Specifications

CAREY STATION URBAN WATER REUSE FACILITY

0.5 MGD TO 1.0 MGD EXPANSION

GREENE COUNTY, GA

for

PIEDMONT WATER COMPANY

January 2025

I certify that I have been in responsible charge of the design of this project in accordance with the rules of the Georgia State Board of Registration for Professional Engineers and Land Surveyors. I further certify, to the best of my knowledge and belief, that these plans and specifications were prepared in accordance with current standard engineering practices and accurately reflect the Design Development Report (DDR) previously reviewed and concurred in by EPD. I further certify that the system as designed can reasonably be expected to consistently meet all currently applicable permit limits, conditions, and regulatory requirements, provided the facility is constructed as designed and properly operated and maintained.

Prepared By

GMC

Goodwyn Mills Cawood, LLC.
801 Board Street, Suite 900
Augusta, GA 30901
www.gmcnetwork.com

GMC PROJECT NUMBER: CAUG230002

CAREY STATION URBAN WATER REUSE FACILITY
0.5 MGD TO 1.0 MGD EXPANSION

FOR

PIEDMONT WATER COMPANY

GMC PROJECT NO. CAUG230002

TABLE OF CONTENTS

SPECIFICATIONS

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

DIVISION 1 – GENERAL REQUIREMENTS

01 42 00	References
01 50 00	Temporary Facilities and Controls
01 60 00	Product Requirements
01 70 00	Execution and Closeout Requirements
01 78 23	Operation and Maintenance Data
01 78 39	Project Record Documents
01 79 00	Demonstration and Training

DIVISION 2 - EXISTING CONDITIONS

02 41 19	Selective Demolition

DIVISION 3 – CONCRETE

03 20 00	Anchorage in Concrete
03 30 00	Cast-in-Place Concrete
03 39 00	Concrete Curing
03 41 00	Precast Structural Concrete
03 60 00	Grouting

DIVISION 4 - MASONRY

04 00 10	Unit Masonry Assemblies

DIVISION 5 – METALS

05 21 00	Steel Joist Framing
05 3 100	Steel Decking
05 40 00	Aluminum Handrail
05 44 00	Cold Formed Metal Trusses
05 50 00	Metal Fabrications
05 51 19	Metal Grating Stairs
05 52 13	Pipe and Tube Railings
05 53 13	Bar Gratings
05 60 00	Aluminum Hatches

DIVISION 6 – WOOD, PLASTICS, & COMP

06 60 00	FRP Weir Plates, Scum Baffles and Brackets

DIVISION 7 – THERMAL & MOISTURE PROTECTION

07 92 00	Joint Sealants

DIVISION 8 - NOT USED

DIVISION 09 – FINISHES

099600	High-Performance Coatings

DIVISION 10 –12 NOT USED

DIVISION 13 - SPECIAL CONSTRUCTION

13 31 00	Fiberglass Reinforced Building Enclosure

DIVISION 14 –25 NOT USED

DIVISION 26 – ELECTRICAL

26 05 02	Basic Electrical Requirements
26 05 04	Basic Electrical Materials and Methods
26 05 05	Conductors
26 05 26	Grounding & Bonding for Electrical Systems
26 05 29	Hangers & Supports for Electrical Systems
26 05 33	Raceways & Boxes for Electrical Systems
26 05 43	Underground Ducts and Raceways for Electrical Systems
26 05 53	Identification for Electrical Systems
26 05 72	Overcurrent Protective Device Short Circuit Study
26 05 73	Overcurrent Protective Device Coordination Study
26 05 74	Overcurrent Protective Device Arc Flash Study
26 08 00	Commissioning of Electrical Systems
26 22 13	Low Voltage Distribution Transformers
26 24 16	Panelboards
26 27 26	Wiring Devices
26 29 23	Variable-Frequency Motor Controllers
26 32 13	Engine Driven Generator Sets

DIVISION 27 - 30 NOT USED

DIVISION 31 – EARTHWORK

31 05 16	Aggregates for Earthwork
31 10 00	Site Clearing
31 20 00	Earth Moving
31 23 19	Dewatering
31 25 00	Erosion and Sedimentation Controls
31 50 00	Excavation Support and Protection

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 12 16	Asphalt Paving
32 13 13	Concrete Paving
32 31 13	Chain Link Fence and Gates
32 91 13	Soil Preparation
32 92 00	Turf and Grasses

DIVISION 33 – UTILITIES

33 01 30.13	Sewer and Manhole Testing
33 01 30.51	Pumping and Bypassing
33 01 30.61	Sewer and Pipe Joint Sealing
33 01 30.62	Manhole Grout Sealing
33 05 05.31	Hydrostatic Testing

33 05 13	Manholes and Structures
33 05 16.13	Precast Concrete Utility Structures
33 05 26	Utility Identification
33 31 00	Sanitary Utility Sewerage Piping
33 41 13	Public Storm Utility Drainage Piping

DIVISION 34-39 NOT USED

DIVISION 40 – PROCESS INTERCONNECTIONS

40 05 06	Couplings Adapters Specials for Process Piping
40 05 07	Hangers and Supports for Process Piping
40 05 13	Common Requirements for Process Piping
40 05 19	Ductile Iron Process Pipe
40 05 23	Stainless Steel Process Pipe and Tubing
40 05 31	Thermoplastic Process Pipe
40 05 51	Common Requirements for Process Valves
40 05 53	Identification for Process Piping
40 05 57	Actuators for Process Valves and Gates
40 05 59	Aluminum Slide Gates
40 05 62	Plug Valves
40 05 63	Ball Valves
40 05 64	Butterfly Valves
40 05 65.23	Swing and Disc Check Valves
40 05 78.21	Air Release Valves for Wastewater Service
40 70 00	Instrumentation Devices
40 71 13	Magnetic Flow Meters
40 71 69	Parshall Flume
40 72 13	Ultrasonic Level Meters
40 72 43.00	Pressure and Differential Pressure Type Level Meters
40 72 76.00	Level Switches
40 75 00	Refrigerated Auto Sampler
40 75 13	PH ORP Sensors
40 75 33	Chlorine-Fluoride Analyzers
40 75 43	Fluorescent Dissolved Oxygen Measuring
40 90 00	Instrumentation and Control for Process Systems
40 94 03	Programmable Logic Controller Subsystem (PLCS)

DIVISION 41 – 42 NOT USED

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

43 25 13	Submersible Centrifugal Pumps
43 41 46	Polyethylene Tanks and Accessories
43 53 54	Blowers

DIVISION 44 – 45 NOT USED

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

46 21 01	Manual Bar Screen

ADVERTISEMENT FOR BIDS

PIEDMONT WATER COMPANY
GREENE COUNTY, GA
CAREY STATION URBAN WATER REUSE FACILITY 0.5 MGD TO 1.0 MGD EXPANSION

General Notice

Piedmont Water Company (Owner) is requesting Bids for the construction of the following Project: Carey Station Urban Water Reuse Facility 0.5 MGD To 1.0 MGD Expansion

The Piedmont Water Company will receive bids until 2:00 p.m. on February 20th 2025. Bids shall be sent electronically to liang.wang@gmcnetwork.com. Bids received after this time will not be accepted.

The Project includes the following Work:

> Expansion of the Carey Station Urban Water Reuse Facility from 0.5 MGD to 1.0 MGD, which includes installation of new Headworks, equalization basin, influent pump station, 3rd clarifier, aerobic digester, blowers for aerobic digester, chlorine contact chamber, chemical tank farm and chemical pumping room, 1.5 MG reject pond, and converting existing aerobic digester to VertiCel aeration basin.

Obtaining the Bidding Documents

Information and Bidding Documents for the Project can be found at the following designated website:

Carey Station 100% Plan and Specs

https://gmcawood-my.sharepoint.com/my?id=%2Fpersonal%2Flwang%5Fgmcnetwork%5Fcom%2FDocuments%2FCarey%20Station%20100%25%20Plan%20and%20Specs&sortField=FileLeafRef&isAscending=true

The designated website will be updated periodically with addenda, lists of registered plan holders, reports, and other information relevant to submitting a Bid for the Project. All official notifications, addenda, and other Bidding Documents will be offered only through the designated website.

Pre-bid Conference

A mandatory pre-bid conference for the Project will be held on January 30th 2025 at 10:00 AM EST at the 4610 Carey Station Road, Greensboro, Georgia 30642. Bids will not be accepted from Bidders that do not attend the mandatory pre-bid conference.

Instructions to Bidders.

For all further requirements regarding bid submittal, qualifications, procedures, and contract award, refer to the Instructions to Bidders that are included in the Bidding Documents.

All requests for technical information from Bidders shall send requests to the Engineer by email only up to five (5) business days prior to bid date.

This Advertisement is issued by:

Owner: Piedmont Water Company
By: Brent Hurst
Title: Chief Operating Officer
Date: January 6, 2025

INSTRUCTIONS TO BIDDERS FOR CONSTRUCTION CONTRACT

TABLE OF CONTENTS

ARTICLE 1—DEFINED TERMS

1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions.

ARTICLE 2—BIDDING DOCUMENTS

2.01 Bidder shall obtain a complete set of Bidding Requirements and proposed Contract Documents (together, the Bidding Documents). See the Agreement for a list of the Contract Documents. It is Bidder's responsibility to determine that it is using a complete set of documents in the preparation of a Bid. Bidder assumes sole responsibility for errors or misinterpretations resulting from the use of incomplete documents, by Bidder itself or by its prospective Subcontractors and Suppliers.

2.02 Bidding Documents are made available for the sole purpose of obtaining Bids for completion of the Project and permission to download or distribution of the Bidding Documents does not confer a license or grant permission or authorization for any other use. Authorization to download documents, or other distribution, includes the right for plan holders to print documents solely for their use, and the use of their prospective Subcontractors and Suppliers, provided the plan holder pays all costs associated with printing or reproduction. Printed documents may not be re-sold under any circumstances.

2.03 Owner has established a Bidding Documents Website as indicated in the Advertisement or invitation to bid. Owner requires that Bidder obtain a complete set of the Bidding Documents from such website. Bidders may rely that sets of Bidding Documents obtained from the Bidding Documents Website are complete, unless an omission is blatant.

2.04 *Electronic Documents*

A. When the Bidding Requirements indicate that electronic (digital) copies of the Bidding Documents are available, such documents will be made available to the Bidders as Electronic Documents in the manner specified.

1. Bidding Documents will be provided in PDF (Portable Document Format) (.pdf). It is the intent of the Engineer and Owner that such Electronic Documents are to be exactly representative of the original copies of the documents. However, because the Owner and Engineer cannot totally control the transmission and receipt of Electronic Documents nor the Contractor's means of reproduction of such documents, the Owner and Engineer cannot and do not guarantee that Electronic Documents and reproductions prepared from those versions are identical in every manner to the original copies.

B. Unless otherwise stated in the Bidding Documents, the Bidder may use and rely upon complete sets of Electronic Documents of the Bidding Documents, described in Paragraph 2.04.A above. However, Bidder assumes all risks associated with differences arising from transmission/receipt of Electronic Documents versions of Bidding Documents and reproductions prepared from those versions and, further, assumes all risks, costs, and responsibility associated with use of the Electronic Documents versions to derive information that is not explicitly contained in original versions of the documents, and for Bidder's reliance upon such derived information.

ARTICLE 3—QUALIFICATIONS OF BIDDERS

3.01 Bidder is to submit the following information with its Bid to demonstrate Bidder's qualifications to perform the Work:

A. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.

B. A written statement that Bidder is authorized to do business in the State of Georgia.

C. Bidder's Georgia Utility Contractors License Number

D. Subcontractor and Supplier qualification information, to the extent available at time of bidding.

E. Other required information regarding qualifications.

3.02 A Bidder's failure to submit required qualification information within the times indicated may disqualify Bidder from receiving an award of the Contract.

3.03 No requirement in this Article 3 to submit information will prejudice the right of Owner to seek additional pertinent information regarding Bidder's qualifications.

ARTICLE 4—PRE-BID CONFERENCE

4.01 A mandatory pre-bid conference will be held at the time and location indicated in the Advertisement or invitation to bid. Representatives of Owner and Engineer will be present to discuss the Project. Proposals will not be accepted from Bidders who do not attend the conference. It is each Bidder's responsibility to sign in at the pre-bid conference to verify its participation. Bidders must sign in using the name of the organization that will be submitting a Bid. A list of qualified Bidders that attended the pre-bid conference and are eligible to submit a Bid for this Project will be issued in an Addendum.

4.02 Information presented at the pre-Bid conference does not alter the Contract Documents. Owner will issue Addenda to make any changes to the Contract Documents that result from discussions at the pre-Bid conference. Information presented, and statements made at the pre-bid conference will not be binding or legally effective unless incorporated in an Addendum.

ARTICLE 5—SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

5.01 *Site and Other Areas*

A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.

5.02 *Existing Site Conditions*

A. *Subsurface and Physical Conditions; Hazardous Environmental Conditions*

1. The Supplementary Conditions identify the following regarding existing conditions at or adjacent to the Site:

a. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data.

b. Those drawings known to Owner of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data.

c. Reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.

d. Technical Data contained in such reports and drawings.

2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.

B. *Underground Facilities:* Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05 of the General Conditions, and not in the drawings referred to in Paragraph 5.02.A of these Instructions to Bidders. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

5.03 *Other Site-related Documents*

A. In addition to the documents regarding existing Site conditions referred to in Paragraph 5.02.A, the following other documents relating to conditions at or adjacent to the Site are known to Owner and made available to Bidders for reference:

1. N/A

B. Owner has not verified the contents of these other Site-related documents, and Bidder may not rely on the accuracy of any data or information in such documents. Bidder is responsible for any interpretation or conclusion Bidder draws from the other Site-related documents.

C. The other Site-related documents are not part of the Contract Documents.

D. Bidders are encouraged to review the other Site-related documents, but Bidders will not be held accountable for any data or information in such documents. The requirement to review and take responsibility for documentary Site information is limited to information in (1) the Contract Documents and (2) the Technical Data.

5.04 *Site Visit and Testing by Bidders*

A. Bidder is required to visit the Site and conduct a thorough visual examination of the Site and adjacent areas. During the visit the Bidder must not disturb any ongoing operations at the Site.

B. A Site visit is scheduled following the pre-bid conference.

C. All access to the Site other than during a regularly scheduled Site visit must be coordinated through the following Owner contact for visiting the Site: Steve Morelli, smorelli@piedmontwater.com. Bidder must conduct the required Site visit during normal working hours. Requests for Site access must be received less than fourteen days prior to the date for opening of Bids.

D. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.

E. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder general access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site. Bidder is responsible for establishing access needed to reach specific selected test sites.

F. Bidder must comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.

G. Bidder must fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

5.05 *Owner's Safety Program*

A. Site visits and work at the Site may be governed by an Owner safety program. If an Owner safety program exists, it will be noted in the Supplementary Conditions.

5.06 *Other Work at the Site*

A. Reference is made to Article 8 of the Supplementary Conditions for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Express Representations and Certifications in Bid Form, Agreement*

A. The Bid Form that each Bidder will submit contains express representations regarding the Bidder's examination of Project documentation, Site visit, and preparation of the Bid, and certifications regarding lack of collusion or fraud in connection with the Bid. Bidder should review these representations and certifications, and assure that Bidder can make the representations and certifications in good faith, before executing and submitting its Bid.

B. If Bidder is awarded the Contract, Bidder (as Contractor) will make similar express representations and certifications when it executes the Agreement.

ARTICLE 7—INTERPRETATIONS AND ADDENDA

7.01 Owner on its own initiative may issue Addenda to clarify, correct, supplement, or change the Bidding Documents.

7.02 Bidder shall submit all questions about the meaning or intent of the Bidding Documents to Owner in writing. Contact information and submittal procedures for such questions are as follows:

A. Questions must be sent electronically to the Engineer by email, liang.wang@gmcnetwork.com

7.03 Interpretations or clarifications considered necessary by Engineer and Owner in response to such questions will be issued by Addenda. All requests for technical information from Bidders shall send requests to the Engineer by email only up to five (5) business days prior to bid date.

7.04 Only responses set forth in an Addendum will be binding. Oral and other interpretations or clarifications will be without legal effect. Responses to questions are not part of the Contract Documents unless set forth in an Addendum that expressly modifies or supplements the Contract Documents.

ARTICLE 8—BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a Bid bond issued by a surety meeting the requirements of Paragraph 6.01 of the General Conditions. Such Bid bond will be issued in the form included in the Bidding Documents.

8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract, furnished the required Contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract and furnish the required Contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited, in whole in the case of a penal sum bid bond, and to the extent of Owner's damages in the case of a damages-form bond. Such forfeiture will be Owner's exclusive remedy if Bidder defaults.

8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of 7 days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.

8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within 7 days after the Bid opening.

ARTICLE 9—CONTRACT TIMES

9.01 The number of days within which, or the dates by which, the Work is to be (a) substantially completed and (b) ready for final payment, and (c) Milestones (if any) are to be achieved, are set forth in the Agreement.

9.02 Provisions for liquidated damages, if any, for failure to timely attain a Milestone, Substantial Completion, or completion of the Work in readiness for final payment, are set forth in the Agreement.

ARTICLE 10—SUBSTITUTE AND "OR EQUAL" ITEMS

10.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration during the bidding and Contract award process of possible substitute or "or-equal" items. In cases in which the Contract allows the Contractor to request that Engineer authorize the use of a substitute or "or-equal" item of material or equipment, application for such acceptance may not be made to and will not be considered by Engineer until after the Effective Date of the Contract.

10.02 All prices that Bidder sets forth in its Bid will be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding Documents, as

supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of "or-equal" or substitution requests are made at Bidder's sole risk.

ARTICLE 11—SUBCONTRACTORS, SUPPLIERS, AND OTHERS

11.01 A Bidder must be prepared to retain specific Subcontractors and Suppliers for the performance of the Work if required to do so by the Bidding Documents or in the Specifications. If a prospective Bidder objects to retaining any such Subcontractor or Supplier and the concern is not relieved by an Addendum, then the prospective Bidder should refrain from submitting a Bid.

11.02 The apparent Successful Bidder, and any other Bidder so requested, must submit to Owner a list of the Subcontractors or Suppliers proposed for the following portions of the Work within five days after Bid opening:

A. Electrical

11.03 If requested by Owner, such list must be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor or Supplier. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor or Supplier, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, in which case apparent Successful Bidder will submit a substitute, Bidder's Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and Owner may consider such price adjustment in evaluating Bids and making the Contract award.

11.04 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors and Suppliers. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor or Supplier, so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.07 of the General Conditions.

ARTICLE 12—PREPARATION OF BID

12.01 The Bid Form is included with the Bidding Documents.

A. All blanks on the Bid Form must be completed in ink and the Bid Form signed in ink. Erasures or alterations must be initialed in ink by the person signing the Bid Form. A Bid price must be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.

B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words "No Bid" or "Not Applicable."

12.02 If Bidder has obtained the Bidding Documents as Electronic Documents, then Bidder shall prepare its Bid on a paper copy of the Bid Form printed from the Electronic Documents version of the Bidding Documents. The printed copy of the Bid Form must be clearly legible, printed on 8½ inch by 11-inch paper and as closely identical in appearance to the Electronic Document version of the Bid Form as may be practical. The Owner reserves the right to accept Bid Forms which nominally vary in appearance from the original paper version of the Bid Form, providing that all required information and submittals are included with the Bid.

12.03 A Bid by a corporation must be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation must be shown. The corporate seal must be affixed and attested by the corporate secretary or an assistant corporate secretary.

12.04 A Bid by a partnership must be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership must be shown.

12.05 A Bid by a limited liability company must be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm must be shown.

12.06 A Bid by an individual must show the Bidder's name and official address.

12.07 A Bid by a joint venture must be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The joint venture must have been formally established prior to submittal of a Bid, and the official address of the joint venture must be shown.

12.08 All names must be printed in ink below the signatures.

12.09 The Bid must contain an acknowledgment of receipt of all Addenda, the numbers of which must be filled in on the Bid Form.

12.10 Postal and e-mail addresses and telephone number for communications regarding the Bid must be shown.

12.11 The Bid must contain evidence of Bidder's authority to do business in the state where the Project is located, or Bidder must certify in writing that it will obtain such authority within the time for acceptance of Bids and attach such certification to the Bid.

12.12 If Bidder is required to be licensed to submit a Bid or perform the Work in the state where the Project is located, the Bid must contain evidence of Bidder's licensure, or Bidder must certify in writing that it will obtain such licensure within the time for acceptance of Bids and attach such certification to the Bid. Bidder's state contractor license number, if any, must also be shown on the Bid Form.

12.13 Bidder must complete and submit Contractor Affidavit, Subcontractor Affidavit, and Certification of Sponsor Drug-Free Workplace forms in Section 00 45 19, 00 45 20, and 00 45 21, respectively.

ARTICLE 13—BASIS OF BID

13.01 *Lump Sum*

A. Bidders must submit a Bid on a lump sum basis as set forth in the Bid Form.

13.02 *Allowances*

A. For cash allowances the Bid price must include such amounts as the Bidder deems proper for Contractor's overhead, costs, profit, and other expenses on account of cash allowances, if any, named in the Contract Documents, in accordance with Paragraph 13.02.B of the General Conditions.

ARTICLE 14—SUBMITTAL OF BID

14.01 The Bidding Documents include one copy of the Bid Form, and, if required, the Bid Bond Form. The copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 2 of the Bid Form.

14.02 A Bid must be received no later than the date and time prescribed and at the web address indicated in the Advertisement or invitation to bid.

14.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted.

ARTICLE 15—MODIFICATION AND WITHDRAWAL OF BID

15.01 An unopened Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the web address where Bids are to be submitted prior to the date and time for the opening of Bids.

15.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 15.01 and submit a new Bid prior to the date and time for the opening of Bids.

15.03 If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, the Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid, the Bidder will be disqualified from further bidding on the Work.

ARTICLE 16—OPENING OF BIDS

16.01 Bids will be opened privately.

ARTICLE 17—BIDS TO REMAIN SUBJECT TO ACCEPTANCE

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

ARTICLE 18—EVALUATION OF BIDS AND AWARD OF CONTRACT

18.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner also reserves the right to waive all minor Bid informalities not involving price, time, or changes in the Work.

18.02 Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible.

18.03 If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of

the Bid, whether in the Bid itself or in a separate communication to Owner or Engineer, then Owner will reject the Bid as nonresponsive.

18.04 If Owner awards the contract for the Work, such award will be to the responsible Bidder of the owner's choice

18.05 Evaluation of Bids

A. In evaluating Bids, Owner will consider whether the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

B. In the comparison of Bids, alternates will be applied in the same order of priority as listed in the Bid Form. To determine the Bid prices for purposes of comparison, Owner will announce to all bidders a "Base Bid plus alternates" budget after receiving all Bids, but prior to opening them. For comparison purposes alternates will be accepted, following the order of priority established in the Bid Form, until doing so would cause the budget to be exceeded. After determination of the Successful Bidder based on this comparative process and on the responsiveness, responsibility, and other factors set forth in these Instructions, the award may be made to said Successful Bidder on its base Bid and any combination of its additive alternate Bids for which Owner determines funds will be available at the time of award.

18.06 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

18.07 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

ARTICLE 19—BONDS AND INSURANCE

19.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds, other required bonds (if any), and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it must be accompanied by required bonds and insurance documentation.

19.02 Article 8, Bid Security, of these Instructions, addresses any requirements for providing bid bonds as part of the bidding process.

ARTICLE 20—SIGNING OF AGREEMENT

20.01 When Owner issues a Notice of Award to the Successful Bidder, it will be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder must execute and deliver the required number of counterparts of the Agreement and any bonds and insurance documentation required to be delivered by the Contract Documents to Owner. Within 10 days thereafter, Owner will deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

BID FORM FOR CONSTRUCTION CONTRACT

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

ARTICLE 1—OWNER AND BIDDER

1.01 This Bid is submitted to: Piedmont Water Company

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

ARTICLE 2—ATTACHMENTS TO THIS BID

2.01 The following documents are submitted with and made a condition of this Bid:

A. Required Bid security;
B. List of Proposed Subcontractors;
C. List of Proposed Suppliers;
D. Evidence of authority to do business in the State of Georgia;
E. Georgia Utility Contractor's license number as evidence of Bidder's State Contractor's License; and
F. Required Bidder Qualification Statement with supporting data.

ARTICLE 3—BASIS OF BID—LUMP SUM BID AND UNIT PRICES

3.01 *Lump Sum Bids*

A. Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price:

1. Lump Sum Price (Single Lump Sum)

Lump Sum Bid Price	$

ARTICLE 4—TIME OF COMPLETION

4.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

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

ARTICLE 5—BIDDER'S ACKNOWLEDGEMENTS: ACCEPTANCE PERIOD, INSTRUCTIONS, AND RECEIPT OF ADDENDA

5.01 *Bid Acceptance Period*

A. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

5.02 *Instructions to Bidders*

A. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security.

5.03 *Receipt of Addenda*

A. Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Bidder's Representations*

A. In submitting this Bid, Bidder represents the following:

1. Bidder has examined and carefully studied the Bidding Documents, including Addenda.
2. Bidder has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Bidder is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
4. Bidder has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
5. Bidder has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, if selected as Contractor; and (c) Bidder's (Contractor's) safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Bidder agrees that no further examinations, investigations, explorations, tests, studies, or data are

necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.

8. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
9. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. The submission of this Bid constitutes an incontrovertible representation by Bidder that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

6.02 *Bidder's Certifications*

A. The Bidder certifies the following:

1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation.
2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
3. Bidder has not solicited or induced any individual or entity to refrain from bidding.
4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 8.02.A:

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

BIDDER hereby submits this Bid as set forth above:

Bidder:

_____
(typed or printed name of organization)

By: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

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

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

Address for giving notices:

_____
_____

Bidder's Contact:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Phone: _____

Email: _____

Address:

_____
_____
_____

Bidder's Contractor License No.: (if applicable) _____

BID BOND

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

BIDDER *(Name and Address)*:

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

OWNER *(Name and Address)*:
Piedmont Water Company
607 Old Phoenix Rd
Eatonton, GA 31024

BID
Bid Due Date: **February 20th, 2025**
Description *(Project Name— Include Location)*: **Carey Station Urban Water Reuse Facility 0.5 MGD To 1.0 MGD Expansion**

BOND
Bond Number:
Date:
Penal sum _____ $ _____
(Words) (Figures)

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

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

Note: Addresses are to be used for giving any required notice.
Provide execution by any additional parties, such as joint venturers, if necessary.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.
2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation shall be null and void if:

   3.1 Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
   3.2 All Bids are rejected by Owner, or
   3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from the Bid due date without Surety's written consent.
6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after the Bid due date.
7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

ARTICLE 1—GENERAL INFORMATION

1.01 Provide contact information for the Business:

Legal Name of Business:			
Corporate Office			
Name:		Phone number:	
Title:		Email address:	
Business address of corporate office:			
Local Office			
Name:		Phone number:	
Title:		Email address:	
Business address of local office:			

1.02 Provide information on the Business's organizational structure:

Form of Business:	☐ Sole Proprietorship ☐ Partnership ☐ Corporation		
☐ Limited Liability Company ☐ Joint Venture comprised of the following companies:			
	1.		
	2.		
	3.		
Provide a separate Qualification Statement for each Joint Venturer.			
Date Business was formed:		State in which Business was formed:	
Is this Business authorized to operate in the Project location?	☐ Yes ☐ No ☐ Pending		

1.03 Identify all businesses that own Business in whole or in part (25% or greater), or that are wholly or partly (25% or greater) owned by Business:

Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			

1.04 Provide information regarding the Business's officers, partners, and limits of authority.

Name:		Title:	
Authorized to sign contracts: ☐ Yes ☐ No		Limit of Authority:	$
Name:		Title:	
Authorized to sign contracts: ☐ Yes ☐ No		Limit of Authority:	$
Name:		Title:	
Authorized to sign contracts: ☐ Yes ☐ No		Limit of Authority:	$
Name:		Title:	

ARTICLE 2—LICENSING

2.01 Provide information regarding licensure for Business:

Name of License:			
Licensing Agency:			
License No:		Expiration Date:	
Name of License:			
Licensing Agency:			
License No:		Expiration Date:	

ARTICLE 3—DIVERSE BUSINESS CERTIFICATIONS

3.01 Provide information regarding Business's Diverse Business Certification, if any. Provide evidence of current certification.

Certification	Certifying Agency	Certification Date
☐ Disadvantaged Business Enterprise		
☐ Minority Business Enterprise		
☐ Woman-Owned Business Enterprise		
☐ Small Business Enterprise		
☐ Disabled Business Enterprise		
☐ Veteran-Owned Business Enterprise		
☐ Service-Disabled Veteran-Owned Business		
☐ HUBZone Business (Historically Underutilized) Business		
☐ Other		
☐ None		

ARTICLE 4—SAFETY

4.01 Provide information regarding Business's safety organization and safety performance.

Name of Business's Safety Officer:		
Safety Certifications		
Certification Name	Issuing Agency	Expiration

4.02 Provide Worker's Compensation Insurance Experience Modification Rate (EMR), Total Recordable Frequency Rate (TRFR) for incidents, and Total Number of Recorded Manhours (MH) for the last 3 years and the EMR, TRFR, and MH history for the last 3 years of any proposed Subcontractor(s) that will provide Work valued at 10% or more of the Contract Price. Provide documentation of the EMR history for Business and Subcontractor(s).

Year									
Company	EMR	TRFR	MH	EMR	TRFR	MH	EMR	TRFR	MH

ARTICLE 5—FINANCIAL

5.01 Provide information regarding the Business's financial stability. Provide the most recent audited financial statement, and if such audited financial statement is not current, also provide the most current financial statement.

Financial Institution:		
Business address:		
Date of Business's most recent financial statement:		☐ Attached
Date of Business's most recent audited financial statement:		☐ Attached
Financial indicators from the most recent financial statement		
Contractor's Current Ratio (Current Assets ÷ Current Liabilities)		
Contractor's Quick Ratio ((Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) ÷ Current Liabilities)		

ARTICLE 6—SURETY INFORMATION

6.01 Provide information regarding the surety company that will issue required bonds on behalf of the Business, including but not limited to performance and payment bonds.

Surety Name:			
Surety is a corporation organized and existing under the laws of the state of:			
Is surety authorized to provide surety bonds in the Project location?	☐ Yes ☐ No		
Is surety listed in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" published in Department Circular 570 (as amended) by the Bureau of the Fiscal Service, U.S. Department of the Treasury? ☐ Yes ☐ No			
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

ARTICLE 7—INSURANCE

7.01 Provide information regarding Business's insurance company(s), including but not limited to its Commercial General Liability carrier. Provide information for each provider.

Name of insurance provider, and type of policy (CLE, auto, etc.):			
Insurance Provider		Type of Policy (Coverage Provided)	
Are providers licensed or authorized to issue policies in the Project location?	☐ Yes ☐ No		
Does provider have an A.M. Best Rating of A-VII or better?	☐ Yes ☐ No		
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

ARTICLE 8—CONSTRUCTION EXPERIENCE

8.01 Provide information that will identify the overall size and capacity of the Business.

Average number of current full-time employees:	
Estimate of revenue for the current year:	
Estimate of revenue for the previous year:	

8.02 Provide information regarding the Business's previous contracting experience.

Years of experience with projects like the proposed project:				
As a general contractor:		As a joint venturer:		
Has Business, or a predecessor in interest, or an affiliate identified in Paragraph 1.03:				
Been disqualified as a bidder by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No				
Been barred from contracting by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No				
Been released from a bid in the past 5 years? ☐ Yes ☐ No				
Defaulted on a project or failed to complete any contract awarded to it? ☐ Yes ☐ No				
Refused to construct or refused to provide materials defined in the contract documents or in a change order? ☐ Yes ☐ No				
Been a party to any currently pending litigation or arbitration? ☐ Yes ☐ No				
Provide full details in a separate attachment if the response to any of these questions is Yes.				

