOLES, AND OTHER EQUIPMENT CRITICAL TO GRADE, BE LOCATED CORRECTLY. IF THIS EQUIPMENT HAS TO BE RAISED OR LOWERED DUE TO INSUFFICIENT INFORMATION FROM THE CUSTOMER, THE CUSTOMER WILL BE RESPONSIBLE FOR REIMBURSING DOMINION ENERGY SOUTH CAROLINA, INC. FOR THIS COST.

DOMINION ENERGY SOUTH CAROLINA, INC. RESPONSIBILITIES:

1. DOMINION ENERGY SOUTH CAROLINA, INC. WILL INSTALL AND FURNISH ALL PRIMARY CABLE AND TERMINATIONS, THE PAD-MOUNTED TRANSFORMER, GALVANIZED U-GUARD OVER THE FIRST 10 FOOT SECTION OF SCHEDULE 40 PVC CONDUIT INSTALLED BY THE DEVELOPER ON THE TERMINAL POLE, CONDUIT UP THE TERMINAL POLE ABOVE THE FIRST 10 FOOT SECTION, AND WILL MAKE THE SECONDARY CONDUIT CONNECTIONS AT THE TRANSFORMER USING THE LUGS FURNISHED BY THE DEVELOPER.

TRANSFORMER PROPERTIES

TRANSFORMER KVA	MAXIMUM CONDUCTORS PER PHASE		APPROXIMATE WEIGHT (LBS)	APPROXIMATE LBS/FT ²
	VOLTAGE 120 / 208 Y	VOLTAGE 277 / 480 Y		
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225	16	14	4,500	150
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500	16	14	6,000	300
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1000	-	14	10,000	400
1500	-	14	12,000	500
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