8.03 List all projects currently under contract in Schedule A and provide indicated information.

8.04 List a minimum of three and a maximum of six projects completed in the last 5 years in Schedule B and provide indicated information to demonstrate the Business's experience with projects similar in type and cost of construction.

8.05 In Schedule C, provide information on key individuals whom Business intends to assign to the Project. Provide resumes for those individuals included in Schedule C. Key individuals include the Project Manager, Project Superintendent, Quality Manager, and Safety Manager. Resumes may be provided for Business's key leaders as well.

ARTICLE 9—REQUIRED ATTACHMENTS

9.01 Provide the following information with the Statement of Qualifications:

A. If Business is a Joint Venture, separate Qualifications Statements for each Joint Venturer, as required in Paragraph 1.02.
B. Diverse Business Certifications if required by Paragraph 3.01.
C. Certification of Business's safety performance if required by Paragraph 4.02.
D. Financial statements as required by Paragraph 5.01.
E. Attachments providing additional information as required by Paragraph 8.02.

F. Schedule A (Current Projects) as required by Paragraph 8.03.
G. Schedule B (Previous Experience with Similar Projects) as required by Paragraph 8.04.
H. Schedule C (Key Individuals) and resumes for the key individuals listed, as required by Paragraph 8.05.
I. Additional items as pertinent.

This Statement of Qualifications is offered by:

Business: _____
(typed or printed name of organization)

By: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(date signed)

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

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address for giving notices:

_____
_____
_____

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

_____
_____
_____

Phone: _____

Email: _____

Schedule A—Current Projects

Name of Organization				
Project Owner		Project Name		
General Description of Project				
Project Cost		Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager
Name				

Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner		Project Name		
General Description of Project				
Project Cost		Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager
Name				

Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner		Project Name		
General Description of Project				
Project Cost		Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager
Name				

Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule B—Previous Experience with Similar Projects

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule B—Previous Experience with Similar Projects

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule C—Key Individuals

Project Manager			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Project Superintendent			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Safety Manager			
Name of individual			

Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Quality Control Manager			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

NOTICE OF AWARD

Date of Issuance:

Owner: Piedmont Water Company Owner's Project No.:

Engineer: Goodwyn Mills Cawood, LLC (GMC) Engineer's Project No.: CAUG230002

Project: Carey Station Urban Water Reuse Facility 0.5 MGD To 1.0 MGD Expansion

Contract Name:

Bidder:

Bidder's Address:

You are notified that Owner has accepted your Bid dated for the above Contract, and that you are the Successful Bidder and are awarded a Contract for:

Expansion of the Carey Station Urban Water Reuse Facility from 0.5 MGD to 1.0 MGD, which includes installation of new Headworks, equalization basin, influent pump station, 3rd clarifier, aerobic digester, blowers for aerobic digester, chlorine contact chamber, chemical tank farm and chemical pumping room, 1.5 MG reject pond, and converting existing aerobic digester to VertiCel aeration basin.

The Contract Price of the awarded Contract is $. Contract Price is subject to adjustment based on the provisions of the Contract, including but not limited to those governing changes, Unit Price Work, and Work performed on a cost-plus-fee basis, as applicable.

An electronic unexecuted copy of the Agreement accompanies this Notice of Award, and one copy of the Contract Documents accompanies this Notice of Award, or has been transmitted or made available to Bidder electronically.

☐ Drawings will be delivered separately from the other Contract Documents.

You must comply with the following conditions precedent within 15 days of the date of receipt of this Notice of Award:

1. Deliver to Owner four (4) counterparts of the Agreement, signed by Bidder (as Contractor).
2. Deliver with the signed Agreement(s) the Contract security (such as required performance and payment bonds) and insurance documentation, as specified in the Instructions to Bidders and in the General Conditions, Articles 2 and 6.

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

Within 10 days after you comply with the above conditions, Owner will return to you one fully signed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

Owner: Piedmont Water Company

By *(signature)*: _____

Name *(printed)*: _____

Title: _____

Copy: Engineer

AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

This Agreement is by and between Piedmont Water Company ("Owner") and ("Contractor"). Terms used in this Agreement have the meanings stated in the General Conditions and the Supplementary Conditions.
Owner and Contractor hereby agree as follows:

ARTICLE 1—WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents.

ARTICLE 2—THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: Expansion of the Carey Station Urban Water Reuse Facility from 0.5 MGD to 1.0 MGD, which includes installation of new Headworks, equalization basin, influent pump station, 3rd clarifier, aerobic digester, blowers for aerobic digester, chlorine contact chamber, chemical tank farm and chemical pumping room, 1.5 MG reject pond, and converting existing aerobic digester to VertiCel aeration basin.

ARTICLE 3—ENGINEER

3.01 The Owner has retained Goodwyn Mills Cawood, LLC. ("Engineer") to act as Owner's representative, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract.
3.02 The part of the Project that pertains to the Work has been designed by Engineer.

ARTICLE 4—CONTRACT TIMES

4.01 *Time is of the Essence*

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

4.03 *Contract Times: Days*

A. The Work will be substantially complete within 365 days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within 420 days after the date when the Contract Times commence to run.

4.05 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the Contract Times, as duly modified. The parties also recognize the delays, expense, and difficulties involved in proving, in a legal proceeding, the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. *Substantial Completion:* Contractor shall pay Owner $500 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.
2. *Completion of Remaining Work:* After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $250 for each day that expires after such time until the Work is completed and ready for final payment.
4. Liquidated damages for failing to timely attain Substantial Completion and final completion are not additive, and will not be imposed concurrently.

B. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, for such delay, except for special damages (if any) specified in this Agreement.

ARTICLE 5—CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents, the amounts that follow, subject to adjustment under the Contract:

A. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

ARTICLE 6—PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on the basis of Contractor's Applications for Payment on or about the 5th day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.

a. 95 percent of the value of the Work completed (with the balance being retainage).
b. 95 percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

B. Upon Substantial Completion **of the entire construction to be provided under the construction Contract Documents**, Owner shall pay an amount sufficient to increase total payments to Contractor to 100 percent of the Work completed, less such amounts set off by

Owner pursuant to Paragraph 15.01.E of the General Conditions, and less 200 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

6.03 *Final Payment*

A. Upon final completion and acceptance of the Work, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

6.04 *Consent of Surety*

A. Owner will not make final payment, or return or release retainage at Substantial Completion or any other time, unless Contractor submits written consent of the surety to such payment, return, or release.

6.05 *Interest*

A. All amounts not paid when due will bear interest at the rate of 10 percent per annum.

ARTICLE 7—CONTRACT DOCUMENTS

7.01 *Contents*

A. The Contract Documents consist of all of the following:

1. This Agreement.
2. Bonds:

    b. Payment bond (together with power of attorney).

3. General Conditions.
4. Supplementary Conditions.
5. Specifications as listed in the table of contents of the project manual (copy of list attached).
6. Drawings (not attached but incorporated by reference) consisting of 135 sheets with each sheet bearing the following general title: Carey Station Urban Water Reuse Facility 0.5 MGD To 1.0 MGD Expansion
7. Addenda (numbers __ to __, inclusive).
8. The following which may be delivered or issued on or after the Effective Date of the Contract and are not attached hereto:

    a. Notice to Proceed.
    b. Work Change Directives.
    c. Change Orders.
    d. Field Orders.
    e. Maintenance Bond.

B. The Contract Documents listed in Paragraph 7.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 7.

D. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

ARTICLE 8—REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS

8.01 *Contractor's Representations*

A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:

1. Contractor has examined and carefully studied the Contract Documents, including Addenda.
2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Contractor is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
6. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
8. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.
9. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

8.02 *Contractor's Certifications*

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 8.02:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;
2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to

establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and
4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

8.03 *Standard General Conditions*

A. Owner stipulates that the General Conditions, Section 00 72 13, that are made a part of this Contract are EJCDC® C-700, Standard General Conditions for the Construction Contract (2018), published by the Engineers Joint Contract Documents Committee, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or "track changes" (redline/strikeout), or in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement.
This Agreement will be effective on _____ (which is the Effective Date of the Contract).

Owner:

_____
(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

_____

_____

_____

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

_____

_____

_____

Phone: _____

Email: _____

(If _____ is a corporation, attach evidence of authority to sign. If _____ is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)

Contractor:

_____
(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

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

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

_____

_____

_____

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

_____

_____

_____

Phone: _____

Email: _____

License No.: _____
(where applicable)

State: _____

CONSTRUCTION SUBCONTRACT

TABLE OF CONTENTS

CONSTRUCTION SUBCONTRACT

This is a Construction Subcontract (Subcontract) between _____ (Contractor) and _____ (Subcontractor). This Subcontract is effective as of_____.
Prime Contract: Contractor has entered into a contract (Prime Contract) dated _____ with Piedmont Water Company (Owner).
Contractor and Subcontractor further agree as follows:

ARTICLE 1—PRELIMINARY MATTERS

1.01 *Prime Contract*

A. The Prime Contract requires Contractor to perform and furnish construction labor, materials, equipment, and services ("Prime Contract Work") in connection with the Project described therein. The Prime Contract (excluding compensation and other confidential information) is incorporated in this Subcontract by reference. Portions of the Prime Contract are attached as Exhibit 1 to this Subcontract; Subcontractor may review other non-confidential portions upon request. The Project described in the Prime Contract is summarized as follows:
Expansion of the Carey Station Urban Water Reuse Facility from 0.5 MGD to 1.0 MGD, which includes installation of new Headworks, equalization basin, influent pump station, 3rd clarifier, aerobic digester, blowers for aerobic digester, chlorine contact chamber, chemical tank farm and chemical pumping room, 1.5 MG reject pond, and converting existing aerobic digester to VertiCel aeration basin.

1.02 *Scope of Subcontract Work*

A. Contractor hereby retains Subcontractor to provide construction labor, materials, equipment, and services under this Subcontract described as follows:

_____
_____
_____
_____
("Subcontract Work").

B. The Subcontract Work is a part of the Prime Contract Work. Except as otherwise stated in this Subcontract, the provisions of the Prime Contract that apply to the performance and quality of the Prime Contract Work apply to the Subcontract Work.

C. The express terms of this Paragraph 1.02 govern in establishing the Subcontract scope of work. The divisions and sections of the Prime Contract's Specifications and the identifications and organization of the Prime Contract's drawings do not control or limit Contractor in dividing the Work among subcontractors or suppliers, or delineating the work to be performed by, or obligations of any specific trade, including Subcontractor.

1.03 *Subcontract Documents*

A. The Subcontract Documents are identified in Article 14 of this Subcontract.

1.04 *Independent Contractor*

A. Subcontractor is an independent contractor, and is not an employee or partner of, or a joint-venturer with Contractor, and has no contractual relationship or privity with Owner or Owner's engineers or consultants.

ARTICLE 2—OBLIGATIONS OF THE PRIME CONTRACT

2.01 *Incorporation of Prime Contract Obligations*

A. The Subcontractor is bound to the Contractor under the Subcontract to the same extent that the Contractor is bound to the Owner under the Prime Contract, and Subcontractor shall comply with all requirements, terms, and conditions of the Prime Contract that relate in any way to the performance and completion of the Subcontract Work.
B. The obligation of the Subcontractor to comply with the requirements, terms, and conditions of the Prime Contract does not provide any rights, benefits, or third-party beneficiary standing to the Subcontractor with respect to the Prime Contract.

2.02 *Precedence of Subcontract*

A. If a provision of this Subcontract conflicts with a provision of the Prime Contract, the terms of this Subcontract govern, unless under controlling laws the conflicted provision of the Prime Contract cannot be waived.

ARTICLE 3—SUBCONTRACT TIMES

3.01 *Subcontract Times*

A. The Subcontract Work will be completed in full pursuant to the attached preliminary progress schedule.
B. Subcontractor shall provide all required submittals on a timely basis, and shall provide sufficient labor and materials to comply with the Contractor's progress schedule and avoid delaying the progress of Contractor's work under the Prime Contract. Subcontractor shall make modifications in the performance and completion of the Subcontract Work as necessary to comply with modifications, if any, in the Contractor's progress schedule.
C. The time for completion of the Subcontract Work, as set forth in Paragraph 3.01.A, and compliance with the Contractor's progress schedule, as set forth in Paragraph 3.01.B, all as duly modified under this Subcontract, together will be referred to as "Subcontract Times."

3.02 *Time of the Essence*

A. Subcontractor's obligation to comply with the Subcontract Times is of the essence of the Subcontract.

3.03 *Damages for Late Completion*

A. Subcontractor and Contractor recognize that Contractor will suffer financial loss if the Subcontract Work is not completed within the Subcontract Times.
B. The damages resulting to the Contractor may include liquidated damages, special damages, and other damages (if any) assessed by the Owner, actual damages claimed by the Owner as a result of the delay, and the Contractor's costs for extended general conditions, field overhead, and home office overhead.
C. As a result of the losses, costs, and damages recognized in Paragraphs 3.03.A. and B., if Subcontractor fails to complete the Subcontract Work within the Subcontract Times, and without limiting any additional remedies available to Contractor, Subcontractor shall pay Contractor for losses, costs, and damages incurred by Contractor for Subcontractor's failure to comply with the Subcontract Times, including the share attributable to Subcontractor of

delay damages and costs imposed on or levied against Contractor. Contractor has the right to set off any such amounts against payments due Subcontractor under this Subcontract.

ARTICLE 4—SUBCONTRACT PRICE

4.01 *Payment Obligation*

A. Contractor shall pay Subcontractor for completion of the Subcontract Work in accordance with the Subcontract Documents an amount equal to the sum of the amounts determined pursuant to the following paragraphs (Subcontract Price).

B. For all Subcontract Work other than Unit Price Work, a lump sum of: $_____.

1. Cash Allowances: All specific cash allowances are included in the above price and include the cost to Subcontractor (less any applicable trade discounts) of materials and equipment required by the cash allowances to be delivered at the site, and all applicable taxes. Subcontractor's costs for unloading and handling on the site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Subcontract Price, and no demand for additional payment on account of any of the foregoing will be valid.

C. For all Unit Price Work, an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work multiplied by the actual quantity of that item:

Unit Price Subcontract Work					
Item No.	**Description**	**Unit**	**Estimated Quantity**	**Unit Price**	**Extended Price**
Total of all Extended Prices (Unit Price Subcontract Work)					**$**

The extended prices for Unit Price Work set forth as of the Subcontract Date are based on estimated quantities. Estimated quantities are not guaranteed, and determinations of actual quantities will be verified by the Contractor and will be subject to any applicable procedures for measurement and verification under the Prime Contract.

ARTICLE 5—PAYMENT PROCEDURES

5.01 *Progress Payments*

A. *Applications for Payments*

1. Ten days prior to the date established in the Prime Contract for submission by the Contractor of the Contractor's application for each progress payment (but not more often than once a month), Subcontractor shall submit to Contractor for review a draft progress payment application covering the Subcontract Work completed as of the date of the progress payment application. The amount requested under each progress payment application will be calculated in accordance with Article 4, and: (a) for lump sum work by determining the percentage of the Subcontract Work completed as of the date of the progress payment application; (b) for unit price work by applying unit prices to units provided; (c) subject to subtraction to account for amounts previously paid. Subcontractor's progress payments will be subject to the retainage provisions of the Prime Contract, or to retainage of 5 percent, whichever is greater.

2. Each Subcontractor progress payment application must be accompanied by supporting documentation required by the Prime Contract to be attached to the Contractor's progress payment submission. The Subcontract progress payment application must also be accompanied by required lien waivers; a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all liens; and for stored material and equipment, evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein. All such supporting documentation must be satisfactory to Contractor and Owner.
3. Beginning with Subcontractor's second progress payment application, each Subcontractor progress payment application must include a Subcontractor's affidavit stating that all previous progress payments received on account of the Subcontract Work have been paid to persons and entities providing labor, equipment, materials and services on account of amounts received on behalf of said sub-subcontractors, suppliers, and vendors from prior progress payment applications. Each Subcontractor's affidavit must list all sub-subcontractors, suppliers, and vendors having contracts with Subcontractor to provide said labor, equipment, material, and services on the Project including the amount of each contract, the amount paid to date and the amount due or to become due to each sub-subcontractor, supplier, and vendor. Each progress payment application must also include lien waivers executed by each sub-subcontractor, supplier, and vendor listed on the Subcontractor's affidavit.

B. *Review of Applications*

1. Within five days after receipt of each draft progress payment application submitted by Subcontractor, Contractor will return the draft progress payment application with corrections (if any). Subcontractor will submit a final progress payment application, incorporating all resolved corrections, together with all supporting documentation, within three days thereafter.
2. Contractor may withhold amounts requested in one or more payment applications from the Subcontractor in whole or part if one or more of the following occurs:
    a. The Subcontract Work is defective, or completed Subcontract Work has been damaged, requiring correction or replacement;
    b. The Subcontract Price has been reduced by change orders;
    c. The Contractor has been required to correct defective Subcontract Work or complete Subcontract Work;
    d. Claims have been made against Contractor on account of Subcontractor's performance or furnishing of the Subcontract Work;
    e. Liens have been filed in connection with the Subcontract Work, except where Subcontractor has delivered a specific bond satisfactory to Contractor and Owner to secure the satisfaction and discharge of such liens;
    f. The Owner has exercised a set-off against payments to Contractor attributable to Subcontractor's activities or performance of the Subcontract Work; or
    g. The Subcontractor has defaulted under the terms of the Subcontract.

C. *Payment:* Contractor shall pay Subcontractor any amounts due to Subcontractor under a payment application for Subcontract Work within ten days after Contractor's receipt from the Owner of payment for such Subcontract Work.

ARTICLE 6—FINAL PAYMENT AND COMPLETION

6.01 *Final Payment*

A. Upon final completion of obligations under the Subcontract, including acceptance by Owner (or its representative) of the Subcontract Work as part of the Work under the Prime Contract, and submission and acceptance of all close-out documents required under the Subcontract, Subcontractor shall submit to Contractor an application for final payment and release of retainage, if any.

B. Final payment becomes due 10 days after Contractor's receipt of payment from the Owner of amounts requested on behalf of Subcontractor. Contractor's receipt of payment of retainage withheld by Owner from amounts due to Contractor for the Subcontract Work is an express condition precedent to Contractor's obligation to pay such retainage to Subcontractor.

6.02 *Final Lien Waivers*

A. Upon the request of Contractor, Subcontractor shall submit, as part of the application for final payment, a final waiver of lien and sworn statement indicating all sub-subcontractors, suppliers, and vendors, their contract amounts, and the final amounts paid to each sub-subcontractor, supplier, and vendor.

6.03 *Warranty of Title*

A. Subcontractor warrants and guarantees that title to all Subcontract Work, materials, and equipment furnished under the Subcontract will pass to Owner free and clear of all liens and other title defects, and all patent, licensing, copyright, or royalty obligations.

6.04 *Waiver of Claims*

A. Final payment by Contractor to Subcontractor constitutes:

1. A waiver of all claims by Contractor against Subcontractor, except claims arising from unsettled liens, from defective Subcontract Work appearing after final inspection, from failure to comply with the Subcontract Documents or the terms of any special guarantees specified therein, or from Subcontractor's continuing obligations under the Prime Contract; and
2. A waiver of all claims by Subcontractor against Contractor other than those previously made in accordance with the requirements herein that remain unsettled.

ARTICLE 7—SUB-SUBCONTRACTORS

7.01 *Subcontractor's Responsibility*

A. Subcontractor shall be fully responsible to Contractor for all acts and omissions of the sub-subcontractors, suppliers, and other individuals or entities performing or furnishing any of the Subcontract Work, just as Subcontractor is responsible for Subcontractor's own acts and omissions.

7.02 *No Third-Party Relationships*

A. Nothing in the Subcontract Documents creates for the benefit of any such sub-subcontractor, supplier, or other individual or entity any contractual relationship between Contractor, Owner, or Owner's engineers or consultants and any such sub-subcontractor, supplier, or other individual or entity.

B. Nothing in the Subcontract Documents creates any obligation on the part of Contractor, Owner, or Engineer to pay or to see to the payment of any money due any such sub-subcontractor, supplier, or other individual or entity, except as may otherwise be required by laws and regulations.

ARTICLE 8—PERFORMANCE OF THE SUBCONTRACT WORK

8.01 *Subcontractor's Obligations*

A. Subcontractor shall provide all material, equipment, services, and labor necessary for the completion of the Subcontract Work.

B. All materials and equipment must be as specified in the Subcontract Documents and be of good quality and new, except as otherwise provided in the Subcontract Documents. Subcontractor shall provide Contractor with such information and test results required under the Prime Contract to verify the quality of the materials and equipment furnished under the Subcontract Documents.

8.02 *Verification of Existing Conditions*

A. The dimensions, locations, and limits of the Subcontract Work are shown or indicated in the Subcontract Documents.

B. The Contractor has used reasonable efforts to verify the accuracy of dimensions, locations, and limits in the Subcontract Documents, but takes no responsibility for the verification of information concerning actual conditions affecting the Subcontract Work. Subcontractor has an independent obligation to verify actual conditions, including but not limited to dimensions, locations, and limits, prior to ordering equipment and materials and performing the Subcontract Work, and shall be responsible for all costs and expenses resulting from the failure to verify such information.

8.03 *Supervision*

A. At all times during the progress of the Subcontract Work, Subcontractor shall assign an authorized representative to provide competent, on-site supervision. Such representative must not be replaced without written notice to Contractor except under extraordinary circumstances.

B. Subcontractor shall be solely responsible for scheduling and coordinating the work of sub-subcontractors, suppliers, and other individuals or entities performing or furnishing any of the Subcontract Work under a direct or indirect contract with Subcontractor.

C. Subcontractor shall supervise, inspect, and direct the Subcontract Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Subcontract Work in accordance with the Subcontract Documents.

8.04 *Coordination with Other Subcontractors; Other Work at the Site*

A. Subcontractor shall cooperate with other subcontractors and coordinate its Subcontract Work and schedule with other subcontractors on the Project. Subcontractor shall attend coordination meetings and endeavor to resolve all conflicts with other subcontractors without the intervention of Contractor. If a conflict cannot be resolved without the intervention of Contractor, the decision of Contractor regarding resolution of the conflict will be final.

B. Subcontractor shall not damage, delay, or interfere with the work of other subcontractors or of Contractor, Owner, or others working at the site, shall be responsible for the cost of damage, delay, or interference caused by the operations of Subcontractor to the work of others.

8.05 *Prosecution of the Subcontract Work*

A. *Clean-up:* On not less than a daily basis, Subcontractor shall be responsible for cleaning up and removing all debris and waste resulting from the Subcontract Work, to avoid interference with the work and progress of others at the site. If Subcontractor fails to clean up and remove waste and debris in accordance with this provision, Contractor may provide for clean-up and removal of waste and debris at Subcontractor's expense.

B. *Hoisting and Lifting:* Subcontractor shall provide all hoisting and lifting required for the Subcontract Work, unless Contractor has otherwise expressly agreed to provide hoisting, lifting, or both.

C. *Temporary Utility Services and Temporary Facilities:* Subcontractor shall at its expense provide temporary utility services and temporary facilities needed for the performance of the Subcontract Work, except those temporary utility services and temporary facilities that Contractor has expressly agreed to provide at its expense.

D. *Safety and Protection*

1. Subcontractor shall perform the Subcontract Work in a safe manner, taking full responsibility for the prevention of harm or injury to its workforce, and taking all reasonable steps necessary to protect from harm, injury, or damage all persons, property, structures, materials, and equipment at or adjacent to the Subcontractor's work areas.
2. Subcontractor shall comply with the safety programs of the Owner and Contractor, when Subcontractor has been made aware of such requirements in writing.
3. Subcontractor shall coordinate the safety of its employees, Subcontractor's lower-tier subcontractors, and Subcontractor's suppliers with Contractor's safety representative, and shall comply with all applicable OSHA and other laws and regulations related to safety and protection. Subcontractor shall ensure that its employees and the on-site employees of Subcontractor's lower-tier subcontractors and suppliers are properly trained and understand (a) Owner's, Contractor's, and Subcontractor's safety requirements, and (b) applicable safety laws and regulations. Subcontractor is responsible for furnishing to Contractor and others as applicable all required material safety data sheets.
4. Subcontractor shall report promptly to Contractor all injuries, accidents, and damage that occurs during the performance of the Subcontract Work, and all failures or near-miss events that could have resulted in serious injury, even if no serious injury actually occurred.

E. *Labor:* Subcontractor shall comply with applicable labor and jurisdictional requirements to prevent strikes and other work stoppages and slowdowns that would interfere with the Subcontract Work and the work of others. Subcontractor shall be responsible for delays resulting from Subcontractor's violation of this provision.

F. *Communications with Owner and Engineer:* Subcontractor shall communicate with Owner, Owner's engineers, and Owner's other representatives solely through Contractor, with the following limited exceptions: (1) in the case of an emergency, Subcontractor may communicate directly with any entity or individual in the interests of safety and protection of property, (2) Subcontractor may directly request Owner to provide information about amounts paid to Contractor on account of Subcontract Work performed, and (3) Subcontractor may directly request Owner to provide Subcontractor with a copy of any payment bond furnished by Contractor.

8.06 *Correction and Warranties*

A. Subcontractor warrants and guarantees to Contractor that all Subcontract Work will be in accordance with the Subcontract Documents and will not be defective. Subcontractor's warranty and guarantee hereunder excludes defects or damage caused by abuse, modification, or improper maintenance or operation by persons other than Subcontractor and its sub-subcontractors, suppliers, or any other individual or entity for whom Subcontractor is responsible; or normal wear and tear under normal usage.
B. Subcontractor's obligation to perform and complete the Subcontract Work in accordance with the Subcontract Documents will be absolute and Subcontractor shall be fully responsible for the Subcontract Work under the Subcontract to the same extent that Contractor is responsible for the Subcontract Work to the Owner under the Prime Contract.
C. Subcontractor shall correct the Subcontract Work to the same extent that Contractor is required to correct the Prime Contract Work (including the Subcontract Work) under the Prime Contract. Subcontractor shall correct Subcontract Work whether or not installed or completed. If the Subcontract Work has been rejected, Subcontractor shall remove such rejected Subcontract Work from the Project at the direction of Contractor, and replace it with Subcontract Work that is not defective.
D. For a period of one year after substantial completion of the Prime Contract Work, and for any additional period beyond one year as required under the Prime Contract for correction by the Contractor of the Prime Contract Work, and promptly after receipt of written notice, Subcontractor shall correct all defective Subcontract Work as directed by Contractor. Subcontractor shall indemnify Contractor, Owner, Owner's engineers and consultants, for all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any such correction or removal (including but not limited to all costs of repair or replacement of work of others).
E. All such correction obligations are in addition to the warranty, guarantee, and contractual duties established above and elsewhere in the Subcontract Documents.
F. The obligations under this Paragraph 8.06 will survive completion of the Subcontract Work and, when the Prime Contract is complete and ready for final payment by Owner, Contractor may assign its rights under this Paragraph 8.06 to Owner upon agreement between Owner and Contractor and notice to Subcontractor.

ARTICLE 9—CHANGES TO THE SUBCONTRACT

9.01 *Changes*

A. Without invalidating the Subcontract, Contractor may, at any time or from time to time, order changes to the Subcontract Work including additions, deletions, or revisions in the Subcontract Work. Subcontractor shall promptly proceed with the Subcontract Work as changed. All changed Subcontract Work will be performed under the applicable conditions of the Subcontract Documents. Subcontractor shall not perform any changes to the Subcontract Work that would increase the Subcontract Price or Subcontract Times without express written authority from Contractor.
B. Subcontractor shall deliver notice of each request for a change in compensation or time within 7 days of the associated directive to perform changed Subcontract Work, and not later than 2 days before Prime Contract requirements relative to submitting claims and change proposals.

C. Changes in the Subcontract Price for changed Subcontract Work will be made on the basis of either a mutually acceptable lump sum price, or under unit prices consistent with the unit prices set forth in the Subcontract as of the Subcontract Date. To the extent the changed Subcontract Work has no predetermined costs or unit prices under the original Subcontract, and the parties do not agree to a lump sum for the changed Subcontract Work, the amount of the request for changed compensation will be based upon Subcontractor's cost of labor (consistent with any applicable rates negotiated under the original Subcontract), plus the direct costs of sub-subcontracts, materials and equipment to be consumed or incorporated in the changed Subcontract Work, plus overhead and profit consistent with the price negotiated for the original Subcontract Work and subject to approval by Contractor.

D. To the extent that a change to the Subcontract Work resulted from a revision of the Prime Contract, the compensation to Subcontractor for such changed Subcontract Work will be limited to the amount collected by Contractor from Owner on behalf of Subcontractor for such change in the Subcontract Work. In the event that the revision results in a deduction of the Subcontract Price, the deduction will be based upon the share of the deduction assessed against Contractor under the Prime Contract that is attributable to the change in Subcontract Work.

ARTICLE 10—BONDS, INSURANCE, AND INDEMNIFICATION

10.01 *Performance Bond, Payment Bond, and Other Bonds*

A. If expressly listed as Subcontract Documents in Article 13, or expressly required of Subcontractor elsewhere in the Subcontract Documents, Subcontractor shall at its expense furnish a performance bond and a payment bond, each in an amount equal to or greater than the Subcontract Price, as security for the faithful performance and payment of all of Subcontractor's obligations under the Subcontract Documents. If the Subcontract Documents as of the Subcontract Date do not require performance and payment bonds, but Contractor subsequently instructs Subcontractor to furnish such bonds, Subcontractor shall do so at Contractor's expense.

B. The performance and payment bonds must remain in effect until not less than the longer of: (1) one year after the date when final payment becomes due from Contractor; or (2) completion of the correction period specified in this Subcontract, except as provided otherwise by applicable laws or regulations. Subcontractor shall also furnish such other bonds as are required by the Subcontract Documents. The performance bond will be issued on EJCDC® C-610 Performance Bond (2018). The Payment Bond will be issued on the EJCDC® C-615 Payment Bond (2018). Terms of these bonds apply except as expressly provided otherwise by laws or regulations.

C. If the Prime Contract requires that Contractor furnish a Warranty Bond, then Subcontractor shall furnish a Warranty Bond with respect to the Subcontract Work, under the same requirements. The bond will be issued using EJCDC® C-612, Warranty Bond (2018).

D. All bonds must be executed by such sureties as are named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

E. Subcontractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.

F. If the surety on a bond furnished by Subcontractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Subcontractor shall promptly notify Contractor and shall, within 20 days after the event giving rise to such notification, furnish another bond and surety, both of which must comply with the bond and surety requirements above.

G. If the Subcontract requires Subcontractor to provide its own performance bond and payment bond, as described in Paragraphs 10.01.A. through D., the Contractor may, at its sole discretion, provide such bonds for the Subcontractor, either as individual instruments or as a part of Contractor's bonding. In such case Subcontractor shall be responsible to Contractor for a proportionate share of Contractor's bond costs, computed as the percentage of the total Subcontract Price relative to the total bonded Contract Price, and the Subcontract Price will be adjusted accordingly.

H. As an alternative to requiring Subcontractor to provide or contribute to the cost of performance bonds or payment bonds as described in this Paragraph 10.01, the Contractor may, at its sole discretion, waive such requirements for this Subcontract, and the Subcontract Price will be adjusted accordingly.

I. If Subcontractor has failed to obtain a required bond, Contractor may exclude the Subcontractor from the site and exercise Contractor's termination rights under Article 11.

J. Upon request, Contractor shall provide a copy of the payment bond to any sub-subcontractor, supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Subcontract Work.

10.02 *Insurance—General Provisions*

A. Subcontractor shall obtain and maintain insurance as required in this Article and in any Subcontract exhibit or supplementary Subcontract Document regarding insurance.

B. All insurance required by the Subcontract to be purchased and maintained by Subcontractor must be obtained from insurance companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue insurance policies for the required limits and coverages. Unless a different standard is indicated elsewhere in the Subcontract Documents, all companies that provide insurance policies required under this Subcontract must have an A.M. Best rating of A-VII or better.

C. Subcontractor shall deliver to Contractor, with copies to each named insured and additional insured (as identified here or elsewhere in the Subcontract Documents), certificates of insurance establishing that Subcontractor has obtained and is maintaining the policies, coverages, and endorsements required by the Subcontract. Upon request by Contractor or any other insured, Subcontractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Subcontractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

D. Failure of Contractor to demand such certificates or other evidence of the Subcontractor's full compliance with these insurance requirements, or failure of Contractor to identify a deficiency

in compliance from the evidence provided, will not be construed as a waiver of the Subcontractor's obligation to obtain and maintain such insurance.

E. If Subcontractor does not purchase or maintain all of the insurance required of it by this Subcontract, the Subcontractor shall notify Contractor in writing of such failure to purchase prior to the start of the Subcontract Work, or of such failure to maintain prior to any change in the required coverage.

F. If Subcontractor has failed to obtain and maintain required insurance, Contractor may exclude the Subcontractor from the site and exercise Contractor's termination rights under Article 11.

G. Without prejudice to any other right or remedy, if Subcontractor has failed to obtain required insurance, Contractor may elect to obtain equivalent insurance to protect Contractor's interests at the expense of Subcontractor, and the Subcontract Price will be adjusted accordingly.

H. Contractor does not represent that insurance coverage and limits established in this Subcontract necessarily will be adequate to protect Subcontractor or Subcontractor's interests.

I. The insurance and insurance limits required herein will not be deemed as a limitation on Subcontractor's liability under the indemnities granted to Contractor and other individuals and entities in the Subcontract Documents.

10.03 *Subcontractor's Insurance*

A. *Workers' Compensation:* Subcontractor shall purchase and maintain workers' compensation and employer's liability insurance for:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts.
2. United States Longshoreman and Harbor Workers' Compensation Act (if applicable) and Jones Act coverage (if applicable).
3. claims for damages because of bodily injury, occupational sickness or disease, or death of Subcontractor's employees (by stop-gap endorsement in monopolist worker's compensation states).
4. Foreign voluntary worker compensation (if applicable).

Workers' Compensation and Related Policies	Policy limits of not less than:
Workers' Compensation	
State	Statutory
Applicable Federal (e.g., Longshoreman's)	Statutory
Foreign voluntary workers' compensation (employer's responsibility coverage), if applicable	Statutory
Jones Act (if applicable)	
Bodily injury by accident—each accident	$
Bodily injury by disease—aggregate	$
Employer's Liability	
Each accident	$
Each employee	$
Policy limit	$
Stop-gap Liability Coverage	
For work performed in monopolistic states, stop-gap liability coverage must be endorsed to either the worker's compensation or commercial general liability policy with a minimum limit of:	$

B. *Commercial General Liability—Claims Covered:* Subcontractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Subcontractor, on an occurrence basis, against:

1. Claims for damages because of bodily injury, sickness or disease, or death of any person other than Subcontractor's employees;
2. Claims for damages insured by reasonably available personal injury liability coverage; and
3. Damages because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

C. *Commercial General Liability—Form and Content:* Subcontractor's commercial liability policy must be written on a 1996 (or later) ISO commercial general liability form (occurrence form) and include the following coverages and endorsements:

1. Products and completed operations coverage:
    a. Such insurance must remain in effect for three years after final payment.
    b. Subcontractor shall furnish Contractor and each other additional insured (as identified in this Article or elsewhere in the Subcontract Documents) evidence of continuation of such insurance at final payment and three years thereafter.
2. Blanket contractual liability coverage, including but not limited to coverage of Subcontractor's contractual indemnity obligations under the Subcontract Documents.
3. Severability of interest.
4. Underground, explosion, and collapse coverage.
5. Personal injury coverage.
6. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or their equivalent if Subcontractor demonstrates that the specified endorsements are not commercially available.
7. For design professional additional insureds, ISO Endorsement CG 20 32 07 04, "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.
8. If governing law invalidates or restricts the use of a specified additional insurance endorsement, then Subcontractor will furnish an endorsement that is compliant with governing law while providing reasonable protection of the interests of the additional insureds.

D. *Commercial General Liability—Excluded Content:* The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:

1. Any modification of the standard definition of "insured contract" (except to delete the railroad protective liability exclusion if Subcontractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).
2. Any exclusion for water intrusion or water damage.

3. Any provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.
4. Any exclusion of coverage relating to earth subsidence or movement.
5. Any exclusion for the insured's vicarious liability, strict liability, or statutory liability (other than worker's compensation).
6. Any limitation or exclusion based on the nature of Subcontractor's work.
7. Any professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.

Commercial General Liability	Policy limits of not less than:
General Aggregate	$
Products—Completed Operations Aggregate	$
Personal and Advertising Injury	$
Bodily Injury and Property Damage—Each Occurrence	$

E. *Automobile Liability:* Subcontractor shall purchase and maintain automobile liability insurance against 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. The automobile liability policy must be written on an occurrence basis.

Automobile Liability	Policy limits of not less than:
Bodily Injury	
Each Person	$
Each Accident	$
Property Damage	
Each Accident	$
[or]	
Combined Single Limit	
Combined Single Limit (Bodily Injury and Property Damage)	$

F. *Umbrella or Excess Liability:* Subcontractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the paragraphs above. The coverage afforded must be at least as broad as that of each and every one of the underlying policies.

Excess or Umbrella Liability	Policy limits of not less than:
Each Occurrence	$
General Aggregate	$

G. *Subcontractor's Pollution Liability Insurance:* Subcontractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Subcontractor's operations and completed operations. The completed operations coverage must remain in effect for no less than three years after final completion.

Contractor's Pollution Liability	Policy limits of not less than:
Each Occurrence/Claim	$
General Aggregate	$

H. *Additional Insureds:* The Subcontractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, and pollution liability policies must include and list as additional insureds Contractor, Owner, and Owner's engineers, architects, and consultants, and any individuals or entities identified as additional insureds elsewhere in the Subcontract Documents; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds must provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Subcontractor shall obtain all necessary endorsements to support these requirements.

I. *Subcontractor's Professional Liability Insurance:* If Subcontractor will provide or furnish professional services under this Subcontract, through a delegation of professional design services or otherwise, then Subcontractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance must cover negligent acts, errors, or omissions in the performance of professional design or related services by the insured or others for whom the insured is legally liable. The insurance must be maintained throughout the duration of the Subcontract and for a minimum of two years after Substantial Completion of the Project. The retroactive date on the policy must pre-date the commencement of furnishing services on the Project.

J. *General provisions:* The policies of insurance required by this Paragraph 10.03 must:

1. include at least the specific coverages provided in this Subcontract.
2. be written for not less than the limits of liability expressly provided in this Subcontract, including any Subcontract exhibit or supplementary Subcontract Document specifying insurance policy limits, or if no such express insurance limits are set forth in the Subcontract, then for not less than the limits required of Contractor by Owner in the Prime Contract, for the corresponding types of insurance. If laws or regulations require a higher limit, then Subcontractor shall meet such legal requirement.
3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 10 days prior written notice has been given to Subcontractor. Within three days of receipt of any such written notice, Subcontractor shall provide a copy of the notice to Contractor and each other insured under the policy.
4. remain in effect at least until final payment (and longer if expressly required herein) and at all times thereafter when Subcontractor may be correcting, removing, or replacing defective Subcontract Work as a warranty or correction obligation, or otherwise, or returning to the site to conduct other tasks arising from the Subcontract Documents.
5. be appropriate for the Subcontract Work being performed and provide protection from claims that may arise out of or result from Subcontractor's performance of the Subcontract Work and Subcontractor's other obligations under the Subcontract Documents, whether it is to be performed by Subcontractor, any lower-tier subcontractor or supplier, or by anyone directly or indirectly employed by any of them to perform any of the Subcontract Work, or by anyone for whose acts any of them may be liable.

K. Subcontractor waives all rights against Owner, Contractor, and all individuals or entities identified in the Prime Contract's Supplementary Conditions to be listed as insureds or additional insureds under the builder's risk, installation floater, or other forms of property insurance, and against the Owner's engineers and consultants, and their consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such builder's risk, installation floater, or other form of property insurance applicable to the work under the Prime Contract; and Contractor waives all rights against Subcontractor for all such losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such builder's risk, installation floater, or other form of property insurance applicable to the work under the Prime Contract.

L. If Contractor is responsible under the Prime Contract and any builder's risk or other property insurance policy for the payment of a deductible, or an amount within a deductible, and the need to pay such deductible or amount within a deductible is attributable in whole or part to the actions or inactions of Subcontractor, its sub-subcontractors, employees, agents, or others for which Subcontractor is responsible, then Subcontractor shall pay its attributable share of such deductible.

M. Upon request the Contractor shall provide to Subcontractor a copy of any builder's risk, installation floater, or other property insurance policy applicable to the work under the Prime Contract. Contractor may block out (redact) any confidential premium or pricing information contained in any such policy. Subcontractor may elect to obtain other insurance at its expense, if it concludes that its interests are not insured under such policy.

10.04 *Indemnification*

A. To the fullest extent permitted by laws and regulations, Subcontractor shall indemnify and hold harmless Contractor, Owner, and Owner's engineers and consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Subcontract Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Subcontract Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Subcontractor, any lower tier subcontractor, supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Subcontract Work or anyone for whose acts any of them may be liable.

B. In addition to the indemnification obligations in the preceding paragraph, Subcontractor shall indemnify Contractor for all economic costs and expenses, including attorney's fees, for any claim against Contractor as a result of and to the extent caused by Subcontractor's breach of any obligation under the Subcontract.

C. In any and all claims against Contractor, Owner, or Owner's engineers or consultants, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Subcontractor, any lower tier subcontractor, any supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Subcontract Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 10.04.A. must not be limited in any way by any limitation on the amount or type of

damages, compensation, or benefits payable by or for Subcontractor, lower-tier subcontractor, supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

D. With respect to the Subcontract Work, the breach of obligations under the Subcontract, and any negligent act or omission of Subcontractor, any lower tier subcontractor, supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Subcontract Work, or anyone for whose acts any of them may be liable, and to the fullest extent permitted by law, Subcontractor assumes the same or corresponding responsibilities as Contractor for indemnity obligations set forth in the Prime Contract.

ARTICLE 11—SUSPENSION AND TERMINATION

11.01 *Contractor May Suspend Work*

A. In the event that Owner suspends the work of Contractor under the Prime Contract, Contractor may suspend the performance of the Subcontract or any portion thereof for a period of not more than 90 consecutive days, by giving notice in writing to Subcontractor of such suspension. Subcontractor shall resume the Subcontract Work when instructed by Contractor to do so. Subcontractor shall be granted an adjustment in the Subcontract Price or an extension of the Subcontract Times, or both, directly attributable to any such suspension only to the extent that Contractor receives an adjustment of the Prime Contract price or the Prime Contract time for the Subcontractor's proportionate share of work under the Prime Contract.

B. Contractor may suspend the Subcontract Work for a period of not more than 90 days, or to the extent permitted by the progress schedule or any express provision of the Subcontract Documents, for Contractor's own purposes.

C. Contractor may suspend the work of Subcontractor with all costs and liability for any delay in the Subcontract Work and others to be assessed against the Subcontractor for the following Subcontract violations until the Subcontractor demonstrates it has cured the violations as follows:

1. Subcontractor fails to comply with the Owner's or Contractor's safety program;
2. Subcontractor or its employees are in violation of OSHA or state or local safety laws or regulations;
3. Subcontractor has installed defective Subcontract Work that is not in compliance with the Subcontract Documents and has failed to cure the defective Subcontract Work;
4. Subcontractor has violated any laws or regulations applicable to the performance of the Subcontract Work; and
5. Subcontractor has failed to pay a supplier or lower-tier subcontractor pursuant to Subcontractor's legal or contractual obligations.

D. If Subcontractor fails to comply with the progress schedule, causing delay to the Subcontract Work or the Prime Contract work, after three days' notice by Contractor and failure of Subcontractor to demonstrate that it has implemented procedures to comply with the schedule through measures such as providing supplemental labor, materials, and tools, then Contractor may implement its own procedures to meet the schedule, by providing supplemental labor, materials, tools, or taking other measures, through its own or other forces, and Contractor may assess the cost of such supplemental procedures against the Subcontract.

11.02 *Contractor May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Subcontractor's persistent failure to perform the Subcontract Work in accordance with the Subcontract Documents (including, but not limited to, failure to supply sufficient skilled workers, suitable materials, or equipment, or failure to adhere to the Subcontract progress schedule);
2. Subcontractor's disregard of laws or regulations of any public body having jurisdiction;
3. Subcontractor's repeated disregard of the authority of Contractor; or
4. Subcontractor's failure to perform or otherwise to comply with a material term of the Subcontract.

B. If one or more of the events identified in the preceding paragraph occur, Contractor may, after giving Subcontractor 7 days written notice of its intent to terminate the services of Subcontractor, or in the event the Subcontractor provided a performance bond covering the Subcontract the Contractor may provide notice to the Subcontractor and surety in accordance with the requirements of the applicable performance bond of its intent to terminate the services of Subcontractor to preserve Contractor's rights under the performance bond. Upon termination of the Subcontract, Contractor may:

1. exclude Subcontractor from the site, and take possession of the Subcontract Work;
2. incorporate in the Subcontract Work all materials and equipment stored at the site, or for which Contractor has paid Subcontractor but which are stored elsewhere; and
3. complete the Subcontract Work as Contractor may deem expedient.

C. If Contractor proceeds as provided in Paragraph 11.02.B., Subcontractor shall not be entitled to receive any further payment until the Subcontract Work is completed. If the unpaid balance of the Subcontract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor arising out of or relating to completing the Subcontract Work, such excess will be paid to Subcontractor. If such claims, costs, losses, and damages exceed such unpaid balance, Subcontractor shall pay the difference to Contractor. When exercising any rights or remedies under this paragraph, Contractor shall not be required to obtain the lowest price for the Subcontract Work performed.

D. Notwithstanding Paragraphs 11.02.A. and 11.02.B., Subcontractor's services will not be terminated if Subcontractor begins within four days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 14 days of receipt of said notice. If the Subcontractor fails to cure within 14 days of receipt of said notice, the Subcontract will be deemed terminated in accordance with provisions 11.02.A through 11.02.C upon two days' notice by the Contractor following the 14-day period.

E. Where Subcontractor's services have been so terminated by Contractor, the termination will not affect any rights or remedies of Contractor against Subcontractor then existing or which may thereafter accrue. Any retention or payment of money due Subcontractor by Contractor will not release Subcontractor from liability.

F. If and to the extent that Subcontractor has provided a performance bond, the termination procedures of that bond will supersede the procedures in this Paragraph 11.02.

11.03 *Termination of Contractor or Rejection of Subcontract by Owner*

A. The Contractor may terminate the Subcontract at any time, if the Prime Contract is terminated by the Owner, or if Owner rejects the Subcontract in accordance with the terms of the Prime Contract, the Contractor may terminate the Subcontract without penalty.
B. In the event of a termination pursuant to Paragraph 11.03, the costs and expenses to be paid to Subcontractor resulting from a termination under this provision must be limited to the costs and expenses recovered by Contractor from Owner on Subcontractor's behalf.

11.04 *Contractor May Terminate for Convenience*

A. Upon 7 days written notice to Subcontractor, Contractor may, without cause and without prejudice to any other right or remedy of Contractor, terminate the Subcontract. In such case, Subcontractor shall be paid for (without duplication of any items):

1. Completed and acceptable Subcontract Work executed in accordance with the Subcontract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Subcontract Work;
2. Expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Subcontract in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and
3. Reasonable expenses directly attributable to termination.

B. Subcontractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

11.05 *Subcontractor May Stop Work or Terminate*

A. If, through no act or fault of Subcontractor, Contractor after receipt of payment from Owner fails to make payment due Subcontractor, for more than 30 days after payment is due, then Subcontractor may, upon 7 days written notice to Contractor, and provided Contractor does not remedy such failure within 7 days thereafter, terminate the Subcontract and recover payment from Contractor subject to the terms of this Subcontract.
B. As an alternative to terminating the Subcontract and without prejudice to any other right or remedy, if a payment owed to Subcontractor is more than 30 days past due, then Subcontractor may, 7 days after written notice to Contractor, stop the Subcontract Work until payment is made of all such amounts due Subcontractor, including interest thereon at an annual rate of five percent per annum, or if applicable at the rate prescribed by law, without penalty.
C. If the Contractor suspends the Subcontractor's work for more than 120 days, the Subcontractor may upon 7 days' written notice terminate the Subcontract and recover the amounts due the Subcontractor for Subcontract Work completed as of the date of termination, including retainage withheld from the Subcontractor to date and interest thereon at an annual rate of five percent per annum, or if applicable at the rate prescribed by law, without penalty.

ARTICLE 12—CLAIMS AND DISPUTE RESOLUTION

12.01 *Claims*

A. As a condition precedent to any consideration, pursuit, or recovery by Subcontractor of any change proposal, request, demand, or claim (collectively referred to as "Claim") seeking an increase in Subcontract Price, Subcontract Time, or both, Subcontractor shall provide notice

of any such Claim to Contractor no less than 30 days after the event giving rise to the Claim, and for Claims related in any way to the Owner or Prime Contract, within five days.

B. Subcontractor's recovery of additional cost, time, or both cost and time for any Claim attributable to the Owner will be limited to the proportionate recovery by Contractor against Owner for such Claim. Subcontractor will cooperate and assist Contractor in pursuing any Claim by Contractor against Owner on behalf of Subcontractor, including the timely preparation and delivery of supporting documentation.

C. If the pursuit of any Claim by Contractor against Owner on Subcontractor's behalf requires the expenditure by Contractor of legal or consulting fees, or results in litigation, arbitration, or any dispute resolution procedures, Subcontractor agrees to pay for a proportionate share of attorneys' fees, consultant fees, and litigation, arbitration, and other resolution costs incurred by Contractor in pursuing the claim on behalf of Subcontractor, based upon the amount claimed by Subcontractor as compared to the total value of the claim pursued by the Contractor.

D. Except as provided by applicable lien, bond, or prompt payment laws, Subcontractor shall not make any direct claims against Owner for compensation or additional compensation for performance of the Subcontract Work.

12.02 *Dispute Resolution*

A. Either Contractor or Subcontractor may request mediation of any dispute between Contractor and Subcontractor in connection with this Subcontract that has not been settled to their mutual satisfaction within the applicable notice or cure periods provided in this Subcontract, or that Contractor has not pursued against Owner as described above. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Subcontract Date. The request for mediation must be submitted in writing to the American Arbitration Association and the other party to this Subcontract.

B. Contractor and Subcontractor shall participate in the mediation process in good faith. The process must be concluded within 60 days of filing of the request. The date of termination of the mediation must be determined by application of the mediation rules referenced above.

C. If the dispute is not resolved by mediation, each party to this Subcontract shall be barred from further action to assert its claim after 30 days after termination of the mediation unless, within that time period, Contractor or Subcontractor:

1. elects in writing to invoke any dispute resolution procedure expressly provided for in a Subcontract exhibit or elsewhere in the Subcontract Documents; or
2. agrees with the other party to submit the dispute to another dispute resolution process; or
3. gives written notice to the other party of the intent to submit the claim to a court of competent jurisdiction.

D. If Contractor is engaged in an arbitration with Owner that relates, in whole or in part, to a dispute between Contractor and Subcontractor, then Contractor shall have the sole and exclusive discretion to join Subcontractor as a party to the Contractor-Owner arbitration. Subcontractor consents to the jurisdiction of any such arbitration proceeding to which it is joined pursuant to this provision.

ARTICLE 13—SUBCONTRACT DOCUMENTS

13.01 *Subcontract Contents*

A. The Subcontract Documents consist of the following:

1. This Subcontract.
2. Prime Contract, with the exception of confidential terms. The following portions of the Prime Contract are attached as Exhibit A:
    a. General Conditions.
    b. Supplementary Conditions.
    c. Specifications, Division 01.
    d. Specifications as listed in the table of contents of the project manual (copy of list attached).
    e. Drawings (not attached but incorporated by reference) consisting of XX sheets with each sheet bearing the following general title: Carey Station Urban Water Reuse Facility 0.5 MGD To 1.0 MGD Expansion
    f. Addenda (numbers __ to __, inclusive).
3. Subcontract Scope of Subcontract work exhibit.
4. Subcontract performance bond.
5. Subcontract payment bond.
6. Subcontractor's bid or proposal.
7. Subcontract dispute resolution procedures, if any.
8. The following which may be delivered or issued on or after the Subcontract Date and are not attached hereto:
    a. Notice to Proceed.
    b. Work Change Directives.
    c. Change Orders.
    d. Field Orders.
    e. Warranty Bond, if any.

B. The documents listed in the paragraph above are attached to this Subcontract (except as expressly noted otherwise above).

C. There are no Subcontract Documents other than those listed above in this Article 14. The Subcontract supersedes prior negotiations, representations, and agreements regarding the Subcontract Work, whether written or oral.

D. The Subcontract Documents may only be amended, modified, or supplemented by written agreement of Contractor and Subcontractor.

ARTICLE 14—MISCELLANEOUS

14.01 *Terms*

Terms used in this Subcontract will have the meanings stated here, or in the Prime Contract's General Conditions and Supplementary Conditions.

14.02 *Assignment of Subcontract*

No assignment by Subcontractor of any rights under or interests in the Subcontract will be binding on Contractor without Contractor's written consent; and, specifically but without limitation, payments that may become due and money that is due may not be assigned by Subcontractor without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Subcontract Documents.

14.03 *Successors and Assigns*

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

14.04 *Severability*

Any provision or part of the Subcontract Documents held to be void or unenforceable under any law or regulation will be deemed stricken, and all remaining provisions must continue to be valid and binding upon Contractor and Subcontractor, which agree that the Subcontract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

ARTICLE 15—SUBCONTRACTOR'S REPRESENTATIONS AND CERTIFICATIONS

15.01 *Subcontractor's Representations*

A. In order to induce Contractor to enter into this Subcontract, Subcontractor makes the following representations:

1. Subcontractor has examined and carefully studied the Subcontract Documents, and any data and reference items identified in the Subcontract Documents, including but not limited to initial schedules identified by Contractor.
2. Subcontractor has visited the site, conducted a thorough visual examination of the site and adjacent areas, and become familiar with the general, local, and site conditions that may affect cost, progress, and performance of the Subcontract Work.
3. Subcontractor is familiar with and is satisfied as to all laws and regulations that may affect cost, progress, and performance of the Subcontract Work.
4. Subcontractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the site and drawings of physical conditions relating to existing surface or subsurface structures at the site that have been identified by the Prime Contract or Subcontract, especially with respect to technical data in such reports and drawings.
5. Subcontractor has carefully studied reports and drawings of hazardous environmental conditions, if any, at or adjacent to the site that have been identified in the Prime Contract or Subcontract, especially with respect to technical data in such reports and drawings.

6. Subcontractor has considered the information known to Subcontractor itself; information commonly known to contractors and subcontractors doing business in the locality of the site; information and observations obtained from visits to the site; the Subcontract Documents; and the site-related reports and drawings, if any, identified in the Prime Contract or Subcontract, with respect to the effect of such information, observations, and documents on (a) the cost, progress, and performance of the Subcontract Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Subcontractor; and (c) Subcontractor's safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraphs, Subcontractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Subcontract Work at the Subcontract Price, within the Subcontract Times, and in accordance with the other terms and conditions of the Subcontract.
8. Subcontractor is aware of the general nature of work to be performed by Owner, Contractor, other subcontractors, and others at the site that relates to the Subcontract Work as indicated in the Subcontract Documents.
9. Subcontractor has given Contractor written notice of all conflicts, errors, ambiguities, or discrepancies that Subcontractor has discovered in the Subcontract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Contractor is acceptable to Subcontractor.
10. The Subcontract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Subcontract Work.
11. Subcontractor's entry into this Subcontract constitutes an incontrovertible representation by Subcontractor that without exception all prices in the Subcontract are premised upon performing and furnishing the Subcontract Work required by the Subcontract Documents.

15.02 *Subcontractor's Certifications*

A. Subcontractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Subcontract. For the purposes of this paragraph:

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

IN WITNESS WHEREOF, Contractor and Subcontractor have signed this Subcontract.
The Effective Date of the Subcontract is _____.

Contractor:	Subcontractor:
_____ *(typed or printed name of organization)*	_____ *(typed or printed name of organization)*
By: _____ *(individual's signature)*	By: _____ *(individual's signature)*
Name: _____ *(typed or printed)*	Name: _____ *(typed or printed)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)*
Date: _____ *(date signed)*	Date: _____ *(date signed)*
	(If Subcontractor is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)
Attest: _____ *(individual's signature)*	Attest: _____ *(individual's signature)*
Name: _____ *(typed or printed)*	Name: _____ *(typed or printed)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)*
Address for giving notices:	Address for giving notices:
_____	_____
_____	_____
Designated Representative:	Designated Representative:
Name: _____ *(typed or printed)*	Name: _____ *(typed or printed)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)*
Address:	Address:
_____	_____
_____	_____
Phone: _____	Phone: _____
Email: _____	Email: _____
(If Contractor or Subcontractor is a corporation, attach evidence of authority to sign.	License No.: _____ *(where applicable)*
	State: _____

NOTICE TO PROCEED

Owner: _____ Owner's Project No.: _____

Engineer: _____ Engineer's Project No.: _____

Contractor: _____ Contractor's Project No.: _____

Project: _____

Contract Name: _____

Effective Date of Contract: _____

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on _____ pursuant to Paragraph 4.01 of the General Conditions.
On that date, Contractor shall start performing its obligations under the Contract Documents. No Work will be done at the Site prior to such date.
In accordance with the Agreement:

The number of days to achieve Substantial Completion is 365 from the date stated above for the commencement of the Contract Times, resulting in a date for Substantial Completion of _____; and the number of days to achieve readiness for final payment is 420 from the commencement date of the Contract Times, resulting in a date for readiness for final payment of _____.

Owner: Piedmont Water Company

By *(signature)*: _____

Name *(printed)*: _____

Title: _____

Date Issued: _____

Copy: Engineer

PERFORMANCE BOND

Contractor	**Surety**
Name:	Name:
Address *(principal place of business)*:	Address *(principal place of business)*:
Owner	**Contract**
Name: **Piedmont Water Company**	Description *(name and location)*:
Mailing address *(principal place of business)*:	Contract Price:
	Effective Date of Contract:

Bond

Bond Amount:

Date of Bond:

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 16

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

Contractor as Principal	Surety
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____

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

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
   3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;
   3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
   3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.
4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.
5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
   5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
   5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
   5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or
   5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

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

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

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.
7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:
   7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
   7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and
   7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.
9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.
12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.
13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such

statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions
    14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
    14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.
    14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.
    14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
    14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
16. Modifications to this Bond are as follows:

WARRANTY BOND

Contractor	**Surety**
Name: Address *(principal place of business)*:	Name: Address *(principal place of business)*:
Owner	**Construction Contract**
Name: **Piedmont Water Company** Address *(principal place of business)*:	Description *(name and location)*: Contract Price: Effective Date of Contract: Contract's Date of Substantial Completion:

Bond

Bond Amount: _____

Date of Bond: _____

Modifications to this Bond form:
☐ None ☐ See Paragraph 9

Bond Period: Commencing 364 days after Substantial Completion of the Work under the Construction Contract, and continuing until

years after such Substantial Completion.

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

Contractor as Principal	Surety
_____ *(Full formal name of Contractor)*	_____ *(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature) (Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title:	Title:

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

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract's Correction Period Obligations. The Construction Contract is incorporated herein by reference.
2. If the Contractor performs the Correction Period Obligations, the Surety and the Contractor shall have no obligation under this Warranty Bond.
3. If Owner gives written notice to Contractor and Surety during the Bond Period of Contractor's obligation under the Correction Period Obligations, and Contractor does not fulfill such obligation, then Surety shall be responsible for fulfillment of such Correction Period Obligations. Surety shall either fulfill the Correction Period Obligations itself, through its agents or contractors, or, in the alternative, Surety may waive the right to fulfill the Correction Period Obligations itself, and reimburse the Owner for all resulting costs incurred by Owner in performing Contractor's Correction Period Obligations, including but not limited to correction, removal, replacement, and repair costs.
4. The Surety's liability is limited to the amount of this Warranty Bond. Renewal or continuation of the Warranty Bond will not modify such amount, unless expressly agreed to by Surety in writing.
5. The Surety shall have no liability under this Warranty Bond for obligations of the Contractor that are unrelated to the Construction Contract. No right of action will accrue on this Warranty Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
6. Any proceeding, legal or equitable, under this Warranty Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and must be instituted within two years after the Surety refuses or fails to perform its obligations under this Warranty Bond.
7. Written notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown in this Warranty Bond.
8. Definitions
   8.1. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page of this Warranty Bond, including all Contract Documents and changes made to the agreement and the Contract Documents.
   8.2. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
   8.3. *Correction Period Obligations*—The duties, responsibilities, commitments, and obligations of the Contractor with respect to correction or replacement of defective Work, as set forth in the Construction Contract's Correction Period clause, EJCDC® C-700, Standard General Conditions of the Construction Contract (2018), Paragraph 15.08, as duly modified.
   8.4. *Substantial Completion*—As defined in the Construction Contract.
   8.5. *Work*—As defined in the Construction Contract.
9. Modifications to this Bond are as follows:

PAYMENT BOND

Contractor	**Surety**
Name:	Name:
Address *(principal place of business)*:	Address *(principal place of business)*:
Owner	**Contract**
Name: **Piedmont Water Company**	Description *(name and location)*:
Mailing address *(principal place of business)*:	Contract Price:
	Effective Date of Contract:

Bond

Bond Amount:

Date of Bond:

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 18

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

Contractor as Principal	Surety
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____

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

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.
4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.
5. The Surety's obligations to a Claimant under this Bond will arise after the following:
   5.1. Claimants who do not have a direct contract with the Contractor
      15..1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
      15..2. have sent a Claim to the Surety (at the address described in Paragraph 13).
   5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).
6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.
7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:
   7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
   7.2. Pay or arrange for payment of any undisputed amounts.
   7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.
9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.
10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.
11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.
14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.
16. Definitions
    16.1. *Claim*—A written statement by the Claimant including at a minimum:
        116..1. The name of the Claimant;
        116..2. The name of the person for whom the labor was done, or materials or equipment furnished;
        116..3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
        116..4. A brief description of the labor, materials, or equipment furnished;

116..5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
116..6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
116..7. The total amount of previous payments received by the Claimant; and
116..8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

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

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

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

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

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

18. Modifications to this Bond are as follows:

Contractor's Application for Payment

Owner:		**Owner's Project No.:**	
Engineer:		**Engineer's Project No.:**	
Contractor:		**Contractor's Project No.:**	
Project:			
Contract:			
Application No.:		**Application Date:**	
Application Period:	**From**	**to**	

1. Original Contract Price				$ -
2. Net change by Change Orders				$ -
3. Current Contract Price (Line 1 + Line 2)				$ -
4. Total Work completed and materials stored to date (Sum of Column G Lump Sum Total and Column J Unit Price Total)				$ -
5. Retainage				
a. _____	X	$ -	Work Completed = $ -	
b. _____	X	$ -	Stored Materials = $ -	
c. Total Retainage (Line 5.a + Line 5.b)				$ -
6. Amount eligible to date (Line 4 - Line 5.c)				$ -
7. Less previous payments (Line 6 from prior application)				
8. Amount due this application				$ -
9. Balance to finish, including retainage (Line 3 - Line 4 + Line 5.c)				$ -

Contractor's Certification

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

Contractor: _____

Signature: _____ **Date:** _____

Recommended by Engineer		**Approved by Owner**	
By:		**By:**	
Title:		**Title:**	
Date:		**Date:**	

Progress Estimate - Lump Sum Work

Contractor's Application for Payment

Owner: _____ **Owner's Project No.:** _____
Engineer: _____ **Engineer's Project No.:** _____
Contractor: _____ **Contractor's Project No.:** _____
Project: _____
Contract: _____

Application No.: _____ **Application Period:** **From** _____ **to** _____ **Application Date:** _____

A	B	C	D	E	F	G	H	I
			Work Completed					
Item No.	Description	Scheduled Value ($)	(D + E) From Previous Application ($)	This Period ($)	Materials Currently Stored (not in D or E) ($)	Work Completed and Materials Stored to Date (D + E + F) ($)	% of Scheduled Value (G / C) (%)	Balance to Finish (C - G) ($)
	Original Contract							
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
	Original Contract Totals	$ -	$ -	$ -	$ -	$ -		$ -

Progress Estimate - Lump Sum Work

Contractor's Application for Payment

Owner: _____ **Owner's Project No.:** _____
Engineer: _____ **Engineer's Project No.:** _____
Contractor: _____ **Contractor's Project No.:** _____
Project: _____
Contract: _____

Application No.: _____ **Application Period:** **From** _____ **to** _____ **Application Date:** _____

A	B	C	D	E	F	G	H	I
			Work Completed					
Item No.	Description	Scheduled Value ($)	(D + E) From Previous Application ($)	This Period ($)	Materials Currently Stored (not in D or E) ($)	Work Completed and Materials Stored to Date (D + E + F) ($)	% of Scheduled Value (G / C) (%)	Balance to Finish (C - G) ($)
Change Orders								
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
	Change Order Totals	$ -	$ -	$ -	$ -	$ -		$ -
Original Contract and Change Orders								
	Project Totals	$ -	$ -	$ -	$ -	$ -		$ -

Stored Materials Summary **Contractor's Application for Payment**

Owner: ____________________
Engineer: ____________________
Contractor: ____________________
Project: ____________________
Contract: ____________________

Owner's Project No.: ____________
Engineer's Project No.: ____________
Contractor's Project No.: ____________

Application No.: ____________ **Application Period:** **From** ____________ **to** ____________ **Application Date:** ____________

A	B	C	D	E	F	G	H	I	J	K	L	M
						Materials Stored			Incorporated in Work			
Item No. (Lump Sum Tab) or Bid Item No. (Unit Price Tab)	Supplier Invoice No.	Submittal No. (with Specification Section No.)	Description of Materials or Equipment Stored	Storage Location	Application No. When Materials Placed in Storage	Previous Amount Stored ($)	Amount Stored this Period ($)	Amount Stored to Date (G+H) ($)	Amount Previously Incorporated in the Work ($)	Amount Incorporated in the Work this Period ($)	Total Amount Incorporated in the Work (J+K) ($)	Materials Remaining in Storage (I-L) ($)
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
								-			-	-
					Totals	$ -	$ -	$ -	$ -	$ -	$ -	$ -

FIELD ORDER NO.: ____

Owner: Owner's Project No.:
Engineer: Engineer's Project No.:
Contractor: Contractor's Project No.:
Project:
Contract Name:
Date Issued: Effective Date of Field Order:

Contractor is hereby directed to promptly perform the Work described in this Field Order, issued in accordance with Paragraph 11.04 of the General Conditions, for minor changes in the Work without changes in Contract Price or Contract Times. If Contractor considers that a change in Contract Price or Contract Times is required, submit a Change Proposal before proceeding with this Work.

Reference:

Specification Section(s):
Drawing(s) / Details (s):

Description:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Attachments:

_____

Issued by Engineer

By: _____
Title: _____
Date: _____

WORK CHANGE DIRECTIVE NO.: ____

Owner: Owner's Project No.:
Engineer: Engineer's Project No.:
Contractor: Contractor's Project No.:
Project:
Contract Name:
Date Issued: Effective Date of Work Change Directive:

Contractor is directed to proceed promptly with the following change(s):
Description:

_____

Attachments:

_____

Purpose for the Work Change Directive:

_____

Directive to proceed promptly with the Work described herein, prior to agreeing to change in Contract Price and Contract Time, is issued due to:

☐ Non-agreement on pricing of proposed change. ☐ Necessity to proceed for schedule or other reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price: $ _____ ☐increase ☐decrease ☐not yet estimated

Contract Time: _____ days ☐increase ☐decrease ☐not yet estimated

Basis of estimated change in Contract Price:

☐ Lump Sum ☐ Unit Price ☐ Cost of the Work ☐ Other

	Recommended by Engineer	Authorized by Owner
By:	_____	_____
Title:	_____	_____
Date:	_____	_____

CHANGE ORDER NO.: ____

Owner: Owner's Project No.:
Engineer: Engineer's Project No.:
Contractor: Contractor's Project No.:
Project:
Contract Name:
Date Issued: Effective Date of Change Order:

The Contract is modified as follows upon execution of this Change Order:
Description:

_____

Attachments:

_____

Change in Contract Price	**Change in Contract Times**
Original Contract Price: $ _____	Original Contract Times: Substantial Completion: _____ Ready for final payment: _____
☐ Increase ☐ Decrease from previously approved Change Orders No. 1 to No. __: $ _____	☐ Increase ☐ Decrease from previously approved Change Orders No.1 to No. __: Substantial Completion: _____ Ready for final payment: _____
Contract Price prior to this Change Order: $ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for final payment: _____
☐ Increase ☐ Decrease this Change Order: $ _____	☐ Increase ☐ Decrease this Change Order: Substantial Completion: _____ Ready for final payment: _____
Contract Price incorporating this Change Order: $ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for final payment: _____

Recommended by Engineer (if required)	Accepted by Contractor
By: _____	_____
Title: _____	_____
Date: _____	_____

Authorized by Owner

By: _____
Title: _____
Date: _____

CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner: Owner's Project No.:
Engineer: Engineer's Project No.:
Contractor: Contractor's Project No.:
Project:
Contract Name:

This ☐ Preliminary ☐ Final Certificate of Substantial Completion applies to:
☐ All Work ☐ The following specified portions of the Work:

_____

Date of Substantial Completion: _____

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 15.03.D of the General Conditions.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work must be as provided in the Contract, except as amended as follows:

Amendments to Owner's Responsibilities: ☐ None ☐ As follows:

_____

Amendments to Contractor's Responsibilities: ☐ None ☐ As follows:

_____

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

_____

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

Engineer

By *(signature)*: _____

Name *(printed)*: _____

Title: _____

NOTICE OF ACCEPTABILITY OF WORK

Owner: Owner's Project No.:
Engineer: Engineer's Project No.:
Contractor: Contractor's Project No.:
Project:
Contract Name:
Notice Date: Effective Date of the Construction Contract:

The Engineer hereby gives notice to the Owner and Contractor that Engineer recommends final payment to Contractor, and that the Work furnished and performed by Contractor under the Construction Contract is acceptable, expressly subject to the provisions of the Construction Contract's Contract Documents ("Contract Documents") and of the Agreement between Owner and Engineer for Professional Services dated March 20, 2023 ("Owner-Engineer Agreement"). This Notice of Acceptability of Work (Notice) is made expressly subject to the following terms and conditions to which all who receive and rely on said Notice agree:

1. This Notice has been prepared with the skill and care ordinarily used by members of the engineering profession practicing under similar conditions at the same time and in the same locality.
2. This Notice reflects and is an expression of the Engineer's professional opinion.
3. This Notice has been prepared to the best of Engineer's knowledge, information, and belief as of the Notice Date.
4. This Notice is based entirely on and expressly limited by the scope of services Engineer has been employed by Owner to perform or furnish during construction of the Project (including observation of the Contractor's Work) under the Owner-Engineer Agreement, and applies only to facts that are within Engineer's knowledge or could reasonably have been ascertained by Engineer as a result of carrying out the responsibilities specifically assigned to Engineer under such Owner-Engineer Agreement.
5. This Notice is not a guarantee or warranty of Contractor's performance under the Construction Contract, an acceptance of Work that is not in accordance with the Contract Documents, including but not limited to defective Work discovered after final inspection, nor an assumption of responsibility for any failure of Contractor to furnish and perform the Work thereunder in accordance with the Contract Documents, or to otherwise comply with the Contract Documents or the terms of any special guarantees specified therein.
6. This Notice does not relieve Contractor of any surviving obligations under the Construction Contract, and is subject to Owner's reservations of rights with respect to completion and final payment.

Engineer
By *(signature)*: _____
Name *(printed)*: _____
Title: _____

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

TABLE OF CONTENTS

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
5. *Bidder*—An individual or entity that submits a Bid to Owner.
6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.
9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
10. *Claim*

    a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal;

seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.

b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.

c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.

d. A demand for money or services by a third party is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.

12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.

13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.

14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.

15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.

16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.

17. *Cost of the Work*—See Paragraph 13.01 for definition.

18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.

19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.

20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.

21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

22. *Engineer*—The individual or entity named as such in the Agreement.
23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.

    a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.
    b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
    c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.

25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.
28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.
30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.
32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.
33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.
34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.

35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals.
36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.
37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.
39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion of such Work.
43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.
44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
46. *Technical Data*

    a. Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or

existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.

b. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.

c. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.

47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.
48. *Unit Price Work*—Work to be paid for on the basis of unit prices.
49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives*: The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or

authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. *Day*: The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*: The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

1. does not conform to the Contract Documents;
2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
3. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).

E. *Furnish, Install, Perform, Provide*

1. The word "furnish," when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
2. The word "install," when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
3. The words "perform" or "provide," when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.
4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words "furnish," "install," "perform," or "provide," then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

F. *Contract Price or Contract Times*: References to a change in "Contract Price or Contract Times" or "Contract Times or Contract Price" or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term "or both" is not expressed.

G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).

B. *Evidence of Contractor's Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of

insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.
B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;
2. a preliminary Schedule of Submittals; and
3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.
B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.
4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.
B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.
C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.
B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.
C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.
D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.
F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
G. Nothing in the Contract Documents creates:

1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or

2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

A. *Standards Specifications, Codes, Laws and Regulations*

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements*: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
2. *Contractor's Review of Contract Documents*: If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take precedence in

resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:

a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or
b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.

B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

A. Contractor and its Subcontractors and Suppliers shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or
2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times 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 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

4.03 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.
2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those

for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:

1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
2. Abnormal weather conditions;
3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and
4. Acts of war or terrorism.

D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:

1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.

E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:

1. The circumstances that form the basis for the requested adjustment;
2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.

Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.

F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.

G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.

2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. *Removal of Debris During Performance of the Work*: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.

C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;
2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and
3. Technical Data contained in such reports and drawings.

B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

C. *Reliance by Contractor on Technical Data*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.

D. *Limitations of Other Data and Documents*: Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;
3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 *Differing Subsurface or Physical Conditions*

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
2. is of such a nature as to require a change in the Drawings or Specifications;
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review*: After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

E. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;

b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,
c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;
b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or
c. Contractor failed to give the written notice required by Paragraph 5.04.A.

3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:

1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
2. complying with applicable state and local utility damage prevention Laws and Regulations;
3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;
4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated

on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.

C. *Engineer's Review*: Engineer will:

1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;
2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;
3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and
4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

F. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

   a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
   b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and
   c. Contractor gave the notice required in Paragraph 5.05.B.

2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.

3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.
4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;
2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.
D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.

H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

I. To the fullest extent permitted by Georgia Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

J. To the fullest extent permitted by Georgia Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of

engineers, architects, attorneys, and other professionals and all court costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to one hundred and ten percent of the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.

B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.

C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or Regulations, and must be issued and signed by a surety named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the State of Georgia, to issue bonds in the required amounts.

E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.

F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.

G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.

H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.

B. All insurance required by the Contract to be purchased and maintained by Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Alternative forms of insurance coverage, including but not limited to self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.

D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.

F. Failure of Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

H. Contractor shall require:

1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and
2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.

I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off

against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.

K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.

M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.

N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

A. *Required Insurance*: Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.

B. *General Provisions*: The policies of insurance required by this Paragraph 6.03 as supplemented must:

1. include at least the specific coverages required;
2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;
3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;
4. apply with respect to the performance of the Work, whether such performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable; and
5. include all necessary endorsements to support the stated requirements.

C. *Additional Insureds*: The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:

1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;

2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;
3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);
4. not seek contribution from insurance maintained by the additional insured; and
5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.

B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.

C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.

D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.

E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or

damage the insurer will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.
2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.

1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.

C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.

D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state

its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.

B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.

C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor

will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.04 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.

B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.05 *"Or Equals"*

A. *Contractor's Request; Governing Criteria*: Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.

1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:

   a. in the exercise of reasonable judgment Engineer determines that the proposed item:

      1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
      2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
      3) has a proven record of performance and availability of responsive service; and
      4) is not objectionable to Owner.

   b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:

      1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.

C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 *Substitutes*

A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.

1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.
2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.
3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:

   a. will certify that the proposed substitute item will:

      1) perform adequately the functions and achieve the results called for by the general design;
      2) be similar in substance to the item specified; and
      3) be suited to the same use as the item specified.

   b. will state:

      1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;

2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.

c. will identify:

1) all variations of the proposed substitute item from the item specified; and
2) available engineering, sales, maintenance, repair, and replacement services.

d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.

F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 *Concerning Subcontractors and Suppliers*

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.

B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.
C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.
D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.
E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.
F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.
G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.
H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.
I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.
J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.
K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.
L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.
M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.

B. To the fullest extent permitted by Georgia Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Georgia Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.09 *Permits*

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Georgia Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees

and charges of engineers, architects, attorneys, and other professionals and all court costs) arising out of or relating to such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.

C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.

B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.

C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:

1. all persons on the Site or who may be affected by the Work;
2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or

in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.

F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.

H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).

J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Contractor shall:

a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

b. determine and verify:

1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;
2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;

c. confirm that the Submittal is complete with respect to all related data included in the Submittal.

2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.
3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.

B. *Submittal Procedures for Shop Drawings and Samples*: Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.

1. *Shop Drawings*

a. Contractor shall submit the number of copies required in the Specifications.
b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.

2. *Samples*

a. Contractor shall submit the number of Samples required in the Specifications.
b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.

3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Engineer's Review of Shop Drawings and Samples*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to

determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.
3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.
5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.
6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.
8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

D. *Resubmittal Procedures for Shop Drawings and Samples*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.
2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.
3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

E. *Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs*

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:

a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.
b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.
c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.
d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.

2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03. 2.04, and 2.05.

F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.

B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:

1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and
2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.

C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
2. normal wear and tear under normal usage.

D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the

Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:

1. Observations by Engineer;
2. Recommendation by Engineer or payment by Owner of any progress or final payment;
3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
4. Use or occupancy of the Work or any part thereof by Owner;
5. Any review and approval of a Shop Drawing or Sample submittal;
6. The issuance of a notice of acceptability by Engineer;
7. The end of the correction period established in Paragraph 15.08;
8. Any inspection, test, or approval by others; or
9. Any correction of defective Work by Owner.

E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

A. To the fullest extent permitted by Georgia Law, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance

and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.

B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.

C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:

1. Checking for conformance with the requirements of this Paragraph 7.19;
2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.

F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.

G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other

work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.

D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:

1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
2. An itemization of the specific matters to be covered by such authority and responsibility; and
3. The extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other

contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.

1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.
2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.

C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim in the Superior Court of Greene County, Georgia, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

9.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.
B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Change Orders*

A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.07 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.08 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.09 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.10 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).

9.11 *Safety Programs*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.
B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and

observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Resident Project Representative*

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.

B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

A. Engineer has the authority to reject Work in accordance with Article 14.
B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.
C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.
D. Engineer's authority as to changes in the Work is set forth in Article 11.
E. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.05 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.
B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.
E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.
C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

11.02 *Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and
4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Work Change Directives*

A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

B. If Owner has issued a Work Change Directive and:

1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.
2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.

B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.
B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.
C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.
B. An adjustment in the Contract Price will be determined as follows:

1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);
2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or
3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit will be determined as follows:

1. A mutually acceptable fixed fee; or

2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

    a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;
    b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;
    c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;
    d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
    e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and
    f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.
B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

A. *Purpose and Content*: Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

B. *Change Proposal Procedures*

1. *Submittal*: Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.
2. *Supporting Data*: The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.

    a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.
    b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

    The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

3. *Engineer's Initial Review*: Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.
4. *Engineer's Full Review and Action on the Change Proposal*: Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.
5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

11.10 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12—CLAIMS

12.01 *Claims*

A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:

1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;
3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and
4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.

B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.

D. *Mediation*

1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.
2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.
3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.

E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not

take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or
2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.

B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.
2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.
5. Other costs consisting of the following:

    a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
    b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

        1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.

    c. *Construction Equipment Rental*

        1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts must cease when the use thereof is no longer necessary for the Work.
        2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.
        3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

    d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.
g. The cost of utilities, fuel, and sanitary facilities at the Site.
h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work does not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.
2. The cost of purchasing, renting, or furnishing small tools and hand tools.
3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
6. Expenses incurred in preparing and advancing Claims.
7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*

1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:

a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.

b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:

1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.
2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.

2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

13.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances*: Contractor agrees that:

1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment for any of the foregoing will be valid.

C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

13.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.
C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.
E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:

   a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
   b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.

2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.
3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.
B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:

1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
3. by manufacturers of equipment furnished under the Contract Documents;
4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and
5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

A. *Contractor's Obligation*: It is Contractor's obligation to assure that the Work is not defective.

B. *Engineer's Authority*: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. *Notice of Defects*: Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.

D. *Correction, or Removal and Replacement*: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. *Preservation of Warranties*: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

F. *Costs and Damages*: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines

levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.
B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.
C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.

    1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.
    2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right

of Owner to stop the Work will not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace defective Work as required by Engineer, then Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.
B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.
C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

A. *Basis for Progress Payments*: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.
B. *Applications for Payments*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.
2. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and

clear of all Liens; and (c) evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

    a. the Work has progressed to the point indicated;
    b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and
    c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

    a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
    b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

    a. to supervise, direct, or control the Work;
    b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;

c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;
d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; or
e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.
6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:

a. the Work is defective, requiring correction or replacement;
b. the Contract Price has been reduced by Change Orders;
c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:

a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;
b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
c. Contractor has failed to provide and maintain required bonds or insurance;
d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;

f. The Work is defective, requiring correction or replacement;
g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
h. The Contract Price has been reduced by Change Orders;
i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;
j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens; or
l. Other items entitle Owner to a set-off against the amount recommended.

2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.
3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

15.03 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.
B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the

preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through 15.03.E for that part of the Work.
2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.04 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

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

15.06 *Final Payment*

A. *Application for Payment*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.
2. The final Application for Payment must be accompanied (except as previously delivered) by:

   a. all documentation called for in the Contract Documents;
   b. consent of the surety, if any, to final payment;
   c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.
   d. a list of all duly pending Change Proposals and Claims; and
   e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. *Engineer's Review of Final Application and Recommendation of Payment*: If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for

payment. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Notice of Acceptability*: In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.

D. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.

E. *Final Payment Becomes Due*: Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

15.07 *Waiver of Claims*

A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim, appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

15.08 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. correct the defective repairs to the Site or such adjacent areas;
2. correct such defective Work;
3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and
4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.

B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.

C. If, after receipt of a notice of defect within 60 days and within the correction period, Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.

D. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

F. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph are not to be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, or failure to adhere to the Progress Schedule);
2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
4. Contractor's repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:

1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and
2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, 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 complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

F. 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, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate for Convenience*

A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and

3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 days' written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, 7 days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17—FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

A. *Disputes Subject to Final Resolution*: The following disputed matters are subject to final resolution under the provisions of this article:

1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and
2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.

B. *Final Resolution of Disputes*: For any dispute subject to resolution under this article, Owner or Contractor may:

1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;
2. agree with the other party to submit the dispute to another dispute resolution process; or
3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to the Superior Court of Greene, County, Georgia.

ARTICLE 18—MISCELLANEOUS

18.01 *Giving Notice*

A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only if delivered:

1. in person, by a commercial courier service or otherwise, to the recipient's place of business;

2. by registered or certified mail, postage prepaid, to the recipient's place of business; or
3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

18.02 *Computation of Times*

A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. 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.

18.04 *Limitation of Damages*

A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination of the Contract or of the services of Contractor.

18.07 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

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

18.10 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT
TABLE OF CONTENTS

Page

SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

These Supplementary Conditions amend or supplement Section 00 72 00, Standard General Conditions of the Construction Contract. The General Conditions remain in full force and effect except as amended.
The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.
The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added—for example, “Paragraph SC-4.05.”

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

No Supplementary Conditions in this Article.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

SC-2.01 Delete Paragraphs 2.01.B. in its entirety and insert the following in their place:

B. *Evidence of Contractor’s Insurance:* When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies (including all endorsements, and identification of applicable self-insured retentions and deductibles) of insurance required to be provided by Contractor in this Contract. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

2.02 *Copies of Documents*

SC-2.02 Amend the first sentence of Paragraph 2.02.A. to read as follows:

Owner shall furnish to Contractor one printed copy of the Contract Documents (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF).

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

No Supplementary Conditions in this Article.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.05 *Delays in Contractor’s Progress*

SC-4.05 Amend Paragraph 4.05.C by adding the following subparagraphs:

5. *Weather-Related Delays*
   a. If “abnormal weather conditions” as set forth in Paragraph 4.05.C.2 of the General Conditions are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the

following: 1) that weather conditions were abnormal for the period of time in which the delay occurred, 2) that such weather conditions could not have been reasonably anticipated, and 3) that such weather conditions had an adverse effect on the Work as scheduled.

b. The existence of abnormal weather conditions will be determined on a month-by-month basis in accordance with Specification Section 01 10 00 - Summary.

ARTICLE 5—SITE, SUBSURFACE AND PHYSICAL CONDITIONS, HAZARDOUS ENVIRONMENTAL CONDITIONS

5.03 *Subsurface and Physical Conditions*

SC-5.03 Add the following new paragraphs immediately after Paragraph 5.03.D:

E. The following table lists the reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data, and specifically identifies the Technical Data in the report upon which Contractor may rely:

Report Title	Date of Report	Technical Data
None	-	-

F. The following table lists the drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data, and specifically identifies the Technical Data upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
None	-	-

5.06 *Hazardous Environmental Conditions*

SC-5.06 Add the following new paragraphs immediately after Paragraph 5.06.A.3:

4. The following table lists the reports known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and the Technical Data (if any) upon which Contractor may rely:

Report Title	Date of Report	Technical Data
None	-	-

5. The following table lists the drawings known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and Technical Data (if any) contained in such Drawings upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
None	-	-

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

SC-6.01 Add the following paragraphs immediately after Paragraph 6.01.B:

1. The correction period specified as one year after the date of Substantial Completion in Paragraph 15.08.A of the General Conditions is hereby revised to be 2 years after Substantial Completion.
2. After Substantial Completion, Contractor shall furnish a maintenance bond issued in the form of 00 61 13.14, Maintenance Bond. The maintenance bond must be in a bond amount of 15 percent of the final Contract Price. The maintenance bond period will extend to a date 2 years after Substantial Completion of the Work. Contractor shall deliver the fully executed maintenance bond to Owner prior to or with the final application for payment, and in any event no later than 11 months after Substantial Completion.
3. The maintenance bond must be issued by the same surety that issues the performance bond required under Paragraph 6.01.A of the General Conditions.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.03 *Labor; Working Hours*

SC-7.03 Add the following new subparagraphs immediately after Paragraph 7.03.C:

1. Regular working hours will be 7:00 AM to 4:30 PM local time.
2. Owner's legal holidays are New Year's Day Holiday, Martin Luther King Day, Good Friday, Memorial Day, Juneteenth, Independence Day, Labor Day, Veterans Day, Thanksgiving Holidays (Thursday and Friday), Christmas Eve, and Christmas Day. Coordination with Owner on exact dates of observed holidays for each calendar year is required.

ARTICLE 8—OTHER WORK AT THE SITE

8.02 *Coordination*

SC-8.02 Add the following new Paragraph 8.02.C immediately after Paragraph 8.02.B:

C. Owner intends to contract with others for the performance of other work at or adjacent to the Site.
   1. Bill Banks (bill.banks@hcwa.com) and James 'Buster' Cook (james.cook@hcwa.com) shall have authority and responsibility for coordination of the various contractors and work forces at the Site;
   2. The following specific matters are to be covered by such authority and responsibility: included but not limited to: operations; construction schedules; construction scopes;
   3. The extent of such authority and responsibilities is: included but not limited to: property not owned by HCWA.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.12 *Owner's Site Representative*

SC-9.12 Add the following new paragraph immediately after Paragraph 9.11 of the General Conditions:

9.12 *Owner's Site Representative*

A. Owner will furnish an "Owner's Site Representative" to represent Owner at the Site and assist Owner in observing the progress and quality of the Work. The Owner's Site Representative is not Engineer's consultant, agent, or employee. Owner's Site Representative will be HCWA CIP Field Liaison. The authority and responsibilities of Owner's Site Representative follow: general observation and coordination with RPR.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.03 *Resident Project Representative*

SC-10.03 Add the following new paragraphs immediately after Paragraph 10.03.B:

C. The Resident Project Representative (RPR) will be Engineer's representative at the Site. RPR's dealings in matters pertaining to the Work in general will be with Engineer and Contractor. RPR's dealings with Subcontractors will only be through or with the full knowledge or approval of Contractor. The RPR will:
   1. *Conferences and Meetings:* Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings (but not including Contractor's safety meetings), and as appropriate prepare and circulate copies of minutes thereof.
   2. *Safety Compliance:* Comply with Site safety programs, as they apply to RPR, and if required to do so by such safety programs, receive safety training specifically related to RPR's own personal safety while at the Site.
   3. *Liaison*
      a. Serve as Engineer's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.
      b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.
      c. Assist in obtaining from Owner additional details or information, when required for Contractor's proper execution of the Work.
   4. *Review of Work; Defective Work*
      a. Conduct on-Site observations of the Work to assist Engineer in determining, to the extent set forth in Paragraph 10.02, if the Work is in general proceeding in accordance with the Contract Documents.
      b. Observe whether any Work in place appears to be defective.
      c. Observe whether any Work in place should be uncovered for observation, or requires special testing, inspection or approval.
   5. *Inspections and Tests*

a. Observe Contractor-arranged inspections required by Laws and Regulations, including but not limited to those performed by public or other agencies having jurisdiction over the Work.
b. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Work.

6. *Payment Requests:* Review Applications for Payment with Contractor.
7. *Completion*
   a. Participate in Engineer's visits regarding Substantial Completion.
   b. Assist in the preparation of a punch list of items to be completed or corrected.
   c. Participate in Engineer's visit to the Site in the company of Owner and Contractor regarding completion of the Work, and prepare a final punch list of items to be completed or corrected by Contractor.
   d. Observe whether items on the final punch list have been completed or corrected.

D. The RPR will not:
1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).
2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.
3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.
4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of construction.
5 Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.
6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.
7. Authorize Owner to occupy the Project in whole or in part.

ARTICLE 11—CHANGES TO THE CONTRACT

No Supplementary Conditions in this Article.

ARTICLE 12—CLAIMS

No Supplementary Conditions in this Article.

ARTICLE 13—COST OF WORK; ALLOWANCES, UNIT PRICE WORK

No Supplementary Conditions in this Article.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCCEPTANCE OF DEFECTIVE WORK

No Supplementary Conditions in this Article.

ARTICLE 15—PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETIONS; CORRECTION PERIOD

15.08 *Correction Period*

SC-15.08 Add the following new Paragraph 15.08.G:

G. The correction period specified as one year after the date of Substantial Completion in Paragraph 15.08.A of the General Conditions is hereby revised to be the number of years set forth in SC-6.01.B.1.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

No Supplementary Conditions in this Article.

ARTICLE 17—FINAL RESOLUTIONS OF DISPUTES

No Supplementary Conditions in this Article.

ARTICLE 18—MISCELLANEOUS

No Supplementary Conditions in this Article.

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY:

A. Briefly and without force and effect and effect upon the Contract Documents, the work of the Contract can be summarized as follows:

1. Clearing & Grubbing, Civil Site Work, etc.
2. Construction or modification of process units in water reuse facility, including headworks, equalization basin, influent pump station, VertiCel biological reactors, secondary clarifier, filters, chlorine contact chamber, aerobic digester, and reject pond.
3. Miscellaneous piping
4. Electrical work and Process Control Programming

1.2 PROJECT/WORK IDENTIFICATION:

A. General: Project name is “Carey Station Water Urban Reuse Facility 0.5 MGD to 1.0 MGD Expansion” as shown on the Drawings and in the Contract Documents prepared by Goodwyn Mills Cawood, LLC

B. Related requirements and conditions that are indicated on the Drawings and in the Contract Documents include, but are not necessarily limited to the following:

1. Existing site conditions of the site.
2. New Sitework, Site Utilities, and Construction.
3. New Plumbing and Electrical systems.
4. Contractor shall be responsible for having any existing utilities located that are within the limits of the work to be performed.

C. Summary by References: Work of the Contract can be summarized by references to the Contract, General Conditions, Supplementary Conditions, (if any), Technical Specification Sections, Drawings, Addenda and modifications to the Contract Documents issued subsequent to the initial printing of the Drawings and Contract Documents, including but not necessarily limited to printed material referenced by any of these. It is recognized that work of the Contract is also unavoidably affected or influenced by governing regulations, natural phenomenon including weather conditions, and other forces outside the contract documents.

1.3 RELATED EDOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01100

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. Section 01 26 00 - Contract Modification Procedures for administrative procedures for handling changes to the Contract.
3. Section 01 32 00 - Construction Progress Documentation for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.2 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:

    a. Application for Payment forms with continuation sheets.
    b. Submittal schedule.
    c. Items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Engineer at earliest possible date, but no later than 14 days before the date scheduled for submittal of initial Applications for Payment.
3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
4. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section where a submittal is required.

1. Identification: Include the following Project identification on the schedule of values:

    a. Project name and location.
    b. Name of Engineer.
    c. Engineer's project number.
    d. Contractor's name and address.
    e. Date of submittal.

2. Arrange schedule of values consistent with format of Contract Documents used (EJCDC, AIA, etc.).
3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:

    a. Related Specification Section or Division.
    b. Description of the Work.
    c. Name of subcontractor.
    d. Name of manufacturer or fabricator.
    e. Name of supplier.
    f. Change Orders (numbers) that affect value.
    g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

        1) Labor.
        2) Materials.
        3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

    a. Include separate line items under contractor and principal subcontracts for Project closeout requirements in an amount totaling no less than 2.5% of the Contract Sum and subcontract amount.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by

measured quantity. Use information indicated in the Contract Documents to determine quantities.

9. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.

10. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by engineer and contractor and paid for by Owner.

    1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

    1. Submit draft copy of Application for Payment five days prior to due date for review by Engineer.

C. Application for Payment Forms: Use form consistent with Contract Documents (EJCDC, AIA, etc.) for Applications for Payment.

    1. Other Application for Payment forms proposed by the Contractor may be acceptable to Engineer and Owner. Submit forms for approval with initial submittal of schedule of values.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor.

    1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
    2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
    3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

F. Transmittal:

1. Deliverable:

    a. Hard Copy: Submit three (3) signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
    b. Digital: Submit one (1) signed and notarized copy of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

2. Contractor’s Affidavit of Payment to Subcontractors

    a. Shall be submitted with each Application for Payment.

3. Contractor Progress Lien Waivers – Specification Section 01 29 00 A

    a. Shall be submitted with each Application for Payment after No. 1.

4. Subcontractor/Supplier Lien Waivers – Specification Section 01 29 00 B

    a. Shall be submitted with each Application for Payment after No. 1.

5. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. List of Contractor's staff assignments.
6. Copies of building and other local/state permits.
7. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.

8. Report of preconstruction conference.
9. Certificates of insurance and insurance policies.
10. Performance and payment bonds.
11. Data needed to acquire Owner's insurance.

H. Application for Payment at Substantial Completion: After Engineer issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

I. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. "Contractor's Affidavit of Payment of Debts and Claims."
5. "Contractor's Affidavit of Release of Liens."
6. "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

CONTRACTOR'S UNCONDITIONAL LIEN WAIVER UPON PROGRESS PAYMENT

The undersigned hereby acknowledge that the amount of

_____

was received from

Piedmont Water Company
The Owner

as Progress Payment for the following goods and/or services:

Carey Station Urban Water Reuse Facility

0.5 MGD to 1.0 MGD Expansion

performed at the property described as:

4610 Carey Station Road, Greensboro, GA 30642

The undersigned hereby waives the right to assert a lien and release any lien against the owner to this extent only. This lien waiver does not affect the right of the undersigned to recover payment for any other goods or services supplied before or after this release date not compensated by the progress payment or any rights which the undersigned may have by contract.

Title and Name of Claimant

Company Details

Signature

Date

SUBCONTRACTOR'S UNCONDITIONAL LIEN WAIVER UPON PROGRESS PAYMENT

The undersigned hereby acknowledges that the amount of

_____

was received from

_____

as Progress Payment for the following goods and/or services:

_____

for the following project:

Carey Station Urban Water Reuse Facility 0.5 MGD to 1.0 MGD Expansion
(Project Name)

Piedmont Water Company_____
(Owner)

performed at the property described as:

4610 Carey Station Road, Greensboro, GA 30642

_____

through the following date:

_____

The undersigned hereby waives the right to assert a lien and release any lien against the owner to this extent only. This lien waiver does not affect the right of the undersigned to recover payment for any other goods or services supplied before or after this release date not compensated by the progress payment or any rights which the undersigned may have by contract.

_____
Title and Name of Claimant

_____
(Company Name)

_____
(Address)

_____
Signature

_____
Date

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. Requests for Information (RFIs).
4. Project Web site.
5. Project meetings.

B. Each contractor shall participate in coordination requirements.

C. Related Requirements:
1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.

1.3 DEFINITIONS

A. RFI: Request from Engineer seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: No less than 15 days prior to starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names,

addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office and at existing treatment facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.

4. Name of Contractor.
5. Name of Engineer
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: As acceptable to the Engineer.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Engineer Action: Engineer will review each RFI, determine action required, and respond. Allow seven working days for Engineer’s response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of Engineer's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within five days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log monthly. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Engineer
4. RFI number including RFIs that were returned without action or withdrawn.

5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's response was received.

F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within five days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.7 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within seven days of the meeting.

B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days before mobilization.

1. Conduct the conference to review responsibilities and personnel assignments.
2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:

a. Tentative construction schedule.
b. Phasing.
c. Critical work sequencing and long-lead items.
d. Designation of key personnel and their duties.
e. Lines of communications.
f. Procedures for processing field decisions and Change Orders.
g. Procedures for RFIs.
h. Procedures for testing and inspecting.
i. Procedures for processing Applications for Payment.
j. Distribution of the Contract Documents.
k. Submittal procedures.
l. Sustainable design requirements.
m. Preparation of record documents.
n. Use of the premises.
o. Work restrictions.

p. Working hours.
q. Owner's occupancy requirements.
r. Responsibility for temporary facilities and controls.
s. Procedures for moisture and mold control.
t. Procedures for disruptions and shutdowns.
u. Construction waste management and recycling.
v. Parking availability.
w. Office, work, and storage areas.
x. Equipment deliveries and priorities.
y. First aid.
z. Security.
aa. Progress cleaning.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preconstruction Conferences: Conduct a preconstruction conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer and owner of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Sustainable design requirements.
i. Review of mockups.
j. Possible conflicts.
k. Compatibility requirements.
l. Time schedules.
m. Weather limitations.
n. Manufacturer's written instructions.
o. Warranty requirements.
p. Compatibility of materials.
q. Acceptability of substrates.
r. Temporary facilities and controls.
s. Space and access limitations.
t. Regulations of authorities having jurisdiction.
u. Testing and inspecting requirements.
v. Installation procedures.
w. Coordination with other work.
x. Required performance results.
y. Protection of adjacent work.
z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with construction if the Preconstruction Conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Engineer, but no later than 60 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

    a. Preparation of record documents.
    b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
    c. Submittal of written warranties.
    d. Requirements for completing sustainable design documentation.
    e. Requirements for preparing operations and maintenance data.
    f. Requirements for delivery of material samples, attic stock, and spare parts.
    g. Requirements for demonstration and training.
    h. Preparation of Contractor's punch list.
    i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
    j. Submittal procedures.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at minimum monthly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so.

Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Progress cleaning.
10) Quality and work standards.
11) Status of correction of deficient items.
12) Field observations.
13) Status of RFIs.
14) Status of proposal requests.
15) Pending changes.
16) Status of Change Orders.
17) Pending claims and disputes.
18) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

F. Coordination Meetings: Conduct Project coordination meetings as necessary. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.

1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to

ensure that current and subsequent activities will be completed within the Contract Time.

b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.

c. Review present and future needs of each contractor present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) Progress cleaning.
12) Quality and work standards.
13) Change Orders.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.
4. Weekly construction reports.
5. Material location reports.
6. Site condition reports.
7. Special reports.

B. Related Requirements:
1. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:
1. PDF electronic file.

B. Startup construction schedule.

C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

D. Construction Reports: Submit at weekly intervals.

E. Material Location Reports: Submit at monthly intervals.

F. Site Condition Reports: Submit at time of discovery of differing conditions.

G. Special Reports: Submit at time of unusual event.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Provide schedule from date established for the Notice to Proceed to date of Substantial Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each phase or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
2. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
3. Startup and Testing Time: Include no fewer than 30 days for startup and testing.
4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work Restrictions: Show the effect of the following items on the schedule:

a. Coordination with existing construction.
b. Limitations of continued occupancies.
c. Uninterruptible services.
d. Partial occupancy before Substantial Completion.
e. Use of premises restrictions.
f. Environmental control.

D. Milestones: Include milestones in schedule indicated in the Contract Documents, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

E. Recovery Schedule: When periodic updates indicate the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for the Notice to Proceed. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10% percent increments within time bar.

2.3 REPORTS

A. Weekly Construction Reports: Prepare a Weekly construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Emergency procedures.
12. Orders and requests of authorities having jurisdiction.
13. Change Orders received and implemented.
14. Work Directives received and implemented.
15. Services connected and disconnected.
16. Equipment or system tests and startups.
17. Partial completions and occupancies.
18. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within two day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule two days before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final completion construction photographs.
4. Preconstruction video recordings.
5. Periodic construction video recordings.
6. Web-based construction photographic documentation.

B. Related Requirements:
1. Section 013300 "Submittal Procedures" for submitting photographic documentation.
2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 CAPTURE OF DIGITAL DOCUMENTATION

A. Key Plan: Develop key plan of Project site with notation of vantage points marked for location and direction of each photograph or video recording.

B. Digital Photographs for Existing Conditions and Construction Documentation:

1. Digital Camera: Minimum sensor resolution of 6 megapixels.
2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
3. Identification: Provide the following information with each image description in file metadata tag:

a. Name of Project.
b. Date photograph was taken.
c. Description of photograph and location
d. Unique sequential identifier keyed to accompanying key plan.

C. Video Recordings:
1. Identification: With each submittal, provide the following information:

a. Name of Project.

b. Date video recording was recorded.
c. Description of video recording and location.
d. Weather conditions at time of recording.

1.4 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Upon request submit the following:

1. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 6 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.
2. Digital Video Recordings: Provide high-resolution, digital video disc in format acceptable to Engineer.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Date and Time: Include date and time in file name for each image.
2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Engineer.

C. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points.

1. Flag construction limits before taking construction photographs.
2. Take photographs to show existing conditions adjacent to property before starting the Work.
3. Take photographs of existing adjoining property to accurately record physical conditions at start of construction.

4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Periodic Construction Photographs: Take photographs at necessary intervals with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

E. Final Completion Construction Photographs: Take color photographs after date of Substantial Completion for submission as project record documents. Retain subparagraph below if date stamp is not required.

1. Do not include date stamp.

END OF SECTION 013233

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
2. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
4. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

3. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Engineer's final release or approval.
    g. Scheduled date of fabrication.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Engineer, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.

C. Paper Submittals: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
3. Include the following information for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Name of subcontractor.
    f. Name of supplier.
    g. Name of manufacturer.
    h. Submittal number or other unique identifier, including revision identifier.

        1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

    i. Number and title of appropriate Specification Section.
    j. Drawing number and detail references, as appropriate.
    k. Location(s) where product is to be installed, as appropriate.
    l. Other necessary identification.

4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

    a. Submit one (1) copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.

5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form.
    a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:

        1) Project name.
        2) Date.
        3) Destination (To:).
        4) Source (From:).
        5) Name and address of Engineer.

6) Name of Contractor.
7) Name of firm or entity that prepared submittal.
8) Names of subcontractor, manufacturer, and supplier.
9) Category and type of submittal.
10) Submittal purpose and description.
11) Specification Section number and title.
12) Specification paragraph number or drawing designation and generic name for each of multiple items.
13) Drawing number and detail references, as appropriate.
14) Indication of full or partial submittal.
15) Transmittal number.
16) Submittal and transmittal distribution record.
17) Remarks.
18) Signature of transmitter.

D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Engineer.
    d. Name of Contractor.
    e. Name of firm or entity that prepared submittal.
    f. Names of subcontractor, manufacturer, and supplier.
    g. Category and type of submittal.
    h. Submittal purpose and description.
    i. Specification Section number and title.
    j. Specification paragraph number or drawing designation and generic name for each of multiple items.
    k. Drawing number and detail references, as appropriate.
    l. Location(s) where product is to be installed, as appropriate.
    m. Related physical samples submitted directly.
    n. Indication of full or partial submittal.
    o. Transmittal number.
    p. Submittal and transmittal distribution record.
    q. Other necessary identification.
    r. Remarks.

5. Metadata: Include the following information as keywords in the electronic submittal file metadata:

    a. Project name.
    b. Number and title of appropriate Specification Section.
    c. Manufacturer name.
    d. Product name.

E. Options: Identify options requiring selection by Engineer.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Submit electronic submittals via email as PDF electronic files.

    a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Action Submittals: Submit one paper copy of each submittal unless otherwise indicated. Engineer will not return paper copies.
3. Informational Submittals: Submit one paper copy of each submittal unless otherwise indicated. Engineer will not return paper copies.
4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:

a. PDF electronic file.
b. One paper copy of Product Data unless otherwise indicated. Engineer will not return paper copies.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Engineer's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

3. Submit Shop Drawings in the following format:

    a. PDF electronic file.
    b. One opaque (bond) copies of each submittal.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Sample source.
    d. Number and title of applicable Specification Section.
    e. Specification paragraph number and generic name of each item.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit 1 set of Samples to the Engineer and Owner for review.

        1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
        2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

F. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

G. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."

H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

J. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.

L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.

3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

V. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

1.5 ACTION SUBMITTALS

A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.

1. Indicate manufacturer and model number of individual components.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Engineer.
2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Engineer.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager shall not have other Project responsibilities.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.

2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
3. Owner-performed tests and inspections indicated in the Contract Document.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspection.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A Nationally Recognized Testing Laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to the National Institute of Standards and Technology, NIST's, National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Engineer.
2. Notify Engineer 7 days in advance of dates and times when mockups will be constructed.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Engineer and owner approval of mockups before starting work, fabrication, or construction.

    a. Allow 7 days for initial review and each re-review of each mockup.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed unless otherwise indicated.

K. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify Engineer/Inspector and testing agencies at least 48 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

L. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

M. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

N. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

O. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

P. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.

Q. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

R. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 ACCEPTABLE TESTING AGENCIES

A. Goodwyn Mills Cawood, LLC

3.2 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

3.3 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017000 "Execution and Closeout Requirements."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities. This information is believed to be accurate as of the date of the Contract Documents.

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov/fdsys.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to Engineer, testing agencies, and authorities having jurisdiction.

B. Sewer Service: Sewer service shall be by the Contractor utilizing portable facilities.

C. Water Service: Pay water-service use charges for water used by all entities for construction operations.

D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction (ADEM), whichever is more stringent.

C. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.

1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
3. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

A. Common-Use Field Office(s): Of sufficient size to accommodate needs of Engineer and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide
3. electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4 foot square tack and marker boards.
4. Drinking water and private toilet.
5. Coffee machine and supplies.
6. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
7. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Provide electrically powered heating and air-conditioning units with air filtration and thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove sewage lawfully.

1. Connect temporary sewers to system as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities. Contractor’s personnel may not use Owner’s or Engineer’s restrooms.

E. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

1. Install electric power service overhead or underground or as required for construction.

F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:
   1. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Final Completion.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

   1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

   1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
   2. Prepare subgrade and install subbase and base for temporary roads.
   3. Recondition base after temporary use, including removing contaminated material, regrading, proof rolling, compacting, and testing.
   4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Section 321216 "Asphalt Paving."

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

   1. Protect existing site improvements to remain including curbs, pavement, and utilities.
   2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: Provide temporary parking areas for construction personnel.

F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted. Subcontractors are not authorized to have signage.

   1. Identification Signs: Provide Project identification signs as indicated on Drawings.
   2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

      a. Provide temporary construction signs as required by funding agencies.

      b. Provide temporary, directional signs for construction personnel and visitors.

   3. Maintain and touchup signs so they are legible at all times.

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017000 "Execution and Closeout Requirements."

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Properties: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing properties.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 011000 "Summary."

C. Temporary Erosion and Sedimentation Control: Comply with authorities having jurisdiction, and requirements specified in Section 312500 “Erosion and Sedimentation Controls.”

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

F. Site Enclosure Fence: Before construction operations begin furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.

G. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

H. Temporary Egress: As may be required, maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

I. Temporary Enclosures: Provide temporary enclosures as required for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Maintenance: Maintain temporary facilities in good operating condition until removal.

B. Termination and Removal: Remove each temporary facility when need for its service has ended, or no later than Substantial Completion. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017000 "Execution and Closeout Requirements."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request.

Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017000 "Execution and Closeout Requirements."

D. Final Guarantee:
1. All work shall be guaranteed by the Contractor for a period of one year from and after the date of acceptance of the Work by the Owner.
2. If, within the guarantee period, repairs or changes are required in connection with guaranteed work, which, in the opinion of the Engineer, is rendered necessary as the result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the Contract Documents, the Contractor shall, promptly upon receipt of notice from the Owner and without expense to the Owner, do the following:
3. Place in satisfactory condition in every particular all of such guaranteed work and correct all defects therein.
4. Make good all damage to the building or site, or equipment or contents thereof, which in the opinion of the Engineer, is the result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the contract.
5. Make good any work or material, or the equipment and contents of building, structure of site disturbed in fulfilling any such guarantee.
6. If the Contractor, after notice, fails within ten days to proceed to comply with the terms of this guarantee, the Owner may have the defects corrected, and the Contractor and his surety shall be liable for all expense incurred, provided, however, that in the case of an emergency where, in the opinion of the Owner, delay would cause loss or damage repairs may be started without notice being given to the Contractor and the Contractor shall pay the cost thereof.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:

    a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.

4. Manufacturers:

    a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

C. Visual Matching Specification: Where Specifications require "match Engineer's sample", provide a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
5. Samples, if requested.
6. The Contractor shall also include in the price bid the modifications necessary for the comparable product to be utilized. This includes but is not limited to, electrical and mechanical changes, engineering time to assess the changes, modifications to buildings, programmable controls and structural modifications.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. SECTION INCLUDES

1. Field engineering.
2. Closeout procedures.
3. Starting of systems.
4. Demonstration and instructions.
5. Testing, adjusting, and balancing.
6. Project record documents.
7. Operation and maintenance data.
8. Manual for materials and finishes.
9. Manual for equipment and systems.
10. Spare parts and maintenance products.
11. Product warranties and product bonds.
12. Examination.
13. Preparation.
14. Execution.
15. Cutting and patching.
16. Protecting installed construction.
17. Final cleaning.

B. Related Requirements:

1. Section 01 33 00 - Submittal Procedures, for submitting copies of submittals for operation and maintenance manuals.
2. Section 01 78 23 - Operation and Maintenance Data, for submitting operation and maintenance manuals.

1.2 FIELD ENGINEERING

A. Employ a land surveyor acceptable to Engineer.

B. Locate and protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.

C. Control datum for survey is indicated on Drawings.

D. Verify setbacks and easements; confirm Drawing dimensions and elevations.

E. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.

F. Submit copy of certificate signed by land surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

G. On completion of foundation walls and major Site improvements, prepare certified survey illustrating dimensions, locations, angles, and elevations of construction and site work

H. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.

I. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

1.3 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:

1. Submit operation and maintenance manuals, Project record documents, and other similar final record data in compliance with this Section.
2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
4. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
5. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
6. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
7. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:

1. When Contractor considers Work to be substantially complete, submit to Engineer:

    a. Written certificate that Work, or designated portion, is substantially complete.
    b. List of items to be completed or corrected (initial punch list).

2. Within seven days after receipt of request for Substantial Completion, Engineer will make inspection to determine whether Work or designated portion is substantially complete.

3. Should Engineer determine that Work is not substantially complete:

    a. Engineer will promptly notify Contractor in writing, stating reasons for its opinion.

b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Engineer.
c. Engineer will re-inspect Work.
d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer and Owner's inspection.

4. When Engineer finds that Work is substantially complete, Engineer will:

a. Prepare Certificate of Substantial Completion on EJCDC C-625 - Certificate of Substantial Completion accompanied by Contractor's list of items to be completed or corrected as verified and amended by Engineer and Owner (final punch list).
b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.

5. After Work is substantially complete, Contractor shall:

a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
b. Complete Work listed for completion or correction within time period stipulated.

C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.

1. When Contractor considers Work to be complete, submit written certification that:

a. Contract Documents have been reviewed.
b. Work has been examined for compliance with Contract Documents.
c. Work has been completed according to Contract Documents.
d. Work is completed and ready for final inspection.

2. Submittals: Submit following:

a. Final punch list indicating all items have been completed or corrected.
b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
d. Accounting statement for final changes to Contract Sum.
e. Contractor's affidavit of payment of debts.
f. Contractor affidavit of release of liens.
g. Consent of surety to final payment.

3. Perform final cleaning for Contractor-soiled areas according to this Section.

D. Final Completion Inspection:

1. Within seven days after receipt of request for final inspection, Owner and Engineer will make inspection to determine whether Work or designated portion is complete.
2. Should Engineer consider Work to be incomplete or defective:

a. Engineer will promptly notify Contractor in writing, listing incomplete or defective Work.
b. Contractor shall remedy stated deficiencies and send second written request to Work is complete.
c. Engineer will re-inspect Work.
d. Redo and Inspection of Deficient Work: Repeated until Work passes inspection.

1.4 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Notify Engineer and owner seven days prior to startup of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to manufacturer's instructions.

G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.

H. Submit a written report that equipment or system has been properly installed and is functioning correctly, as well as a certificate/field report from the manufacturer from his inspection of the installation.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel as equipment becomes available for use and not later than 14 days prior to date of Substantial Completion.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at designated location.

D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

1.6 TESTING, ADJUSTING, AND BALANCING

A. Contractor with Engineer approval will appoint and employ services of independent firm to perform testing, adjusting, and balancing. Contractor shall pay for services.

B. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or noncompliance with requirements of Contract Documents.

1.7 PROJECT RECORD DOCUMENTS

A. Maintain on Site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, product data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates used.
3. Changes made by Addenda and modifications.

F. Record Drawings: Legibly mark each item to record actual construction as follows:

1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
2. Include locations of concealed elements of the Work.
3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
5. Identify and locate existing buried or concealed items encountered during Project.
6. Measured depths of foundations in relation to finish floor datum.
7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
9. Field changes of dimension and detail.

10. Details not on original Drawings.

G. Submit marked-up paper copy documents to Engineer with claim for final Application for Payment.

1.8 OPERATION AND MAINTENANCE DATA

A. See Section 01 78 23 - Operation and Maintenance Data for operation and maintenance manuals.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual Specification Sections.

D. Verify that utility services are available with correct characteristics and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

3.3 EXECUTION

A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until completion of construction.

B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer/Engineer before proceeding.

C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Engineer for final decision.

E. Allow for expansion of materials and building movement.

F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.

1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.

1. Refer questionable mounting heights choices to Engineer/Engineer for final decision.
2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.

H. Adjust operating products and equipment to ensure smooth and unhindered operation.

I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

3.4 CUTTING AND PATCHING

A. Employ skilled and experienced installers to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements affecting:

1. Structural integrity of element.
2. Integrity of weather-exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Visual qualities of sight-exposed elements.
5. Work of Owner or separate contractor.

C. Execute cutting, fitting, and patching including excavation and fill to complete Work and to:

1. Fit the several parts together, to integrate with other Work.

2. Uncover Work to install or correct ill-timed Work.
3. Remove and replace defective and nonconforming Work.
4. Remove samples of installed Work for testing.
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.

E. Cut masonry and concrete materials using masonry saw or core drill.

F. Restore Work with new products according to requirements of Contract Documents.

G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.

H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

I. At penetrations of fire-rated walls, partitions, ceiling, or floor construction, completely seal voids with fire-rated material to full thickness of penetrated element.

J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

K. Identify hazardous substances or conditions exposed during the Work to Engineer for decision or remedy.

3.5 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual Specification Sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

3.6 FINAL CLEANING

A. Execute final cleaning prior to final Project assessment.

1. Employ experienced personnel or professional cleaning firm.

B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces, and vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.

D. Clean filters of operating equipment.

E. Clean debris from roofs, gutters, downspouts, and drainage systems.

F. Clean Site; sweep paved areas, rake clean landscaped surfaces.

G. Remove waste and surplus materials, rubbish, and construction facilities from Site.

END OF SECTION 017000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

B. Related Requirements:
1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
b. Enable inserted reviewer comments on draft submittals.

2. Two paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.

1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Engineer.
7. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
8. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch and 11 x 17 paper (Z-folded); with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of

contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.

4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared record Drawings in Section 017839 "Project Record Documents."

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:
1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Submit copies of marked-up record prints as follows:

a. Initial Submittal:

1) Submit electronic files or one (1) hard copy set. Engineer will review and return, with comments as necessary.

b. Final Submittal:

1) After incorporation of Engineer’s comments, submit electronic files and one (1) hard copy set of final marked-up record prints to the Engineer and electronic files and one (1) hard copy set to the Owner.

c. Engineer will be responsible for generating record drawings based on the Contractor’s marked-up record prints and delivering three (3) hard copy sets to the Owner.

B. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued. Contractor shall maintain a set of marked up prints on the job site for review prior to pay request approval.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Accurately record information in an acceptable drawing technique.
    c. Record data as soon as possible after obtaining it.
    d. Record and check the markup before enclosing concealed installations.
    e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.
    b. Revisions to details shown on Drawings.
    c. Depths of foundations below first floor.
    d. Locations and depths of underground utilities.
    e. Revisions to routing of piping and conduits.
    f. Revisions to electrical circuitry.
    g. Actual equipment locations.
    h. Duct size and routing.
    i. Locations of concealed internal utilities.
    j. Changes made by Change Order or Work Change Directive.
    k. Changes made following Engineer's written orders.
    l. Details not on the original Contract Drawings.
    m. Field records for variable and concealed conditions.
    n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Engineer.
    e. Name of Contractor.

2.2 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

END OF SECTION 017839

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module.

B. Attendance Record: For each training module/session, submit list of participants and length of instruction time.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Records: Submit two (2) copies within seven (7) days of the end of each training module/session for the specific equipment for which training was performed.

1. Identification: On each copy, provide an applied label with the following information:

a. Name of Project.
b. Name and address of Manufacturer.
c. Name of Instructor
d. Name of Engineer.
e. Name of Construction Manager.
f. Name of Contractor.
g. Date of Training/Instruction.

1.5 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

1.6 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Operational Requirements, and Criteria: Include the following:

a. System, subsystem, and equipment descriptions.
b. Equipment function.
c. Operating characteristics.
d. Limiting conditions.

2. Documentation: Review the following items in detail, as applicable:

a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Identification systems.
e. Warranties.
f. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.

e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following, as applicable:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following, as applicable:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following, as applicable:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following, as applicable:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location if applicable.

3.2 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel on how to: adjust, operate, and maintain equipment.

B. Scheduling: Provide instruction at mutually agreed times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner, through Engineer with at least five (5) days' advance notice.

C. Training Location and Reference Material: Conduct training on-site at the operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

END OF SECTION 01 79 00

SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.
4. Protecting existing work to remain.
5. Cleaning soled materials that are to remain.
6. Disconnecting and capping utilities.
7. Removing debris and equipment.
8. Removal of items indicated on Drawings.
9. Salvageable items to be retained by the Owner as indicated on the Drawings and during pre-construction meeting.

B. Related Requirements:

1. Section 01 10 00 – Summary, for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Demolish: To forcefully tear down or take apart a structure.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Engineering Survey: Submit engineering survey of condition of building.

C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

D. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Comply with Section 01 32 33 - Photographic Documentation. Submit before Work begins.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.6 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.8 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.10 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video and survey/3D scan.

1. Comply with requirements specified in Section 01 32 33 - Photographic Documentation.
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 - Temporary Facilities and Controls.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and

finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least two hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling."

D. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.

5. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction and/or recycle or dispose of them.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 032000 – ANCHORAGE IN CONCRETE

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes the following:

1. Requirements for cast-in-place concrete, mechanical, and adhesive anchors for concrete.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related work specified elsewhere includes:

1. Section 033000 – Cast-in-Place Concrete
2. Division 46 – Water and Wastewater Equipment

1.3 SUBMITTALS:

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

PART 2 - PRODUCTS

2.1 WEDGE TYPE ANCHORS

A. Anchors shall feature a stainless steel split expansion ring; a threaded stud body; and integral cone expander, nut and washer.

B. Anchor bodies smaller than 3/4 inch, excluding countersunk anchors, shall be made from AISI 316 and shall have the following minimum bolt fracture loads:

Anchor Diameter (in.)	Minimum Fracture Load (lb)
1/4	2,900
3/8	7,200
1/2	12,400
5/8	21,900

C. Anchor bodies 3/4 inch and larger, and all stainless steel post nut anchor bodies, shall be made from AISI 316 stainless steel and shall have the following minimum mechanical properties:

Anchor Diameter (in.)	Min. Tensile Strength (ksi)	Min. Yield Strength (ksi)
≤5/8	90	76
≥3/4	76	64

D. All nuts shall meet the dimensional requirements of ASTM F 594.

E. Washers shall meet the dimensional requirements of ANSI B18.22.1, Type A, plain.

F. Expansion sleeve for anchors shall be made from AISI 316. All nuts and washers shall be made from AISI 316.

G. Anchor size and depth shall be as shown on drawings.

H. Manufacturers
1. Trubolt as manufactured by ITW-Redhead, Inc.
2. Kwik Bolt 3 as manufactured by Hilti, Inc.
3. Or Equal

2.2 ADHESIVE ANCHOR SYSTEM

A. Adhesive anchor system shall consist of an injectable two-part epoxy.

B. Application system shall be in accordance with manufacturer's recommendations. System shall keep the two components separated until application of product directly into drilled hole.

C. System shall thoroughly blend the two parts by means of a static mixer nozzle.

D. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness.

E. Anchor rods shall be as shown on drawings or as specified in other sections of these specifications.
1. Anchor rods shall be furnished with chamfered ends so that either end will accept a nut and washer
2. Alternately,

F. Nuts and washers shall be provided for anchor rods in the same material as the anchor rod.

G. Manufacturers
1. HIT RE 500 Epoxy Adhesive Anchor as manufactured by Hilti, Inc.
2. G5 Adhesive Anchoring System as manufactured by ITW-Redhead, Inc.
3. Or Equal

2.3 CAST-IN-PLACE ANCHOR BOLTS

A. Cast-in-place anchors shall be made of corrosion resistant material in accordance with the dimensions shown on drawings.

1. As a minimum, provide A36 steel cast-in-place anchors.

B. If anchor bolt size is not shown on drawings, Contractor shall provide anchors capable of providing four (4) times the load applied to the bolt.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Layout anchors before drilling into concrete to ensure proper placement. Following manufacturer's recommendation for spacing of anchors. Notify Engineer of conflicts between existing conditions and requirements by manufacturer.

B. Install anchors per manufacturer's recommendations.

C. Embedment length shall be per manufacturer's recommendations for load conditions.

D. Check all equipment anchors after equipment has operated. Retighten any loose anchors.

END OF SECTION 033100

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 03 31 00 "Anchorage in Concrete"

C. Cast-in-Place concrete includes the following:

1. Foundations and footings
2. Slabs-on-grade
3. Foundation walls
4. Shear walls
5. Equipment pads and bases

1.3 REFERENCES

A. American Concrete Institute:

1. ACI 301 – Specifications for Structural Concrete
2. ACI 305R – Guide to Hot Weather Concreting
3. ACI 306.1 – Standard Specifications for Cold Weather Concreting
4. ACI 308.1 – Specification for Concrete Curing
5. ACI 318 – Building Code Requirements for Structural Concrete

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections

B. Manufacturer shall provide, at a minimum, the following information in accordance with Section 013300 Submittals:

1. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Engineer.

2. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.

3. Shop drawings for formwork indicating fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.

4. Samples of materials as requested by Engineer, including names, sources, and descriptions, as follows:

   a. Normal weight aggregates
   b. Fiber reinforcement
   c. Form liners

5. Laboratory test reports for concrete materials and mix design test.

6. Material certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

   1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
   2. ACI 318, "Building Code Requirements for Reinforced Concrete."
   3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
   4. ACI 350R-89, “Environmental Engineering Concrete Structures.”

B. Concrete Testing Service: Engage a testing agency acceptable to Engineer to perform material evaluation tests and to design concrete mixes.

C. Materials and installed work may require testing and retesting at any time during progress of Work. Allowances for materials testing are set in Section 01210. If no allowance is set, all testing and retesting of rejected materials for installed Work, shall be done at Contractor's expense.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section “Project Meetings” and the following:

1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

a. Contractor’s superintendent
b. Agency responsible for concrete design mixtures
c. Agency responsible for field quality control
d. Ready-mix concrete producer
e. Concrete subcontractor
f. Primary admixture manufacturers

1.7 DELIVERY, STORAGE AND HANDLING

A. Steel reinforcement: Deliver store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Engineer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

D. Forms for Cylindrical Columns and Supports: Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to support weight of placed concrete without deformation.

F. Carton Forms: Biodegradable paper surface, treated for moisture-resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

G. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

H. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.

1. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf), hot dip galvanized after fabrication and bending.

C. Epoxy Coated Reinforcing Bars: ASTM A 775.

D. Steel Wire: ASTM A 82, plain, cold drawn steel.

E. Welded Wire Fabric: ASTM A 185 welded steel wire fabric.

F. Deformed Steel Welded Wire Fabric: ASTM A 497.

G. Epoxy Coated Welded Wire Fabric: ASTM A 884, Class A.

H. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II. The cement shall be low alkali, less than 0.60 percent. All cement used in concrete that will be in contact with wastewater shall have a tricalcium aluminate (C_3A) content of less than 8 percent.

1. Use one brand of cement throughout Project unless otherwise acceptable to Engineer.

B. Fly Ash: ASTM C 618, Type F.

C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.

1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
2. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Engineer.

D. Lightweight Aggregates: ASTM C 330.

E. Water: Potable

F. Fiber Reinforcement: Polypropylene fibers engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C 1116, Type III.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Gilco Fibers, Cormix Construction Chemicals.
b. Durafiber, Durafiber Corp.
c. Fiberstand 100, Euclid Chemical Co.
d. Fibermesh, Fibermesh Co., Div. Synthetic Industries, Inc.
e. Forta CR, Forta Corp.
f. Grace Fibers, W.R. Grace & Co.
g. Polystrand, Metalcrete Industries

G. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.

H. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Air Tite, Cormix Construction Chemicals.
b. Air Mix or Perma Air, Euclid Chemical Co.
c. Darex AEA or Daravair, W.R. Grace & Co.
d. MB VR or Micro Air, Master Builders, Inc.
e. Sealtight AEA, W.R. Meadows, Inc.
f. Sika AER, Sika Corp.

I. Water-Reducing Admixture: ASTM C 494, Type A.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Chemtard, ChemMasters Corp.
b. PSI N, Cormix Construction Chemicals.
c. Eucon WR 75, Euclid Chemical Co.
d. WRDA, W.R. Grace & Co.
e. Pozzolith Normal or Polyheed, Master Builders, Inc.
f. Metco W.R., Metalcrete Industries.
g. Prokrete N, Prokrete Industries.
h. Plastocrete 161, Sika Corp.

J. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G. High-range water reducing admixtures shall be in all concrete used in the construction of structures designed to hold water.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Super P, Anti Hydro Co., Inc.
b. Cormix 200, Cormix Construction Chemicals.
c. Eucon 37, Euclid Chemical Co.
d. WRDA 19 or Daracem, W.R. Grace & Co.
e. Rheobuild or Polyheed, Master Builders, Inc.
f. Superslump, Metalcrete Industries.
g. PSPL, Prokrete Industries.
h. Sikament 300, Sika Corp.

K. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Q Set, Conspec Marketing & Manufacturing Co.
b. Lubricon NCA, Cormix Construction Chemicals.
c. Accelguard 80, Euclid Chemical Co.
d. Daraset, W.R. Grace & Co.
e. Pozzutec 20, Master Builders, Inc.
f. Accel Set, Metalcrete Industries.

L. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

    a. SI R Plus, Cormix Construction Chemicals.
    b. Eucon Retarder 75, Euclid Chemical Co.
    c. Daratard 17, W.R. Grace & Co.
    d. Pozzolith R, Master Builders, Inc.
    e. Protard, Prokrete Industries.

M. High Early Strength Concrete (may only be used when authorized by Engineer):

1. High Early Concrete shall not be used on Environmental Structures covered under ACI 350.
2. Shall be proprietary mix by Concrete Supplier that has documented experience with high early strength mix designs for a minimum of 10 years. High early strength mix design Submittal shall include: design mix materials descriptions, materials quantities/proportions, and compressive strength at 24 hours.

2.4 RELATED MATERIALS

A. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217-inch-thick (26-gage) galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized sheet steel, not less than 0.0336 inch thick (22 gage) with bent tab anchors. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.

C. Sand Cushion: Clean, manufactured or natural sand.

D. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:

1. Polyethylene sheet not less than 8 mils thick.
2. Water-resistant barrier consisting of heavy kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.

    a. Product: Subject to compliance with requirements, provide Moistop by Fortifiber Corporation.

E. Vapor Barrier: Premolded seven-ply membrane consisting of reinforced core and carrier sheet with fortified bitumen layers, protective weathercoating, and plastic antistick sheet. Water vapor transmission rate of 0.00 grains per sq. ft. per hr. when tested according to ASTM E 96, Method B. Provide manufacturer's recommended mastics and gusset tape.

1. Product: Subject to compliance with requirements, provide Sealtight Premoulded Membrane by W.R. Meadows, Inc.

F. Nonslip Aggregate Finish: Provide fused aluminum oxide granules or crushed emery as the abrasive aggregate for a nonslip finish, with emery aggregate containing not less than 50

percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, nonglazing, and unaffected by freezing, moisture, and cleaning materials.

G. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

H. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper
2. Polyethylene film
3. Polyethylene-coated burlap

I. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
   a. Highseal, Conspec Marketing and Mfg. Co.
   b. Sealco VOC, Cormix Construction Chemicals.
   c. Safe Cure and Seal, Dayton Superior Corp.
   d. Aqua Cure, Euclid Chemical Co.
   e. Dress & Seal WB, L&M Construction Chemicals, Inc.
   f. Masterkure 100W, Master Builders, Inc.
   g. Vocomp 20, W.R. Meadows, Inc.
   h. Metcure, Metalcrete Industries.
   i. Stontop CS1, Stonhard, Inc.

J. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

   a. Aquafilm, Conspec Marketing and Mfg. Co.
   b. Eucobar, Euclid Chemical Co.
   c. E Con, L&M Construction Chemicals, Inc.
   d. Confilm, Master Builders, Inc.
   e. Waterhold, Metalcrete Industries.

K. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch thick to feathered edges.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

   a. K-15, Ardex, Inc.
   b. Self-Leveling Wear Topping, W.R. Bonsal Co.
   c. Conflow, Conspec Marketing and Mfg. Co.
   d. Corlevel, Cormix Construction Chemicals.
   e. LevelLayer II, Dayton Superior Corp.
   f. Flo-Top Euclid Chemical Co.
   g. Gyp-Crete Gyp-Crete Corp.

h. Levelex, L&M Construction Chemicals, Inc.
i. Underlayment 110, Master Builders, Inc.
j. Stoncrete UL1, Stonhard, Inc.
k. Concrete Top, Symons Corp.
l. Thoro Underlayment Self-Leveling, Thoro System Products.

L. Bonding Agent: Polyvinyl acetate or acrylic base.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Polyvinyl acetate or acrylic base.
1) Superior Concrete Bonder, Dayton Superior Corp.
2) Euco Weld, Euclid Chemical Co.
3) Weld Crete, Larsen Products Corp.
4) Everweld, L&M Construction Chemicals, Inc.
5) Herculox, Metalcrete Industries.
6) Ready Bond, Symons Corp.

b. Acrylic or Styrene Butadiene:
1) Acrylic Bondcrete, The Burke Co.
2) Strongbond, Conspec Marketing and Mfg. Co.
3) Day-Chem Ad Bond, Dayton Superior Corp.
4) SBR Latex, Euclid Chemical Co.
5) Daraweld C, W.R. Grace & Co.
6) Hornweld, A.C. Horn, Inc.
7) Everbond, L&M Construction Chemicals, Inc.
8) Acryl-Set, Master Builders, Inc.
9) Intralok, W.R. Meadows, Inc.
10) Acrylpave, Metalcrete Industries.
11) Soncrete, Sonneborn-Chemrex
12) Stonlock LB2, Stonhard, Inc.
13) Strong Bond, Symons Corp.

M. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.

1. Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Burke Epoxy M.V., The Burke Co.
b. Spec Bond 100, Conspec Marketing and Mfg. Co.
c. Resi Bond (J 58), Dayton Superior.
d. Euco Epoxy System #452 or #620, Euclid Chemical Co.
e. Epoxtite Binder 2390, A.C. Horn, Inc.
f. Epabond, L&M Construction Chemicals, Inc.
g. Concresive Standard Liquid, Master Builders, Inc.
h. Rezi Weld 1000, W.R. Meadows, Inc.
i. Metco Hi Mod Epoxy, Metalcrete Industries.
j. Sikadur 32 Hi Mod, Sika Corp.
k. Stonset LV5, Stonhard, Inc.

l. R-600 Series, Symons Corp.

2.5 PROPORTIONING AND DESIGNING MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.

1. Do not sue the same testing agency for field quality control testing.
2. Limit use of fly ash to not exceed 25 percent of cement content by weight.

B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been approved by Engineer.

C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:

1. Class A 4000-psi, 28-day compressive strength; 0.45 maximum with 6% air-entrainment (± 1%). Use for all structures designed to be watertight. Use of HRWR (High-range water reducer) may be used with approved mix design.
2. Class B 3000-psi, 28-day compressive strength; water-cement ratio, 0.54 maximum (air-entrained).
3. Mud-mat 2500-psi, 28-day compressive strength; water-cement ratio, 0.58 maximum

D. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows: (W/C ratio is defined by weight as the maximum water/cementitious material ratio, including the use of flyash as a cementitious component.

1. Subjected to freezing and thawing: W/C 0.45.
2. Subjected to deicers/watertight: WC 0.40.
3. Subjected to brackish water, salt spray, or deicers: W/C 0.40.

E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
2. Reinforced foundation systems: Not less than 1 inch and not more than 4 inches.
3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-4 inch slump concrete.
4. Other concrete: Not more than 4 inches.

F. Lightweight Structural Concrete: Lightweight aggregate and concrete shall conform to ASTM C 330. Proportion mix to produce concrete with a minimum compressive strength of 3000 psi at 28 days and a calculated equilibrium unit weight of 110 pcf plus or minus 3 pcf as determined by ASTM C 567. Concrete slump at the point of placement shall be the minimum necessary for efficient mixing, placing, and finishing. Maximum slump shall be 6 inches for pumped concrete and 5 inches elsewhere. Air entrain concrete exposed to weather according to ACI 301 requirements.

G. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in Work.

H. Fiber Reinforcement: Add to mix at rate of 1.5 lb per cu. yd. unless otherwise recommended by manufacturer.

2.6 ADMIXTURES

A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.

B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).

C. Use high-range water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, Engineering concrete, parking structure slabs, concrete required to be watertight, and concrete with water-cement ratios below 0.50.

D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits.

1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:

    a. 4.5 percent (moderate exposure); 5.5 percent (severe exposure) for 1-1/2-inch maximum aggregate.
    b. 4.5 percent (moderate exposure); 6.0 percent (severe exposure) for 1-inch maximum aggregate.
    c. 5.0 percent (moderate exposure); 6.0 percent (severe exposure) for 3/4-inch maximum aggregate.
    d. 5.5 percent (moderate exposure); 7.0 percent (severe exposure) for 1/2-inch maximum aggregate.

2. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.

E. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

2.7 CONCRETE MIXING

A. Job-Site Mixing: Mix concrete materials in appropriate drum-type batch machine mixer. For mixers of 1 cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than 1 cu. yd., increase minimum 1.

1. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

B. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.

1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2. All batch plants and equipment including mixer trucks or other delivery equipment shall meet requirements of the NRMCA and be certified by the Georgia Department of Transportation as a class A or Class B plant.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

B. Samples shall be collected from each pour made and test certificates shall be furnished to the Engineer by an approved commercial testing laboratory. All concrete samples shall be clearly identified so the location in which the sampled concrete was placed can be determined in the event of a compressive strength less than that specified. The cost of all concrete and other material testing shall be included in the lump sum bid for the work.

C. Unless otherwise specified, the floors of all structures holding water, the entrance stoops of the buildings, the sidewalks, walkways and other surfaces on which operating personnel will walk, shall be provided with a brush or broom finish.

D. A detailed layout of the reinforcing steel in the several structures shall be submitted to the Engineer for approval prior to fabrication.

E. All exterior concrete surfaces that are not wetted or subject to splash shall be rubbed to remove all voids and form marks, and then coated with a two coat modified epoxy concrete paint, Indurall.

F. All surfaces to be coated shall first be cured for at least 40 days, and then inspected for any signs of any remaining moisture. Concrete surfaces shall be swept clean and dry prior to application of the paint.

G. Each of the two coats shall be applied to an 8 mil DFT per coat and cured in strict accordance with the manufacturers directions. A representative of the paint company shall visit the site to give specific instructions prior to beginning the work.

3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

1. Provide Class A tolerances for concrete surfaces exposed to view.
2. Provide Class C tolerances for other concrete surfaces.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.

D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER/BARRIER INSTALLATION

A. General: Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.

B. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape

3.4 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.

1. Reinforcing steel shall be placed in accordance with the drawings and reviewed shop drawings and the applicable requirements of the “Codes and Standards” herein before specified.

2. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Engineer.

D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports with 16 gauge steel tie wire to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. In all structures, the horizontal reinforcing bars shall be wrapped around the corners of the wall and the horizontal baffles, weirs, beams and other transverse members shall be doweled into the walls.

E. Splices:

1. Laps of splices, where indicated on the drawings, shall be adequate to transfer stress by bond.
2. Lap Splices:

    a. For Environments Structure: Lap bars according to ACI 350, Class B.
    b. For Other Structures: Lap bars according to ACI 318, Class B unless otherwise noted.
    c. For Masonry: Lap bars according to ACI 350.
3. Wherever possible, splices of adjacent bars shall be staggered.
4. All splices not indicated shall be subject to acceptance by the Engineer.
5. Mechanical connections for reinforcing bars may be used subject to acceptance by the Engineer.
6. Welded wire fabric shall be overlapped wherever successive mats are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than the spacing of the cross wires plus 2 inches.

F. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Engineer.

B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.

C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.

D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

E. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

F. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

3.6 INSTALLING EMBEDDED ITEMS

A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

B. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.

C. Install dovetail anchor slots in concrete structures as indicated on drawings.

D. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.7 PREPARING FORM SURFACES

A. Forms shall be set and braced to provide exterior surfaces that are straight and true both horizontally and vertically, within a maximum tolerance of ± ¼" in a length of 40 feet.

B. General Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.

C. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

D. All exposed surface corners and edges shall be provided with a formed 1" chamfer in all directions

3.8 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.

C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location. Tremies shall be used where required in order to prevent segregation and splashing. Concrete that has splashed and dried on reinforcing prior to embedment shall be removed by acceptable methods. Fresh concrete shall be protected from rains, running water and damage. The Contractor shall always have available for prompt use sufficient protective covering.

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations
3. Maintain reinforcement in position on chairs during concrete placement.

F. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

G. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

H. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas..
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.

3.9 FINISHED FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

3.10 MONOLITHIC SLAB FINISHES

A. Scratch Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.

1. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.

1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F(F) 20 (floor flatness) and F(L) 17 (floor levelness) measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.

D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

E. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

F. Nonslip Aggregate Finish: Apply nonslip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and where indicated.

1. After completing float finishing and before starting trowel finish, uniformly spread 25 lb of dampened nonslip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with

surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as specified.

2. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose nonslip aggregate.

G. Colored Wear-Resistant Finish: Apply a colored wear-resistant finish to monolithic slab surface indicated.

1. Apply dry shake materials for the colored wear-resistant finish at a rate of 100 lb per 100 sq. ft., unless a greater amount is recommended by material manufacturer.
2. Cast a trial slab approximately 10 feet square to determine actual application rate, color, and finish, as acceptable to Engineer.
3. Immediately following the first floating operation, uniformly distribute with mechanical spreader approximately two-thirds of the required weight of the dry shake material over the concrete surface, and embed by power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material with overlapping applications to ensure uniform color, and embed by power floating.
4. After broadcasting and floating, apply a trowel finish as specified. Cure slab surface with a curing compound recommended by the dry shake material manufacturer. Apply the curing compound immediately after the final finishing.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Steels Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and trowel-finish concrete surfaces.

E. Pipe Penetrations: provide pipe sleeves or collars wherever pipe penetrations of walls or slabs are required.

3.12 CONCRETE CURING AND PROTECTION

A. General: All concrete shall be cured in accordance with ACI Standard 308, “Recommended Practice for Curing Concrete” except that the concrete shall be protected from direct rays of sun for at least a three-day period. Protect freshly placed concrete from premature drying and

excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

C. All concrete surfaces on hydraulic structures shall be kept continuously moist for a period of not less than seven days by direct application of potable water by means of sprinklers or perforated piping. The water shall be clean and free from any elements that might cause permanent discoloration of the concrete. Application of plastic film or liquid membrane forming curing compounds is not acceptable for use on concrete structures designed to contain water.

D. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.

E. Provide moisture curing by the following methods:

1. Keep concrete surface continuously wet by covering with water.
2. Use continuous water-fog spray
3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.

F. Provide moisture-retaining cover curing as follows:

1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

G. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:

1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

H. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

I. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.

1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

J. The Contractor shall protect finish surfaces from damage, stains and abrasions. The concrete surfaces including floors and stairs or edges likely to be marred during construction shall be protected by leaving the forms in place or covering the concrete in a manner satisfactory to the Engineer

3.13 REMOVING FORMS

A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 3 days after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. The Engineer will accept a reduction to 24 hours so long as the contractor can demonstrate that the concrete will not be damaged by the form removal and the wet curing requirements are maintained.

C. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

D. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.14 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Engineer.

B. Mix dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.

1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent. Ridges and bulges shall be removed by careful chipping or tooling, followed by rubbing with a grinding stone.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

D. Repairing Unformed Surfaces: Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Engineer.
4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

E. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Place dry-pack before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

F. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar. If in the process of cutting out defective areas, reinforcing bars are exposed, the chipping shall continue until a depth of 2 " behind the exposed reinforcement. The grout shall be installed in strict accordance with the recommendations of the manufacturer.

G. Repair methods not specified above may be used, subject to acceptance of Engineer.

3.15 CONCRETE STRUCTURES SHRINKAGE CRACK REPAIR PROCEDURE

A. All concrete structures that are to hold water shall first be cured for 30 days, and then filled with clean water and allowed to stand for at least 10 days. Then, the structure shall be carefully examined on the floor and inside and outside surfaces for shrinkage cracks, and other sources of seepage or leaks. All sources of seepage and obvious cracks shall then be repaired.

B. The repair procedure to be used shall be to drill 5/8" diameter holes diagonally along each crack to intercept the crack near the center of the wall. A high pressure packer shall then be fitted into each drill hole, and high pressure water pumped into the packer to clean out the interior of the crack, and to minimize the number of holes that must be drilled. When all the holes that are necessary have been drilled and flushed with water, plural component pumping equipment shall then be used to inject a dense polyurethane resin to seal the crack.

C. The repairs shall be conducted by a skilled and experienced contractor that is familiar with this procedure, such as Structural Solutions, Wedowee, Alabama.

D. Within 30 days of the expiration of the one year warranty period on the plant, the Contractor shall return to the site, re-inspect all crack repairs, and then rub the entire exterior area where the cracking occurred with neat cement grout and carborumdum stone to remove all visible evidence of leaks, cracks, and repairs.

3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. General: The Contractor will employ a testing agency to perform tests and to submit test reports to the Engineer.

B. Sampling and testing for quality control during concrete placement may include the following, as directed by Engineer.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

    a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
    b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
    c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
    d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
    e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
3. When total quantity of a given class of concrete is less than 50 cu. yd., Engineer may waive strength testing if adequate evidence of satisfactory strength is provided/
4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

C. Test results will be reported in writing to Engineer, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

F. Contractor shall “Wet-Test” all water retaining structures in accordance with Section 01030 before the structure is backfilled.

END OF SECTION 03 30 00

SECTION 03 39 00 - CONCRETE CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Initial and final curing of horizontal and vertical concrete surfaces.

B. Related Requirements

1. Section 03 30 00 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frames, slabs on fill or grade, and other concrete components associated with construction.

1.2 REFERENCE STANDARDS

A. American Concrete Institute

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 302.1 - Guide to Concrete Floor and Slab Construction.
3. ACI 308.1 - Specification for Curing Concrete.
4. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
5. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

B. ASTM International

1. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
2. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
3. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
4. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's information on curing compounds, mats, paper, and film, including compatibilities and limitations.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Qualifications Statemen

1. Submit qualifications for manufacturer.

1.4 QUALITY ASSURANCE

A. Perform Work according to ACI 350.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Membrane-Curing Compound

1. Description: Comply with ASTM C171.

B. Water: Potable; not detrimental to concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Verify that substrate surfaces are ready to be cured.

3.2 APPLICATION

A. Horizontal Surfaces

1. Comply with ACI 308.1, using Section 7 (Addition of Water: Water-Absorbent Materials); Section 3 (Moisture Retention: Liquid Membrane-Forming Curing Compounds).

2. Absorptive Mat

a. Saturate burlap-PE and place burlap-side down over floor slab areas.
b. Lap ends and sides.
c. Maintain in place for seven days.

3. Membrane-Curing Compound: Apply curing compound uniformly at the rate recommended by the manufacturer.

B. Vertical Surfaces

1. Comply with ACI 308.1, using Water Absorbent Materials method.
2. Spraying: Spray water over surfaces and maintain wet for seven days.
3. Membrane-Curing Compound: Apply compound uniformly at the rate recommended by the manufacturer.

3.3 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not permit traffic over unprotected floor surfaces.

3.4 ATTACHMENTS

A. Liquid Retaining Structures

1. Description: Absorptive mats.
2. Type: Burlap-PE.

B. Elevated Slabs

1. Description: Membrane-curing compound.
2. Type: Acrylic.
3. Color: Clear.

C. Concrete Pavement

1. Description: Membrane-curing compound.
2. Color: Opaque.

D. Other Floor Areas

1. Description: Membrane-curing compound.
2. Type: Acrylic.
3. Color: Translucent.

END OF SECTION 03 39 00

SECTION 03 41 00 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Precast structural concrete.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete for concrete topping and placing connection anchors in concrete.
2. Section 05 12 00 - Structural Steel Framing for furnishing and installing connections attached to structural-steel framing.
3. Section 05 50 00 - Metal Fabrications for kickers and other miscellaneous steel shapes.
4. Section 07 19 00 - Water Repellents for water-repellent finish treatments.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.

C. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate separate face and backup mixture locations and thicknesses.
5. Indicate type, size, and length of welded connections by AWS standard symbols.
6. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
7. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
8. Include and locate openings larger than 10 inches. Where additional structural support is required, include header design.

9. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
10. Indicate relationship of precast structural concrete units to adjacent materials.
11. Indicate estimated camber for precast floor slabs with concrete toppings.
12. Indicate shim sizes and grouting sequence.
13. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Material Certificates: For the following:

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Insulation.
6. Structural-steel shapes and hollow structural sections.

D. Material Test Reports: For aggregates, by a qualified testing agency.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance, to erect Category S1 - Simple AND/OR Category S2 - Complex Structural Systems.

C. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."
2. AWS D1.4, "Structural Welding Code - Reinforcing Steel."

1.6 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on non-staining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements, to design precast structural concrete units.

B. Design Standards: Comply with ACI 318 and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

C. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.

D. Structural Performance: Provide precast structural concrete units and connections capable of withstanding the design loads within limits and under conditions indicated in the plans and specifications and as required by the IBC.

1. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318.

a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of plus 20 to plus 100 deg F.

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed.

C. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615, Grade 60 or ASTM A 706, deformed bars, assembled with clips.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497 or ASTM A 1064, flat sheet.

F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.4 PRESTRESSING TENDONS

A. Pretensioning Strand: ASTM A 416, Grade 250 or Grade 270, uncoated, seven-wire, low-relaxation strand.

B. Unbonded Post-Tensioning Strand: ASTM A 416, Grade 270, uncoated, seven-wire, low-relaxation strand.

C. Post-Tensioning Bars: ASTM A 722, uncoated high-strength steel bar.

2.5 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.

B. Supplementary Cementitious Materials:

1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C 618, Class N.
3. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse aggregates complying with required class. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

1. Water-Reducing Admixtures: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
7. Plasticizing Admixture: ASTM C 1017, Type I.
8. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
9. Corrosion-Inhibiting Admixture: ASTM C 1582.

2.6 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36.

B. Carbon-Steel-Headed Studs: ASTM A 108, Grade 1010 through 1020, cold finished, AWS D1.1, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.

C. Carbon-Steel Plate: ASTM A 283, Grade C.

D. Malleable-Iron Castings: ASTM A 47, Grade 32510 or Grade 35028.

E. Carbon-Steel Castings: ASTM A 27, Grade 60-30.

F. High-Strength, Low-Alloy Structural Steel: ASTM A 572.

G. Carbon-Steel Structural Tubing: ASTM A 500, Grade B or Grade C.

H. Wrought Carbon-Steel Bars: ASTM A 675, Grade 65.

I. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.

J. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 OR SSPC-Paint 25 according to SSPC-PA 1.

K. Welding Electrodes: Comply with AWS standards.

L. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.7 BEARING PADS

A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D 2240; minimum tensile strength 2250 psi, ASTM D 412.
2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D 2240; capable of supporting a compressive stress of 3000 psi with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D 2240; complying with AASHTO's "AASHTO LRFD Bridge Design Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless- or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

2.8 ACCESSORIES

A. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install structural precast concrete units.

2.9 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218.

B. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881, of type, grade, and class to suit requirements.

2.10 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Limit use of fly ash to 20 percent replacement of portland cement by weight and ground granulated blast-furnace slag to 20 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 116 when tested according to ASTM C 1218.

D. Normal-Weight Concrete Mixtures: Proportion face and backup mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: For structural precast concrete with an Engineerural finish, limit water absorption to 6 percent by weight or 14 percent by volume, tested according to ASTM C 642, except for boiling requirement.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.11 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Edge and Corner Treatment: Uniformly chamfered.

2.12 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1 and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than 6 inches in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified in ASTM A 775, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

H. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

I. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

J. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

K. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

L. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

M. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Engineer's approval.

2.13 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

2.14 COMMERCIAL FINISHES

A. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch in width that occur more than once per 2 sq. in. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch.

B. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

2.15 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

B. Strength of precast structural concrete units is considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

C. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

D. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Engineer's approval. Engineer reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

D. Field cutting of precast units is not permitted without approval of Engineer.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable requirements in AWS D1.1 and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil-thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780.
3. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

1. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
4. Place grout end cap or dam in voids at ends of hollow-core slabs.
5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
6. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Engineer.

3.4 FIELD QUALITY CONTROL

A. Visually inspect field welds and test according to ASTM E 165 or to ASTM E 709 and ASTM E 1444. High-strength bolted connections are subject to inspections.

B. Testing agency will report test results promptly and in writing to Contractor and Engineer.

C. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.5 REPAIRS

A. Repair precast structural concrete units if permitted by Engineer.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.

C. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

D. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Engineer.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03 41 00

SECTION 036000 - GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Portland cement grout.
2. Rapid-curing epoxy grout.
3. Nonshrink cementitious grout.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer information regarding grout.

B. Manufacturer's Certificate: Products meet or exceed specified requirements.

C. Manufacturer Instructions: Mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.

D. Qualifications Statement:

1. Qualifications for manufacturer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials according to manufacturer instructions.

B. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT GROUT

A. Portland Cement: Comply with ASTM C150/C150M, Type I and II.

B. Water:

1. Potable.

2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:

    a. Corrosion of steel.
    b. Volume change increasing shrinkage cracking.
    c. Efflorescence.
    d. Excess air entraining.

C. Fine Aggregate:

1. Washed natural sand.
2. Gradation:

    a. Comply with ASTM C33/C33M.
    b. Represented by smooth granulometric curve within required limits.
3. Free from injurious amounts of organic impurities according to ASTM C40/C40M.

D. Mix:

1. Portland cement, sand, and water.
2. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 RAPID-CURING EPOXY GROUT

A. Description:

1. High-strength, three-component epoxy grout formulated with thermosetting resins and inert fillers.
2. Rapid-curing, high adhesion, and resistant to ordinary chemicals, acids, and alkalis.

B. Performance and Design Criteria:

1. Compressive Strength:

    a. Comply with ASTM C579.

2. Minimum Tensile Strength:

    a. Comply with ASTM C307.

3. Coefficient of Expansion:

    a. Comply with ASTM C531.

4. Shrinkage:

    a. None.
    b. Comply with ASTM C827/C827M.

2.3 NONSHRINK CEMENTITIOUS GROUT

A. Description:

1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, and no chlorides.

B. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to CRD-C621 for Type D nonshrink grout:

a. Setting Time:

1) Initial: Approximately two hours.
2) Final: Approximately three hours.
3) Comply with ASTM C191.

b. Maximum Expansion: 0.10 to 0.40 percent.
c. Compressive Strength:

1) Comply with CRD-C621.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify areas to receive grout.

3.2 PREPARATION

A. Remove defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by brushing, hammering, chipping, or other similar means until sound and clean concrete surface is achieved.

B. Roughen concrete lightly, but not to interfere with placement of grout.

C. Remove foreign materials from metal surfaces in contact with grout.

D. Align, level, and maintain final positioning of components to be grouted.

E. Saturate concrete surfaces with clean water, and then remove excess water.

3.3 INSTALLATION

A. Formwork:

1. Construct leakproof forms anchored and shored to withstand grout pressures.

2. Install formwork with clearances to permit proper placement of grout.

B. Mixing:

1. Nonshrink Cementitious Grout:

a. Mix and prepare according to manufacturer instructions.
b. Minimum Compressive Strength: 2500 psi in 48 hours and 5000 psi in 28 days.

C. Placing of Grout:

1. Do not use pneumatic-pressure or dry-packing methods.
2. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or by using wet burlap method.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three days.

3.4 FIELD QUALITY CONTROL

A. Testing:

1. Tests of grout components may be performed to ensure compliance with specified requirements.

END OF SECTION 036000

SECTION 04 00 10 – UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of each type of masonry work is indicated on the Drawings and Schedules.

B. This Section includes the following:

1. Concrete unit masonry.
2. Decorative concrete masonry units.
3. Standard grey color mortar at painted interior and concealed locations and custom colored mortar at exposed exterior and other locations.
4. Anchors, ties, reinforcing, insulation, masonry accessories, concealed flashings, and steel lintels.
5. Cavity Drainage Material.
6. Water Repellents:

    a. Field mixed as integral component of all exterior mortar and grout.
    b. Field applied to all completed exterior masonry work.

1.2 RELATED DOCUMENTS:

A. Related work specified elsewhere includes:

1. Section 03 30 00 – Cast-in-Place Concrete
2. Section 07 21 19 – Foamed-In-Place Insulation
3. Section 07 92 00 – Joint Sealants
4. Section 09 96 00 - High-Performance Coatings

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide concrete unit masonry that develops the following installed compressive strengths (f'_m): f'_m = 1,500 psi.

1.4 SUBMITTALS

A. General:

1. Submit the following in accordance with Conditions of the Contract.
2. Manufacturer's product data for each different masonry unit, accessory, water repellents, and other manufactured product indicated, including certifications that each item and type complies with specified requirements.

    a. Include instructions for handling, storage, installation, and protection.

B. Shop drawings for reinforcing, if any, detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315 "Details and Detailing of Concrete Reinforcing" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement.

C. Samples for initial verification purposes, the following:

1. Colored masonry mortar samples to coordinate with brick color scheme selected by Owner.
2. Split face CMU color samples, showing full extent of colors and variations anticipated, for each standard and special shape unit.

1.5 QUALITY ASSURANCE

A. Fire Performance Characteristics: Where indicated, provide materials and construction identical to those of assemblies whose fire resistance has been determined per ASTM E 119 by a testing and inspecting organization, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

B. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

C. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

D. Single-Source Responsibility for Water Repellents: Obtain integrated applied water repellents from a single manufacturer for the entire project.

1. Verify full compatibility with any other coatings, fluid applied waterproofing, etc., prior to application of this and other products. Notify Engineer in writing and in detail, of any incompatible products, prior to any application, and await Engineer’s written direction on how to proceed.

E. Field-Constructed Mock-Ups: Prior to installation of unit masonry (min 30 days), erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated for final unit of Work:

1. Locate mock-ups on site in locations indicated or, if not indicated, as directed by Engineer.
2. Build mock-ups for the following types of masonry in sizes of approximately 4 feet long by 4 feet high by full thickness, including face and backup wythes as well as accessories.

   a. Each type of exposed unit masonry construction, utilizing mortar color and joint detail selected and/or specified.
   b. Incorporate integral and applied water repellents, the same as required for the completed work.

3. Notify Engineer one week in advance of the dates and times when mock-ups will be erected.

4. Protect mock-ups from the elements with weather-resistant membrane.
5. Retain and maintain mock-ups during construction in undisturbed condition as standard for judging completed unit masonry construction.

    a. When directed, demolish and remove mock-ups from Project site.

F. Subcontractors:

1. Subcontractors shall have been established in their own firms for at least 5 verifiable years and shall have successfully completed at least 4 verifiable projects of this size, scope, and complexity. Furnish names and telephone numbers of General Contractors for each project submitted for consideration of experience requirements.

1.6 DELIVER, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.

C. Store cementitious materials and insulation off the ground, under cover, and in dry location.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

F. Store water repellents in strict accordance with manufacturer's written recommendations, off of ground, under cover, and otherwise as required to protect from damage, contamination, etc.

1.7 PROJECT CONDITIONS

A. Protection of Masonry:

1. During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
2. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
3. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention:

1. Prevent grout, mortar, and soil from staining the face of masonry to be left exposed, painted, and/or to receive any other coatings. Remove immediately any grout, mortar, and soil that come in contact with such masonry.
2. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface, until landscaping or other improvements indicated adjacent to completed masonry work are in place.
3. Protect sills, ledges, and projections from mortar droppings.
4. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes from mortar droppings, coatings, water repellents, and/or any other damage.

D. Clean Air Space:

1. Prevent grout and mortar from occurring in, bridging, forming ledges, and/or filling air space between masonry and back-up walls.
2. Remove excess grout and mortar flush with back side of masonry as work progresses, using trowel, board pulled up through air space, or other effective and acceptable method(s), pre-approved by Engineer.

E. Cold-Weather Construction: Comply with referenced unit masonry standard for cold-weather construction and the following:

1. Do not lay masonry units that are wet or frozen.
2. Remove masonry damaged by freezing conditions.

F. Hot-Weather Construction: Comply with referenced unit masonry standard, or applicable Building Code requirements.

G. Thoroughly clean and rinse all masonry prior to application of water repellents, water-proofing, coatings, paint, etc. Comply with written recommendations of each manufacturer of products to be applied to masonry work.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.

2.2 CONCRETE MASONRY UNITS

A. General:

1. Comply with requirements indicated below applicable to each form of concrete masonry unit required.
2. Provide special shapes where indicated and as follows:

a. For lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.

b. Square-edged units for outside corners, except where indicated as bullnose, or otherwise required.

3. Size: Provide concrete masonry units complying with requirements indicated below for size that are manufactured to specified face dimensions within tolerances specified in the applicable referenced ASTM specification for concrete masonry units.
4. Concrete Masonry Units:

a. Manufacturer's standard 16-inches long x 8-inches x 8-inches nominal dimension, unless indicated otherwise on Drawings.
b. Provide manufactured 1/4-notched foundation block and other preformed shapes, if any, as indicated on the Drawings.

5. Concrete Building Brick: Standard Modular, 3-5/8-inches wide by 2-1/4-inches high by 7-5/8-inches long.
6. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

B. Hollow Load-Bearing Concrete Masonry Units - (CMU):

1. ASTM C 90, Grade N, Type 1.
2. Unit Compressive Strength: Provide units with minimum average net area compressive strength of 1,900 psi.
3. Weight Classification: Lightweight, at above-grade locations.
4. Weight Classification: Normal weight, at below-grade locations.

C. Concrete Building Brick:

1. ASTM C 55, Grade N, Type 1.
2. Unit Compressive Strength: Provide units with minimum average net area compressive strength of 3,500 psi.
3. Weight Classification: Lightweight.

B. Decorative CMUs: ASTM C90.

1. Density Classification: Normal weight.
2. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.
3. Pattern and Texture:

1. Standard pattern, split-face finish.

(ii) Colors: As selected by Engineer from manufacturer's full range.

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement for Grout: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce required mortar color.

B. Masonry Cement:

1. ASTM C 91.

2. For colored pigmented mortars use premixed colored masonry cements of formulation required to produce color to match that at existing facilities indicated.

C. Sand: ASTM C 144.

D. Hydrated Lime: ASTM C 207, Type S.

E. Aggregate for Mortar:

1. ASTM C 144, except for joints less than 1/4 inch use aggregate graded with 100 percent passing the No. 16 sieve.
2. White Mortar Aggregates: Natural white sand or ground white stone.

F. Aggregate for Grout: ASTM C 404.

G. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars.

H. Water: Clean and potable.

2.4 REINFORCING STEEL

A. General: Provide reinforcing steel complying with requirements of referenced unit masonry standard and this article.

B. Steel Reinforcing Bars: Billet steel complying with ASTM A 615.

2.5 JOINT REINFORCEMENT

A. General:

1. Provide joint reinforcement complying with requirements of referenced unit masonry standards and this article, formed from the following:
2. Galvanized carbon steel wire, coating class as required by referenced unit masonry standard for application indicated, complying with ASTM A 82, hot-dipped galvanized after fabrication to comply with ASTM A 153, class B-2 coating (1.5 ounces per square foot).

B. Description: Provide welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet in widths approximately 2 inches less than nominal width of walls and partitions, as required for full mortar embedment and mortar coverage of not less than 5/8 inch at exterior sides and not less than 1/2 inch elsewhere; with prefabricated corner and tee units, and complying with requirements indicated below, unless otherwise indicated:

1. Wire Diameter for Side Rods: 09 gage
2. Wire Diameter for Cross Rods: 0.1483 inch (9 gage).
3. For single-wythe CMU masonry provide type as follows with single pair of side rods:

a. Truss design with continuous diagonal cross rods spaced not more than 16 inches o.c.

4. For multi-wythe masonry provide type as follows:

   a. Truss design with diagonal cross rods spaced not more than 16 inches o.c. and number of side rods as follows:

      1) Number of Side Rods for Multi-wythe Concrete Masonry: One side rod for each face shell of hollow masonry units more than 4 inches in nominal width plus one side rod for each wythe of masonry 4 inches or less in nominal width.

C. Manufacturers: Subject to compliance with requirements, provide joint reinforcement by one of the following:

1. AA Wire Products Co.
2. Dur-O-Wal, Inc.
3. Heckman Building Products, Inc.
4. Hohmann & Barnard, Inc.
5. Masonry Reinforcing Corp. of America.
6. National Wire Products Industries.
7. Southern Construction Products, Inc.

2.6 TIES AND ANCHORS, GENERAL

A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standards and of this article.

B. Galvanized Carbon Steel Wire:

1. ASTM A 82, coating class as required by referenced unit masonry standard for application indicated.
2. Wire Diameter: 0.1875 inch.

C. Galvanized Steel Sheet as follows: ASTM A 366 (commercial quality) cold-rolled carbon steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153, Class B2 (for unit lengths over 15 inches) and Class B3 (for unit lengths under 15 inches), for sheet metal ties and anchors exposed to the weather and not completely embedded in mortar and grout.

D. Thickness of Steel Sheet Galvanized After Fabrication: Uncoated thickness of steel sheet hot-dip galvanized after fabrication:

1. 0.0598 inch (16 gage).

E. Steel Plates and Bars: ASTM A 36, hot-dip galvanized to comply with ASTM A 123 or ASTM A 153, Class B3, as applicable to size and form indicated.

F. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AA Wire Products Co.
2. Dur-O-Wal, Inc.
3. Heckman Building Products, Inc.
4. Hohmann & Barnard, Inc.

5. Masonry Reinforcing Corp. of America.
6. National Wire Products Industries.
7. Southern Construction Products, Inc.

2.7 ADJUSTABLE ANCHORS, FOR CONNECTING MASONRY TO STRUCTURAL FRAMEWORK

A. General: Two-piece assemblies as described below allowing vertical or horizontal differential movement between wall and framework parallel to plane of wall, but resisting tension and compression forces perpendicular to it.

B. For anchorage to new concrete, provide manufacturer's standard with dovetail anchor section formed from sheet metal and triangular-shaped wire tie section sized to extend within 1-inch of masonry face and 16-inches o.c. vertically and 24-inches o.c. horizontally (minimum).

C. For anchorage to steel framework provide manufacturer's standard anchors with crimped 1/4-inch-diameter wire anchor section for welding to steel and triangular-shaped wire tie section sized to extend within 1-inch of masonry face and 24-inches o.c. vertical (minimum):

1. Wire Diameter: 0.1875 inch.

2.8 RIGID ANCHORS AT LOCATIONS INDICATED OR REQUIRED

A. Provide straps of form and length indicated, or required (if any), fabricated from metal strips 1-1/2-inches wide by 1/4-inch thick.

2.9 MISCELLANEOUS ANCHORS AT LOCATIONS INDICATED OR AS REQUIRED BY PROJECT CONDITIONS

A. Unit Type Masonry Inserts new in Concrete: Cast iron or malleable iron inserts of type and size indicated.

B. Dovetail Slots for New Concrete: Furnish dovetail slots, with filler strips, of slot size indicated, fabricated from 0.0336-inch (22-gage) galvanized sheet metal.

C. Anchor Bolts: Steel bolts complying with A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations, as indicated on the Drawings, or if not indicated, as required for the intended use:

1. Headed bolts.
2. Nonheaded bolts, straight.
3. Nonheaded bolts, bent in manner indicated.

2.10 ADJUSTABLE MASONRY VENEER ANCHORS FOR CONNECTING MASONRY TO METAL STUDS AND WHERE THRU-WALL JOINT REINFORCING CANNOT BE USED

A. General: Provide 2-piece assemblies where required (if any), allowing vertical or horizontal differential movement between wall and framework parallel to plane of wall, but resisting tension and compression forces perpendicular to it; for attachment over sheathing to metal studs or masonry back-up and with the following structural performance characteristics:

1. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in either tension or compression without deforming over, or developing play in excess of, 0.05-inch.

B. Screw-Attached (to studs) and expansion anchor attached (to existing masonry back-up) Masonry Veneer Anchors:

1. Units consisting of wire tie section and metal anchor section complying with the following requirements:

a. Wire Tie Shape: Z-shaped pintel.
b. Wire Tie Length: As required to extend 1-1/2-inches into masonry wythe of veneer face.

2. Anchor Section: 16-gauge sheet metal plate, with screw hole(s) at top and outward legs bent to form leg to bridge insulation and abut studs, or masonry; of overall size as required for intended application.

C. Steel Drill Screws for Steel Studs or Masonry: ASTM C 954 except manufactured with hex washer head and neoprene washer, #10 diameter by length required to penetrate steel stud flange by not less than 3-exposed threads, and masonry but not less than 1-inch, and with corrosion protective coating; as recommended by manufacturer for the intended use.

D. Products: Subject to compliance with requirements, provide products of one of the following manufacturers:

1. Jim Taylor, Inc./Ty-wal.
2. National Wire Products Industries/Pos-i-tie.
3. Elco Industries/Tapcon
4. Hilti Corporation
5. Rawl Plug Co., Inc. (Zamac Nail-in anchor system, additional acceptable fasteners for masonry veneer and some other anchors).

E. Galvanize all components

2.11 POST-INSTALLED ANCHORS, WHERE INDICATED OR AS REQUIRED

A. Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing laboratory.

1. Type: Expansion anchors.
2. Material: Zinc-plated carbon steel, hot-dipped galvanized after fabrication, or Zamac, or other non-corrosive or coated material in compliance with requirements and submitted for prior approval.

3. For post-installed anchors in grouted concrete masonry units: Capability to sustain, without failure, a load equal to 6-times loads imposed by masonry.

2.12 EMBEDDED FLASHING MATERIALS

A. Rubberized Asphalt and Cross-Laminated Polyethylene Film Composite Sheet Flashing:

1. Flexible sheet flashings especially formulated from rubberized asphalt and composite with materials, to remain flexible and waterproof in concealed masonry applications, black in color and of thickness indicated below:

a. Thickness: 40-mils.

2. Product/Manufacturer: "Perm-A-Barrier," as manufactured by W. R. Grace & Co., or pre-approved equivalent submitted at least 14-days prior to original Bid Date and subsequently approved, including mastic, and where required companion surface conditioner product, and all other materials and components required.
3. Application: Use where flashing is fully concealed in masonry, including in part, wall flashing, below parapets, wall caps and sills, at lintels, above grade weeps at base of exterior walls, etc.

B. Adhesive for Flashings: Bituthene mastic, except when other type recommended by manufacturer of flashing material for use indicated.

2.13 MISCELLANEOUS MASONRY ACCESSORIES

A. Nonmetallic Expansion Joint Strips: Pre-molded filler strips complying with ASTM D 1056, Type 2 (closed cell), Class A (cellular rubber and rubber-like materials with specific resistance to petroleum base oils), Grade 1 (compression-deflection range of 2-5 psi), compressible up to 35 percent, of width and thickness indicated, formulated from the following material:

1. Flexible Cellular Neoprene.

B. Preformed Control Joint Gaskets:

1. Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated, or if not indicated, T-shape (or other special shapes required by project conditions to fit inside sash block, and of depth through joint to allow proper sealant application with only one backer rod.
2. Styrene-Butadiene Rubber Compound: ASTM D 2000, Designation 2AA-805.

C. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep Holes, provide the following: Cotton sash cord; 3/8-inch outside diameter by length(s) as required to overlap cord 2-inches past adjacent weep hole at bottom of air space at interior wall cavity, extend through exterior wythe(s), and 4-inches on exterior side - until water repellent is applied and excess is trimmed flush with raked mortar joint at flashing.

1. Wet cord prior to embedding in mortar.

2.14 MASONRY CLEANERS

C. Proprietary Buffered Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Diedrich Technologies, Inc.
2) EaCo Chem, Inc.
3) ProSoCo, Inc.
4) Or Approved Equal.

B. Chemical Applicator must be trained and use equipment approved by the chemical manufacturer

2.15 MORTAR AND GROUT MIXES

A. General:

1. Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
2. Do not use calcium chloride in mortar or grout.

B. Mixing: Combine and thoroughly mix cementitious, water and aggregates in a mechanical batch mixer; comply with referenced ASTM standards for mixing time and water content.

C. Mortar for Unit Masonry:

1. Comply with ASTM C 270, Proportion Specification, for types of mortar required, unless indicated otherwise.
2. Use type M mortar for masonry below grade and in contact with earth, and where indicated.
3. Use type S mortar for reinforced masonry and where indicated.
4. Use type S mortar for exterior, above-grade load-bearing and non-loadbearing walls and parapet walls; for interior load-bearing walls; for interior non-loadbearing partitions, and for other applications where another type is not indicated.

D. Mortar Colors: To coordinate with brick and block veneer color selections as approved by Owner.

E. Grout for Unit Masonry:

1. Comply with ASTM C 476 for grout for use in construction of reinforced and nonreinforced unit masonry. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.
2. Use fine grout in grout spaces less than two inches (2") in horizontal direction, unless otherwise indicated.

3. Use coarse grout in grout spaces two inches (2") or more in least horizontal dimension, unless otherwise indicated.

2.16 DRAINAGE FILL FOR CAVITY WALLS

A. General:

1. Provide drainage fill at flashing locations in cavity walls and where shown.

B. Manufacturers:

1. Spycor Building Products – Mount Pleasant, SC (MBII Mortar Break)
2. MasonPro – Northville, MI (Pronet DT)
3. Approved Equal

B. Drainage Fill System.

1. Polymer Core geomatrix woven into a 1.5” thick mat with approximate installed depth of 10 inches.

2.17 WATER REPELLENT

A. Provide from a manufacturer and by an applicator complying with experience requirements in "Special Conditions," as follows: 40% Silane Solution in alcohol carrier.

B. Submit for approval prior to application.

C. Application rate not to exceed 125 SF per gallon.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of unit masonry, if any.

B. Examine rough-in and built-in construction to verify actual locations of other or related work, prior to installation.

C. Do not proceed until any unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with referenced unit masonry standards and other requirements indicated, applicable to each type of installation included in Project.

B. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

C. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 8 inches of masonry between chase or recess and jamb of openings and between adjacent chases and recesses.

D. Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.

E. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

1. Use dry cutting saws to cut concrete masonry units.

F. Wetting Clay Brick: Wet brick made from clay or shale which have ASTM C 67 initial rates of absorption (suction) of much than 30 grams per 30 sq. in. per minute. Use wetting methods which ensure each clay masonry unit being nearly saturated but surface dry when laid.

G. Do not wet concrete masonry units.

H. Cleaning Reinforcing: Before placing, remove loose rust, ice and other coatings from reinforcing.

I. Wet sash cord weeps prior to embedding in mortar, so it will not draw water out of mortar.

3.3 CONSTRUCTION TOLERANCES – REQUIRED FOR ACCEPTANCE

A. Comply with construction tolerances of referenced unit masonry standards.

B. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4-inches in 10-feet, or 3/8-inches in a story height not to exceed 20-feet, nor 1/2-inches in 40-feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4-inches in any story or 20-feet maximum, nor 1/2-inch in 40-feet or more. For vertical alignment of head joints do not exceed plus or minus 1/4-inches in 10-feet, 1/2-inch maximum.

C. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4-inches in any bay or 20-feet maximum, nor 1/2-inches in 40' or more. For top surface of bearing walls do not exceed 1/8-inches between adjacent floor elements in 10' or 1/16" within width of a single unit.

D. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.

E. Variation in Cross Sectional Dimensions: Do not exceed bed joint thickness indicated by more than plus or minus 1/8". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.

B. Layup walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less that nominal 4-inch horizontal face dimensions at corners or jambs.

1. Running bond, unless otherwise indicated on Drawings.

D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

E. Stopping and Resuming Work: In each course, rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.

F. Built-In Work:

1. As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
2. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
3. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of zinc expanded metal lath in the joint below and rod mortar or grout into core.
4. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

G. Build non-load-bearing interior partitions full height of story to underside of sold floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and building into top of partition. Grout cells of CMUs solidly around plastic tubes down into grout to provide ½-in clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units as follows:

1. With full mortar coverage on horizontal and vertical face shells and cross webs.
2. Bed webs in mortar in starting course on footings and in all courses of walls, piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
3. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

B. Cut joints flush for masonry walls to be concealed or to be covered by base, crown moulding, and/or other materials, unless otherwise indicated.

C. Tool all joints in exposed exterior work as follows:

1. Tooled slightly concave with a tool of at least 50% but no more than 100% larger than joint width, at CMU and concealed masonry.

D. Tool all joints in all interior work as follows:

1. Tooled same as for CMU and concealed masonry at exterior.
2. Struck smooth behind base and crown mouldings.

E. Maintain joint widths of 3/8 inch, except for minor variations required to maintain bond alignment, or as otherwise required to align with or mach adjacent existing work.

F. Collar Joints: After each coarse is laid, fill vertical longitudinal joint between wythes solidly with mortar, for the following work:

1. Exterior walls, except where clear air space above flashing is indicated.
2. Interior bearing walls.

3.6 STRUCTURAL BONDING OF MULTI-WYTHE MASONRY

A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes, at 16 inches o.c. vertically (maximum) at running bond and 8 inches o.c. (maximum) at stacked bond.

B. Corners:

1. Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.
2. Provide continuity with horizontal joint reinforcement at corners using prefabricated "L" units, in addition to masonry bonding.

C. Intersecting and Abutting Walls:

1. Unless vertical expansion or control joints are shown or necessary at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
2. Provide individual metal ties to columns and stud walls, at 16 inches o.c. vertically (maximum).

a. Provide additional anchors within 1'-0" of openings and at intervals around perimeter not exceeding 3'-0" o.c.

3. Provide continuity with horizontal joint reinforcement using prefabricated "T" units.
4. Provide continuous dovetail slots, with anchors at 16 inches o.c. maximum vertically and 24 inches o.c., at new concrete back-up walls, columns, etc.

3.7 MASONRY CAVITY WALL AND MASONRY – CELL INSULATION

A. Provide a thermal and acoustical amino-plast foam insulation inside unit masonry cells according to Section 07 21 19 – Foamed-In-Place Insulation.

3.8 CAVITIES/AIR SPACES

A. Keep cavities/air spaces clean of mortar droppings and other materials during construction. Strike joints facing cavities/air spaces flush.

1. Where not possible and at metal studs, tie exterior wythe to backup with individual metal ties spaced not more than 16 inches o.c. vertically and 24" o.c. horizontally. Stagger alternate courses.

B. Provide weepholes in exterior wythe of new cavity walls, located immediately above ledges and flashing, spaced 32 inches o.c. unless otherwise indicated.

C. Tie exterior wythe to backup and multi-wythe walls with continuous horizontal joint reinforcing at 16 inches o.c. vertically.

3.9 HORIZONTAL JOINT REINFORCEMENT

A. General: Provide continuous horizontal joint reinforcement as indicated and as required by Code, but not more than 16 inches o.c. vertically at running bond and 8 inches o.c. vertically at stacked bond. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcing a minimum of 6 inches.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

D. Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcement placed in 2 horizontal joints approximately 8" apart, immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2’-0" beyond jambs of the opening except at control joints.

3.10 ANCHORING MASONRY WORK

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.
2. Anchor masonry to structural members with flexible anchors which allow 4-way movement embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally.

B. Anchor single-wythe masonry veneer to studs with masonry veneer anchors to comply with the following requirements:

1. Fasten each anchor section through sheathing to studs with 2 metal fasteners of type indicated.
2. Embed tie section in masonry joints. Provide not less than 1-inch air space between back of masonry veneer wythe and face of sheathing.
3. Locate anchor section relative to course in which tie section is embedded to allow maximum vertical differential movement of tie up and down.
4. Space anchors as indicated but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally with not less than one anchor for each 2 sq. ft. of wall area. Install additional anchors within 1'-0" of openings and at intervals around perimeter not exceeding 3'-0" o.c.

3.11 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joints in unit masonry where existing in floor slabs, walls, and roof, and as required (or otherwise indicated). Build in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

B. Form control joints in concrete masonry as follows: Install preformed control joint gaskets designed to fit standard sash block. Fill recesses with backer rod and flexible sealant, as specified in Section 07 92 00 - Joint Sealers.

C. Where not otherwise indicated, provide control joints at straight runs of masonry walls, not to exceed 30'-0" o.c. at exterior walls and 40'-0" o.c. at interior walls. Obtain prior approval from Engineer for specific locations.

3.12 LINTELS

A. Install galvanized steel lintels where indicated.

B. Provide masonry lintels where shown and wherever openings of more than 1'-0" for brick size units and 2'-0" for block size units are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

1. For hollow concrete masonry unit walls, use specially formed bond beam units with reinforcement bars placed as indicated and filled with coarse grout.

C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

1. Unless indicated otherwise, fill jamb cells with concrete, from structure below up to bottom of lintel bearing, 8 inches wide x wall thickness minimum.

3.13 FLASING/WEEP HOLES

A. General: Install embedded concealed flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in exterior walls, and where indicated.

B. Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive/sealant/tape, as recommended by flashing manufacturer before covering with mortar.

1. Where indicated or required by manufacturer, provide continuous seal at top edge, using their recommended materials.

C. Install flashings as follows:

1. At lintels and shelf angles, extend flashing a minimum of 4 inches (nominal) into masonry at exterior end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches, and seal to the interior face of the back-up wall.
2. At heads and sills, extend flashing as specified above unless otherwise indicated but turn up ends not less than 2 inches to form a pan.
3. Cut off flashing 1/2-inch from exterior face of wall and rake joint in accordance with flashing manufacturer's requirements.
4. Comply with manufacturer's instructions and recommendations.
5. Seal top edge of flashing with manufacturer's recommended product.

D. Install weep holes, in the head joints in exterior wythes of the first course of masonry immediately above embedded flashings and as follows:

1. Form weep holes with product specified in 2.14.
2. Space weep holes 32 inches o.c., unless otherwise indicated.
3. Wet cotton sash cord prior to embedding in mortar.

3.14 INSTALLATION OF REINFORCED UNIT MASONRY

A. General: Install reinforced unit masonry to comply with requirements of referenced unit masonry standards, and as indicated on the Drawings.

3.15 REPARING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.

C. Final Cleaning - After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave 1/2 panel un-cleaned for comparison purposes. Obtain Engineer’s approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
4. Saturate wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean brick by means of bucket and brush hand-cleaning method described in BIA "Technical Note No. 20 Revised", to clean brick masonry made of clay or shale, except use detergent as the masonry cleaner.
6. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 45 applicable to type of stain present on exposed surfaces.

    a. Comply with masonry manufacturer's instructions.

3.16 WATER REPELLENTS

A. Apply water repellents to all exterior masonry after thorough cleaning and rinsing, prior to any backfill or any other concealment.

B. Install in strict accordance with manufacturer's written recommendations.

3.17 PROTECTIONS

A. Trim excess sash cord flush with cured mortar joint at exterior side of walls.

B. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

END OF SECTION 04 00 10

SECTION 05 21 00 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. KCS-type K-series steel joists.
3. K-series steel joist substitutes.
4. Joist accessories.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete for installing bearing plates in concrete.
2. Section 04 20 00 - Unit Masonry for installing bearing plates in unit masonry.
3. Section 05 12 00 - Structural Steel Framing for field-welded shear connectors.
4. Section 09 96 00 - High-Performance Coatings

1.3 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and professional Engineer.

B. Welding certificates.

C. Manufacturer certificates.

D. Mill Certificates: For each type of bolt.

E. Comprehensive Engineering analysis of special joists signed and sealed by the qualified professional Engineer responsible for its preparation.

F. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications".

1. Manufacturer's responsibilities include providing professional Engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications".

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

A. Deliver steel bearing plates to be built into cast-in-place concrete and masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.

1. Use Load and Resistance Factor Design (LRFD); data are given at service level and must be factored.

2. Design special joists to withstand design loads with live-load deflections no greater than the following:

a. Floor Joists: Vertical deflection of 1/360 of the span.
b. Roof Joists: Vertical deflection of 1/360 of the span.

2.2 K-SERIES STEEL JOISTS

A. Manufacture steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: K-series steel joists and KCS-type K-series steel joists.

B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Provide holes in chord members for connecting and securing other construction to joists.

D. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."

E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

F. Do not camber joists.

G. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 PRIMERS

A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.4 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. Steel bearing plates with integral anchorages are specified in Section 05 50 00 - Metal Fabrications.

C. Welding Electrodes: Comply with AWS standards.

D. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications", joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds according to AWS D1.1.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

3.4 PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.

1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2 or power-tool cleaning according to SSPC-SP 3.
2. Apply a compatible primer of same type as primer used on adjacent surfaces.

END OF SECTION 05 21 00

SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof deck

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates

B. Product Certificates

C. Product Test Reports

D. Evaluation Reports: For steel deck, from ICC-ES

E. Field quality-control reports

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 ROOF DECK

A. Manufacturers:

1. Alabama Steel Supply
2. Sloan Supply
3. D-MAC Industries, Inc.
4. ASC Profiles, Inc.
5. Roof Deck, Inc.
6. Approved Equal

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008, structural steel shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

a. Color: Manufacturer's standard

2. Deck Profile: Type B
3. Profile Depth: 1-1/2 inches
4. Span Condition: Simple span
5. Side Laps: Overlapped or interlocking seam at Contractor's option

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, with factory-punched hole of 3/8-inch minimum diameter.

J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch-wide flanges and level or sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

L. Galvanizing Repair Paint: ASTM A780

M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Prepare test and inspection reports.

3.4 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas of prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

END OF SECTION 05 31 00

SECTION 05 40 00 - ALUMINUM HANDRAIL

PART 1 - GENERAL

1.1 SCOPE

A. The work covered by this section includes furnishing all labor, equipment and materials required to furnish and install aluminum component handrail including all fittings, anchors, bases and accessories, as required by the Contract Documents.

B. All guardrails shall be furnished with a toe board, except where concrete curbs are shown (if any).

C. This section shall be used for all handrail except in areas where stairs and handrail are congruent as specified in Section 05 52 13.

1.2 RELATED DOCUMENTS

A. Related work specified elsewhere includes:

1. Section 03 30 00 – Cast-in-Place Concrete
2. Section 05 50 00 – Metal Fabrications

1.3 SUBMITTALS

A. Submit complete shop drawings and product data in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Submit structural calculations, including anchorages.

1.4 STORAGE AND PROTECTION

A. Handrails shall be properly packaged to prevent scratching and denting during shipment, storage and erection. Maintain protective wrapping until project is completed.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Component aluminum handrail system shall be designed and constructed in strict compliance with the requirements of OSHA and the International Building Code.

B. Guardrails shall be designed to withstand a uniform horizontal load of 50 pounds per foot with a simultaneous vertical load of 100 pounds per foot applied to the top rail.

C. Handrail shall be designed to withstand a uniform horizontal load of 50 pounds per foot applied to the top rail.

D. In addition, guardrails, handrails shall be designed to withstand a concentrated load of 200 pounds applied in any direction, at any point on the railing system.

2.2 ACCEPTABLE PRODUCTS/MANUFACTURERS

A. Component aluminum handrail system shall be

1. "TUFrail" by Thompson Fabricating - Birmingham., AL.
2. "Interna-Rail" by Hollaender Corp. – Cincinnati., Ohio
3. Alumagard - Denver, CO.
4. Or equal

2.3 MATERIAL AND CONSTRUCTION

A. Handrail shall be the product of a company normally engaged in the manufacture of pipe railing. Railing shall be shop assembled in lengths not to exceed 24 feet for field erection.

B. Post spacing shall be a maximum of 6'-0". Posts and rails shall be a minimum of 1 1/2" schedule 40 aluminum pipe, alloy 6063-T6 or 6105-T5, ASTM B-429 or B-221.

C. Handrail shall be made of pipe and fittings mechanically fastened together with stainless steel hardware. Handrail systems which use fittings that are glued or pop-riveted will not be acceptable.

D. Toe board shall conform to OSHA standards. Toe board shall be a minimum of 4" high and shall attach to the post using clamps which will allow for expansion and contraction between posts. Toe board shall be set 1/4" above the walking surface.

E. Wedge anchors shall be spaced 10d apart and 5d edge distance for no reduction in pullout strength. A safety factor of 4 shall be used on pullout values published by the manufacturer. Wedge anchors shall be type 304 stainless steel.

F. Openings in the railing shall guarded by a self-closing gate (OSHA 1910.23). Safety chains are not acceptable.

G. All handrail and components shall be clear anodized per Aluminum Association M10C22A41 (215-R1). The pipe shall be plastic wrapped to protect the finish.

H. All aluminum surfaces in contact with concrete, grout or dissimilar metals shall be protected with a coat of bituminous paint, mylar isolators or other approved material.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field fabrication of the railing system is not permitted.

B. Set handrails plumb within 1/8" of vertical and align horizontally to within 1/8" in 12 feet.

C. Install wedge anchors to proper depth to develop full pullout and shear values. Check all fasteners and bolts in base connections and splices for tightness.

D. Adequate provisions for expansion and contraction shall be incorporated into the rail. Expansion joints shall be placed at 60-foot intervals and at all concrete expansion joints.

E. Toe boards shall be shipped loose and attached to the handrail in the field. Attachment to the posts shall be made with clamps which will allow for expansion and contraction while maintaining a straight line.

F. All defective, damaged or otherwise improperly installed handrail shall be removed and replaced with material which complies with this section at no additional cost to the Owner.

G. Following installation, aluminum handrail shall be cleaned with a mild soap and clean water. Acid solutions, steel wool or harsh abrasives shall not be used.

END OF SECTION 05 40 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 05 44 00 - COLD-FORMED METAL TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-formed steel trusses for roofs.

B. Related Requirements:

1. Section 05 35 15 - Cold-Formed Metal Framing for cold-formed steel studs.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated-Design Submittal: For cold-formed steel trusses.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product test reports.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel." PART

2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MarinoWARE.
2. TrusSteel; an ITW company.
3. USA Frametek.
4. Or Approved Equal.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements," to design cold-formed steel trusses.

B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:

a. Roof Trusses: Vertical deflection of 1/360 of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

C. Cold-Formed Steel Framing Design Standards:

1. Roof Trusses: Design according to AISI S214.

2.3 COLD-FORMED STEEL TRUSS MATERIALS

A. Steel Sheet: ASTM A 1003, structural grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: G60, A60, AZ50, or GF30.

2.4 ROOF TRUSSES

A. Roof Truss Members: Manufacturer's standard C-shaped steel sections.

1. Connecting Flange Width: 1-5/8 inches, minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
2. Minimum Base-Metal Thickness: 0.0329 inch.
3. Section Properties: As designed.

2.5 TRUSS ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, structural grade, Type H, metallic coated, of same grade and coating weight used for truss members.

B. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 as appropriate for the substrate.

1. Uses: Securing cold-formed steel trusses to structure.
2. Type: Torque-controlled expansion anchor.
3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

C. Power-Actuated Fasteners: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B.

B. Shims: Load bearing, of high-density multimonomer plastic, nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

2.8 FABRICATION

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate trusses using jigs or templates.
2. Cut truss members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install bridge, and brace cold-formed steel trusses according to AISI S200, AISI S202, AISI S214, and manufacturer's written instructions unless more stringent requirements are indicated.

1. Coordinate with wall framing to align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure.
2. Anchor trusses securely at all bearing points.

3. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to CFSEI's Technical Note 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses."

B. Install cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened.

1. Erect trusses with plane of truss webs plumb and parallel to each other. Align and accurately position trusses at required spacings.
2. Fasten cold-formed steel trusses by welding or mechanical fasteners.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings; comply with requirements for spacing, edge distances, and screw penetration.

C. Install temporary bracing and supports to secure trusses and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to trusses are secured.

D. Truss Spacing: As indicated.

E. Do not alter, cut, or remove framing members or connections of trusses.

F. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.2 FIELD QUALITY CONTROL

A. Field and shop welds will be subject to testing and inspecting.

B. Prepare test and inspection reports.

3.3 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed metal trusses are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 44 00

SECTION 055000 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes, but is not limited to, furnishing and installation of all miscellaneous metals and/or related items as necessary and indicated on the Drawings for proper and complete performance of this work.

1. Shop fabricated steel and aluminum or items requiring special fabrication.
2. Miscellaneous angle and channel supports, flat bars and fastenings, all as shown on the Drawings and not provided under structural steel frame.
3. Brackets and supports for millwork and counters.
4. Cleanout doors and wheel guards.
5. Anchor bolts.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related work specified elsewhere includes:

1. Section 099113 – Exterior Painting

1.3 REFERENCES:

A. AA DAF-45 - Designation System for Aluminum Finishes; The Aluminum Association, Inc.

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association.

C. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

D. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.

E. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

F. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements.

G. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

H. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

I. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

J. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

K. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

L. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

M. ASTM A 325 / 325M - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength.

N. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

O. ASTM A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

P. ASTM B 26/B 26M - Standard Specification for Aluminum-Alloy Sand Castings.

Q. ASTM B 85 - Standard Specification for Aluminum-Alloy Die Castings.

R. ASTM B 177 - Standard Guide for Chromium Electroplating on Steel for Engineering Use.

S. ASTM B 209 / 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

T. ASTM B 210 / 210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.

U. ASTM B 211 / 211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

V. ASTM B 221 / 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

W. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

X. AWS D1.1 - Structural Welding Code – Steel.

Y. AWS D1.2 – Structural Welding Code – Aluminum.

Z. AWS D1.3 – Structural Welding Code – Stainless Steel.

AA. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings.

BB. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings.

CC. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings.

1.4 SUBMITTALS

A. See Section 013300 – Submittals

B. Product Data and Shop Drawings shall show dimensions, sizes, thickness, gauges, finishes, joining, attachments and relationship of work to adjoining construction. Indicate profiles, connection attachments, reinforcing, anchorage, size and type of fasteners, and any accessories. Include erection drawings, elevations, and details where applicable. Where items must fit, and coordinate with finished surfaces and/or constructed spaces, measurements from the site shall control.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

C. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months

D. Provide samples for anchors

1.5 QUALITY ASSURANCE

A. Design by or under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of work being performed.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Deliver materials in coordination with erection schedule.

B. Store materials above ground and under cover. Keep dry and clean.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be new, top quality of their respective kinds, standard sizes and fabricated in a shop whose principal business is manufacturing the items specified in this Section. Materials shall be free of defect impairing strength, durability or appearance. Miscellaneous anchors, plates, clips, bolts, nuts and the like shall be provided as necessary to complete the work, whether or not they appear on the Drawings or in the Specifications.

B. Steel:
1. Steel Sections: ASTM A 36/A 36M.
2. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.
3. Plates: ASTM A 283.
4. Pipe: ASTM A 53/A, Grade B Schedule 40, black finish.

5. Fasteners: As specified elsewhere and shown on the drawings.
6. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M) galvanized to ASTM A 153/A 153M for galvanized components.
7. Welding Materials: AWS D1.1; type required for materials being welded.
8. Shop and Touch-Up Primer: SSPC-Paint 15, Type I – Red Oxide.
9. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type 1 – Inorganic.

C. Aluminum:

1. Extruded Aluminum: ASTM B 221 (ASTM B 221M), 6063 alloy, T6 temper.
2. Sheet Aluminum: ASTM B 209 (ASTM B 209M), 5052 alloy, H32 temper.
3. Aluminum-Alloy Drawn Seamless Tubes: ASTM B 210 (ASTM B 210M), 6063 alloy, T6 temper.
4. Aluminum-Alloy Bars: ASTM B 211 (ASTM B 211M), 6061 alloy, T6 temper.
5. Aluminum-Alloy Sand Castings: ASTM B 26.
6. Aluminum-Alloy Die Castings: ASTM B 85.
7. Bolts, Nuts, and Washers: Stainless steel.
8. Welding Materials: AWS D1.1; type required for materials being welded.

2.2 MANUFACTURED UNITS

A. Bumper Posts and Guard Rails: As detailed; ship with prime paint finish.

B. Bollards: Steel pipe, concrete filled with crowned cap, as detailed; ship with prime paint finish.

C. Joint and Equipment Pipe Hangers: Strap anchors, fabricated with minimum of 18 gauge (1.21 mm) steel; galvanized finish.

D. Inserts and sleeves: Provide all necessary inserts and sleeves of type and manufacturer best suited for work.

E. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of metal decking; ship with prime paint finish.

F. Lintels: Steel Plate: ASTM A 514/A. As detailed; prime paint finish.

G. Sill Angles for Tempered Glass Railing Assemblies: ASTM A 36/A 36M steel angles with anchoring devices, prime paint finish.

H. Door Frames for Overhead Door Openings, Wall Openings, and Lintels: Channel sections; prime paint finish.

I. Foot Scrapers, Mud and Foot Grilles, and Pans: As detailed; aluminum, mill finish.

J. Elevator Hoistway Divider Beams: Beam sections; prime paint finish.

K. Toilet Partition Suspension Members: Steel channel sections; prime paint finish.

L. Anchors: Shall be cast in place unless otherwise shown and approved by Engineer. Provide two nuts, a jam nut, and a washer for all anchor bolts indicated to have locknuts. Provide two nuts and a washer for all other anchor bolts. Provide anti-seize lubricant for stainless steel anchor bolts before tightening of nuts. Provide sufficient threads and thread length for full assembly of nuts.

The diameter of the bolts, if unspecified, shall be 1/8" less than the taps on the equipment base plate.

1. Anchor Bolt Material:
   a. Carbon Steel: ASTM A307
   b. Stainless Steel: Bolts, ASTM F593, Alloy Group 1 or 2; nuts, ASTM F594, Alloy Group 1 or 2.
   c. Galvanized Steel: Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.
2. Threaded Rod Anchor and Nut Material:
   a. Carbon Steel: ASTM A307 or A36.
   b. Stainless Steel: Bolts, ASTM F593, Alloy Group 1 or 2; nuts, ASTM F594, Alloy Group 1 or 2.
   c. Galvanized Steel: Carbon steel bolts and nuts, dot-dipped galvanized, ASTM A153 and A385.
   d. Where indicated on the Drawings and approved by Engineer, threaded rod anchors may be drill (or core-drill, as required) and epoxy in place in lieu of cast in place anchors. The embedment depth shall be a minimum 15 rod diameters. The concrete shall be hardened and cured prior to drilling operations. The diameter of drilled holes shall match epoxy manufacturer's recommendations. The epoxy shall be moisture-insensitive and shall be NSF approved for use in drinking water treatment processes, where applicable. The drilled holes shall be cleaned and free of cuttings. Epoxy shall meet following requirements:
      1) Floors and Horizontal Surfaces:
         a) Low Viscosity – Sika Sikadur 35, Hi Mod LV
         b) Medium Viscosity - Sika Sikadur 32, Hi-Mod
      2) Vertical Surfaces and Overhead Applications:
         a) Sika Sikadur 31, Hi-Mod Gel
3. Adhesive Anchors (for grout filled masonry):
   a. System: Hilti "HIT C-100 System, ITW Ramset/Redhead "Epcon Ceramic 6 System", or Rawlplug "Foil Fast Injection Gel System."
   b. Threaded Rod Anchors and Nuts: As specified for threaded rod anchors.
   c. Adhesive: Two-component liquid, moisture-insensitive epoxy adhesive with viscosity appropriate for the location and application. Components shall be packaged at the factory in a dual chambered cartridge.
4. Adhesive Anchors (for hollow masonry):
   a. ITW Ramset/Redhead "Epcon Ceramic 6 System" or Rawlplug "Foil Fast Injection Gel System."
   b. Threaded Rod Anchors and Nuts: As specified for threaded rod anchors.
   c. Adhesive: Two-component liquid, moisture-insensitive epoxy adhesive with viscosity appropriate for the location and application. Components shall be packaged at the factory in a dual chambered cartridge.
5. Flat Washers:
   a. ANSI B18.22.1; of the same material as anchor bolts and nuts.
6. Expansion Anchors (Where shown and approved by Engineer)
   a. Hilti "Kwik-Bolt II", ITW Ramset/Red Head "Trubolt Wedge Anchor" or Rawlplug "Rawl-Stud Anchor."
7. Base Plate Preparation:
   a. All equipment base plates, unless shown or required otherwise, shall be leveled by non-shrink grout, minimum 1-1/2" thickness, and leveling nuts.

2.3 FABRICATION

A. General: Fabricate metals of unused mill of foundry products, free from defects impairing strength, durability and appearance. Form metals clean and straight with smooth finished surfaces. Furnish al parts necessary for securing metal work to other construction. Wherever possible, fit and assemble work in shop, ready for erection assemble items in largest practical sections, for delivery to site. Shop attach all miscellaneous metals to structural steel by welding or bolting, unless a field attachment is indicated. Grind all exposed welds smooth. If flush welds are indicated, grind welds flush with adjacent surfaces.

B. Fabricate items with joints tightly fitted and secured. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

C. Continuously seal joined members by intermittent welds and plastic filler.

D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.4 FINISHES

A. Steel:
1. Shop Primers:
   a. Primer for structural steel in areas to receive epoxy finish:

Manufacturer	Product
Tnemec Co., Inc.	66-1211
Induron	

   b. Primer for structural steel in other areas: Select one of the following:

Manufacturer	Product
PPG Industries	G9366
Porter Paint Co.	274 (Gray)
Tnemec Co., Inc.	10-1009

2. Prime paint all steel items.
   a. Exceptions: Galvanize items to be embedded in concrete or masonry and items specified for galvanized finish.
   b. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
3. Prepare surfaces to be primed in accordance with SSPC-SP2.
4. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
5. Prime Painting: One coat.
6. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A 123/A 123M. Provide minimum 1.3 oz/sq ft (390 g/sq m) galvanized coating.
7. Galvanizing: of Non-structural Items: Galvanize after fabrication to ASTM A 123/A 123M. Provide minimum 1.3 oz/sq ft (390 g/sq m) galvanized coating

B. Aluminum:
1. Exterior Aluminum Surfaces: Class I natural anodized.
2. Interior Aluminum Surfaces: Class I natural anodized.
3. Comply with AA DAF-45 for aluminum finishes required.

4. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.
5. Class II Natural Anodized Finish: AAMA 611 AA-M12C22A31 Clear anodic coating not less than 0.4 mils (0.01 mm) thick.
6. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick; light bronze.
7. Class I Color Anodized Finish: AAMA 611 AA-C22A44 Electrolytically deposited colored anodic coating not less than 0.7 mils (0.018 mm) thick; light bronze.
8. Class II Color Anodized Finish: AAMA 611 AA-M12C22A32 Integrally colored anodic coating not less than 0.4 mils (0.01 mm) thick; light bronze.
9. Class II Color Anodized Finish: AAMA 611 AA-M12C22A34 Electrolytically deposited colored anodic coating not less than 0.4 mils (0.01 mm) thick; light bronze.
10. Pigmented Organic Coating System: AAMA 2603 polyester or acrylic baked enamel finish; color as scheduled.
11. High Performance Organic Coating System: AAMA 2604 multiple coat, thermally cured fluoropolymer system; color as scheduled.
12. Superior Performance Organic Coating System: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride system; color as scheduled.
13. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementations or dissimilar materials.

2.5 SOURCE QUALITY CONTROL

A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).

C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).

D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).

E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable, ready to receive work and measurements at the jobsite have been verified.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.3 INSTALLATION

A. General: Erect miscellaneous metals plumb, straight, true and accurately fitted with even, close joints and connections. Coordinate all metal work with adjoining work for details of attachment, fittings, etc. Grind all field welds smooth. If flush welds are indicated, grind welds flush with adjacent surfaces. Tighten bolted connections and nick threads to prevent loosening. Insulate dissimilar metals in contact with each other by methods and materials as approved by the Engineer. Protect from galvanic corrosion by pressure tapes, coatings or isolators as approved. Do not drill or punch holes; do not use cutting torch.

B. Install items plumb and level, accurately fitted, free from distortion or defects. Conceal all fastenings where practicable. Joints exposed to weather shall be formed to exclude water.

C. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Field weld components indicated in accordance with AWS D1.1, AWS D1.2, AWS D1.3.

E. Obtain approval prior to site cutting or making adjustments not scheduled.

F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 FIELD QUALITY CONTROL

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

C. Maximum Out-of-Position: 1/4 inch (6 mm).

END OF SECTION 055000

SECTION 05 51 19 - METAL GRATING STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes industrial-type, straight-run stairs with aluminum-grating treads and railings attached to aluminum grating stairs.

B. Related Requirements

1. Section 05 52 13 – Pipe and Tube Railings

1.2 COORDINATION

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate pipes and other various mechanical devices that may conflict with the structural stairway. Modify stair structure to accommodate and approve modifications with the Engineer.

1.3 ACTION SUBMITTALS

A. Product Data: For metal grating stairs

B. Shop Drawings: Include plans, elevations, sections, details, and attachments.

C. Delegated-Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional Engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional Engineer, as defined in Section 01 40 00 - Quality Requirements, to design stairs and railings.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Aluminum Plates, Shapes, and Bars: ASTM A 429, Alloy 6063-T5.

C. Corrugated Nosings: Extruded aluminum, with an integral corrugated non-slip finish.

2.3 FASTENERS

A. General: Provide type 316 stainless steel fasteners with coating complying with ASTM F 593. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers.

C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Bituminous Paint: Cold applied asphalt emulsion complying with ASTM D1187.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Form exposed work with accurate angles and surfaces and straight edges.

C. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 4 welds: good quality, uniform undressed weld with minimal splatter.

D. Fabricate joints that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.6 ALUMINUM-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of structural aluminum channels.

   a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of aluminum channel headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from pressure-locked aluminum grating with 1-1/4-by-3/16-inch bearing bars at 15/16 inch o.c. and crossbars at 4 inches o.c.
2. Fabricate treads and platforms from pressure-locked steel grating with openings in gratings no more than 1/2 inch in least dimension.
3. Surface: Serrated.
4. Finish: Mill finish.
5. Fabricate grating treads with non-slip nosing and with aluminum angle or aluminum plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
6. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Mechanically attach grating to platform framing.

2.7 STAIR RAILINGS

A. Comply with applicable requirements in Section 05 52 13 - Pipe and Tube Railings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel-stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, nonshrink grout unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

END OF SECTION 05 51 19

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum pipe and tube railings.

B. This section shall be used for areas where stairs and handrail are congruent. For all other handrail, refer to Section 05 40 00 - Aluminum Handrail.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Requirements:

1. Section 05 50 00 - Metal Fabrications
2. Section 05 51 19 - Metal Grating Stairs

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

D. Coordinate railings with gate and valve operators, as well as electrical components.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, and posts.
2. Fittings and brackets.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."
2. AWS D1.2, "Structural Welding Code - Aluminum."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Aluminum Pipe and Tube Railings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. ATR Technologies, Inc.
    b. Thompson Fabricating, LLC.
    c. Tubular Specialties Manufacturing, Inc.
    d. Or Equal

B. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements, to design railings, including attachment to building or structural construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform horizontal load of 50 lbf/ft applied in any direction to the top rail
2. Concentrated load of 200 lbf applied in any direction

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 ˚F, ambient; 180 ˚F.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.4 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Tubing: ASTM B 221, Alloy 6063-T5/T52.

C. Extruded Structural Pipe and Round Tubing: ASTM B 429, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

D. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832.

E. Plate and Sheet: ASTM B 209, Alloy 6061-T6.

F. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.

G. Castings: ASTM B 26, Alloy A356.0-T6.

2.5 FASTENERS

A. General: Provide the following:

1. Aluminum Railings: Type 316 stainless-steel fasteners.
2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
2. Provide Phillips OR square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

C. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.7 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.

H. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

J. Form Changes in Direction as Follows:

1. As detailed.
2. By flush bends or by inserting prefabricated flush-elbow fittings.

K. Close exposed ends of railing members with prefabricated end fittings.

L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

O. For railing posts set in concrete, provide stainless-steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

P. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than $1/40^{th}$ of post height. Provide socket covers designed and fabricated to resist being dislodged.

1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

Q. Toe Boards: Where indicated or required by OSHA, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.8 ALUMINUM FINISHES

A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A31.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Cover anchorage joint with flange of same metal as post, attached to post with set screws.

C. Leave anchorage joint exposed with anchoring material flush with adjacent surface.

D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.

E. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

A. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 ADJUSTING AND CLEANING

A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 05 52 13

SECTION 05 53 13 - BAR GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes metal bar gratings and metal frames and supports for gratings.

B. Related Requirements:

1. Section 05 52 13 - Pipe and Tube Railings for metal pipe and tube handrails and railings.
2. Section 05 51 19 - Metal Grating Stairs

1.3 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Clips and anchorage devices for gratings.
2. Paint products.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For gratings, including manufacturers' published load tables.

1.5 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Alabama Metal Industries Company; a Gibraltar Industries company.
2. All American Grating.
3. Harsco Industrial IKG, a division of Harsco Corporation.
4. Ohio Gratings, Inc.
5. Or Approved Equivalent

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors: Uniform load of 150 lbf/sq. ft. or concentrated load of 2000 lbf, whichever produces the greater stress.
2. Walkways and Elevated Platforms Used as Exits: Uniform load of 125 lbf/sq. ft.
3. Heavy Equipment Room Floors: 300 lbf/sq. ft. or concentrated load of 3000 lbf, whichever produces the greater stress.
4. Electrical Room Floors: 250 lbf/sq. ft. or concentrated load of 2500 lbf, whichever produces the greater stress.
5. Limit deflection to L/360 or 1/4 inch, whichever is less.

B. Seismic Performance: Gratings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

2.3 METAL BAR GRATINGS

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

B. Pressure-Locked, Rectangular-Bar Aluminum Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.

1. Bearing Bar Spacing: 1-3/16 inch o.c. (max)
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Plain.
6. Aluminum Finish: Mill Finish.

2.4 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A 510.

D. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30.

E. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33, with G90 coating.

F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 240/A 240M, Type 316L.

G. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316L.

2.5 ALUMINUM

A. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.

B. Extruded Bars and Shapes: ASTM B 221, alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.

C. Aluminum Sheet: ASTM B 209, Alloy 5052-H32.

2.6 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 2.

C. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for All Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.7 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: 4 inches unless otherwise indicated.

F. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
2. Provide no fewer than four saddle clips for each grating section containing rectangular bearing bars 3/16 inch or less in thickness and spaced 15/16 inch or more o.c., with each clip designed and fabricated to fit over two bearing bars.
3. Provide no fewer than four weld lugs for each grating section containing rectangular bearing bars 3/16 inch or less in thickness and spaced less than 15/16 inch o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.

4. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
5. Furnish stainless steel flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

G. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

H. Do not notch bearing bars at supports to maintain elevation.

2.8 GRATING FRAMES AND SUPPORTS

A. Aluminum or stainless-steel frames and supports in the following locations:

1. Exterior.
2. Interior.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I.

B. The portion of aluminum frames in contact with concrete shall have a bitumastic coating for protection.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 53 13

SECTION 05 60 00 – ALUMINUM HATCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Aluminum hatches

1.2 RELATED DOCUMENTS

A. Related work specified elsewhere includes:

1. Section 05 50 00 – Metal Fabrications

1.3 SUBMITTALS

A. Contractor shall submit to the Engineer for approval:

1. Shop drawings.
2. Product data including load information.
3. Warranties

PART 2 - PRODUCTS

2.1 DRIP PROOF HATCH

A. Manufacturers

1. Thompson Fabricating Company; Birmingham, AL
2. Or Approved Equal

B. Floor access doors shall be drip-proof type. Door leaf shall be ¼" aluminum checkered plate reinforced with structural aluminum channels and shall be capable of withstanding a 300 pound/s.f. uniform load with minimal deflection. (Calculations shall be provided to the Engineer upon request.) The following items shall be type 316 stainless steel: slam locks, brackets, hinges and hardware. The door shall have a 316 stainless steel gas spring with integral hold open device which will assist in opening the door and shall lock automatically in the open position. The door shall open a minimum of 90 degrees. The aluminum gutter frame shall be provided with a 1 ½" threaded drain fitting and shall have a thickness not less than ¼" and shall incorporate a neoprene gasket that will reduce air leakage to less than 1 CFM per linear foot of frame when the interior of the hatch is subjected to a 2 inch water column vacuum. All fasteners which penetrate into the "Dry" area of the hatch shall be sealed with "O" Ring Seals to

prevent incidental water and gas leakage. The portion of the frame which is in contact with the concrete shall receive a protective bituminous coating.

C. All double leaf access doors shall have two interconnected slam locks which latch at both ends of the plate and can be un-latched from a single point. "Watertight" for standard single leaf doors shall be for a 1" to 2" head of water.

D. Hatches shall be provided with a fall protection system.

2.2 TRAFFIC LOAD HATCH

A. Manufacturers

1. Thompson Fabricating Company; Birmingham, AL
2. Or Approved Equal

B. Floor access doors shall be type "TH-H20" (gutterless) or "THG-H20" (gutter type) (WATERTIGHT, ODORTIGHT and GASTIGHT) as manufactured by Thompson Fabricating Company, Birmingham, AL. Door leaf shall be ¼" aluminum checkered plate reinforced with structural aluminum channels and shall be capable of withstanding wheel loads up to AASHTO-H20 at OFF-STREET locations only. (Calculations will be provided to the engineer upon request.) The following items shall be type 316 stainless steel: slam locks, brackets, hinges and hardware. The door shall have a 316 stainless steel gas spring with integral hold open device which will assist in opening the door and shall lock automatically in the open position. The door shall open a minimum of 90 degrees. The aluminum extruded frame shall have a thickness not less than ¼" and shall incorporate a neoprene gasket that will reduce air leakage to less than 1 CFM per lineal foot of frame when the interior of the hatch is subjected to a 2 inch water column vacuum. For type "THG" doors the gutter frames shall be provided with a 1 ½" threaded drain coupling. All fasteners which penetrate into the "Dry" area of the hatch shall be sealed with "O" Ring Seals to prevent incidental water and gas leakage. The portion of the frame which is in contact with the concrete shall receive a protective bituminous coating.

C. All double leaf access doors shall have two interconnected slam locks with latch at both ends of the plate and can be un-latched from a single point. "Watertight" for single leaf H20 doors shall be for a 1" to 2" head of water.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install where shown on the drawings according to manufactures recommendations.

END OF SECTION 05 60 00

SECTION 06 60 00 – FRP WEIR PLATES, SCUM BAFFLES AND BRACKETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Glass-fiber-reinforced, resin Weir Plates.
   2. Glass-fiber-reinforced, resin Scum Baffles
   3. Reinforcing brackets, members, fasteners, anchors, and like, for the completion of this Work.

1.2 REFERENCE STANDARDS

A. ASTM International:

   1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. FM Global:

   1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. Intertek Testing Services (Warnock Hersey Listed):

   1. WH - Certification Listings.

D. National Fire Protection Association:

   1. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

E. Underwriters Laboratories Inc.:

   1. UL - Fire Resistance Directory.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on specified component products.

C. Shop Drawings: Indicate design load parameters**,** dimensions, adjacent construction, materials, thicknesses, fabrication details, required clearances, field jointing, tolerances, colors, finishes, methods of support, and anchorages.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for closeout procedures.

1.5 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. The weir plates and scum baffles shall be manufactured by:
1. Warminster Fiberglass Company; Southampton, PA
2. NEFCO Inc., Palm Beach Gardens, FL
3. Approved Equivalent.

2.2 WEIR PLATES, SCUM BAFFLES AND BRACKETS

A. Weir Plates, Scum Baffles, Brackets, and Plates: Fiberglass reinforced polyester resin, compression molded in matched metal die molds; provide all required lap plates, cover plates, and support brackets.
1. Plates fabricated from cut plate stock with cut edges, notches, etc., will not be accepted.

B. Fiberglass Laminate Construction: Sheet Molding Compound (SMC) for use in water treatment systems.
1. Glass content of laminate; 20 percent plus/minus 3 percent by weight. Resin fillers: 40 percent plus/minus 2 percent of resin mixture.
2. Final laminate thickness: Plus/minus 10 percent of nominal specified thickness.
3. Tensile strength (ASTM D 638): 10,000 psi.
4. Flexural strength (ASTM D 790): 20,000 psi.
5. Flexural modulus (ASTM D 790): 800,000 psi.
6. Impact, notched, Izod (ASTM D 256): 10 ft-lb
7. Barcol hardness (resin-rich surface) (ASTM D 2583): 35 minimum, average.
8. Water absorption (ASTM D 570): 0.2 percent at 24 hrs.
9. Coefficient of thermal expansion, ave. (ASTM D 696): 0.0000105 in/in/degree F.
10. Test coupons prepared in accordance with ASTM D 618.
11. Chemical resistance: Comply with ANSI/AWWA F102, Type II classification.

C. Weir Plates:
1. 1/4 inch nominal thickness.
2. Color: White
3. Height: 9-1/8 inches.

4. Notches: 2-5/8 inches deep by 90 degrees on 6 inch centers.
5. Length: As required for installation.
6. Mounting holes on round tanks: 2-1/2 inches square at 20 inches on center to provide a minimum 2 inches vertical or horizontal adjustment.
7. Mounting: 1/2 inch diameter stainless steel anchor bolts and 5 inch square fiberglass cover plates to prevent short circuiting of water.
8. Ends secured with 6 by 4 inch high lap plates to allow for horizontal expansion.
9. Provide stainless steel anchor bolts.

D. Scum Baffle Plates:
1. 1/4 inch nominal thickness.
2. Color: White.
3. Height: 12 inches.
4. Mounting holes: As required to attach to support brackets.
5. Lengths as required to suit project conditions, up to 12 feet maximum each.

E. Lap Plates:
1. Size: 6 by 12 inches.
2. Provide as required to secure ends of baffle plates.
3. Provide stainless steel hardware to secure baffle plates to support brackets and to lap plates.

F. Assembly Hardware:

1. Stainless steel, Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the contract documents.

C. Install in accordance with approved shop drawings and in true and proper alignment.

D. Adjust weir plate elevation for flow indicated or as directed by the Engineer.

E. When necessary to adjust lengths of plates due to field conditions and when approved by the Engineer, seal cut or machined edges thus exposed with polyester resin. Excessive cutting will not be acceptable.

3.3 ADJUST AND CLEAN

A. Clean surfaces in accordance with manufacturer's instructions.

B. Remove trash and debris, and leave the site in a clean condition.

END OF SECTION 066000

SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work described in this section includes joint sealer systems.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related work specified elsewhere includes:

1. Section 03 30 00 – Cast-in-Place Concrete
2. Section 09 96 00 – High-Performance Coatings

1.3 SYSTEM PERFORMANCES

A. Provide joint sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product specifications, handling, installation, curing instructions, color charts and performance tested data sheets for each product required.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an Installer who has successfully completed within the last three years at least three (3) joint sealer applications similar in type and size to that of this project and who will assign mechanics from these earlier applications to this project, of which one will serve as lead mechanic.

B. Single Source Responsibility for Joint Sealer Materials: Obtain joint sealer materials from a single manufacturer for each different product required.

1.6 DELIVER, STORAGE AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40ºF.
2. When joint substrates are wet due to rain, frost, condensation or other causes.

B. Joint Width Conditions: Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by testing and field experience.

B. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by from manufacturer's standard colors.

2.2 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those for Type, Grade, Class and Uses.

B. Multi-Part Nonsag Urethane Sealant: Type M, Grade NS, Class 25, Uses NR, M, A and, as applicable to joint substrates indicated, O.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Dynatrol 11"' Pecora Corp.
b. "Sonolastic NP-2"; Sonneborn.
c. "Dymeric 511"; Tremco Inc.
d. "Vulkem 922"; Mameco International, Inc.

2. Locations for Use: Exterior joints and penetrations in vertical surfaces of stucco, concrete, and between metal and concrete, mortar of stone; overhead or ceiling joints; perimeters of metal frames in exterior walls; vertical expansion and control joints in masonry and concrete; and at all miscellaneous locations requiring a joint sealant.
3. Equivalent 1-part sealants will be acceptable, by one of the above named manufacturers.

C. Two-Part Pourable Urethane Sealant: Type M, Grade P, Class 25; Uses T, M, A and, as applicable to joint substrates indicated, O.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Chem-Calk 550"; Bostik Construction Product Div.
b. "Vulkem 245"; Mameco International, Inc.
c. "Pourthane"; W. R. Meadows, Inc.
d. "NR-200 Urexpan"; Pecora Corp.
e. "Sonolastic Paving Joint Sealant"; Sonneborn Building Products Div.,
f. "Rexnord Chem. Prod. Inc.
g. "THC-900/901"; Tremco Corp.

2. Locations for Use: Exterior and interior expansion, control and construction joints in horizontal surfaces; and joints subject to pedestrian and light vehicular traffic.
3. Equivalent 1-part sealants will be acceptable, by one of the above named manufacturers.

D. One-Part Mildew-Resistant Silicone Sealant: Type S, Grade NS; Class 25, Uses NT, G, A and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide for sealing interior joints with nonporous substrates around ceramic tile, showers, sinks and plumbing fixtures.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Dow-Corning 786"; Dow Corning Corp.
b. "SCS 1702"; General Electric.
c. "863 #345 White"; Pecora Corp.
d. "Proglaze White"; Tremco Corp.

2. Locations for Use: Interior joints in vertical surfaces and terminal edges of tile; and joints at damp areas, such as around sinks and plumbing fixtures and pipe penetrations; and exposed terminal edges of vinyl flooring, such as around door frames and terminations at concrete.

2.3 LATEX JOINT SEALERS

A. Acrylic-Emulsion Sealant: Manufacturer's standard, one part nonsag, acrylic, mildew resistant, acrylic emulsion sealant complying with ASTM C 834, formulated to be paintable and recommended for exposed applications on interior and on protected exterior exposures involving joint movement of not more than + 7.5%.

1. Products: Subject to compliance with requirements, provide with one of the following:

a. "Chem-Calk 600"; Bostik Construction Products Div.
b. "AC-20"; Pecora Corp.
c. "Sonolac"; Sonneborn Building Products Div; Rexnord Chemical Prod., Inc.
d. "Tremco Acrylic Latex Caulk"; Tremco Inc.

2. Locations for Use: Interior joints in field-painted vertical and overhead surfaces at perimeter of metal door frames, gypsum drywall, plaster and concrete or concrete masonry; and all other interior locations not indicated otherwise.

2.4 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type which are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Plastic Foam Joint-Fillers:

1. Preformed, compressible, resilient, non-waxing, non-extruding strips of plastic foam of material indicated below, and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
2. Backer Rod: Premium grade, closed cell polyethylene foam rod; Sealtight Backer Rod, as manufactured by W.R. Meadows, Inc., or approved equal.
3. Joint Filler: "Ceramar" flexible foam expansion joint filler, as manufactured by W.R. Meadows, Inc., or approved equal.

C. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing bond between sealant and joint filler or other materials at back (3rd) surface of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated.

B. Cleaners for Nonporous Surfaces: Provide non-staining, chemical cleaner of type acceptable to manufacturer of sealant and sealant backing materials which are not harmful to substrates and adjacent nonporous materials.

C. Masking Tape: Provide non-staining, non-absorbent type compatible with joint sealants and to surface adjacent to joints.

PART 3 - EXECUTION

3.1 INSPECTION

A. Require Installer to inspect joints indicated to receive joint sealers for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Obtain Installer's written report listing any conditions detrimental to performance of joint sealer work. Do not allow joint sealer work to proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; oil; grease; waterproofing; water repellents; water; surface dirt and frost.
2. Clean concrete, masonry, unglazed surfaces of ceramic tile and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, acid washing or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
3. Remove laitance and form release agents from concrete.
4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile and other non-porous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.

B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Latex Sealant Installation Standard: Comply with requirements of ASTM C 790 for use of latex sealants.

D. Installation of Sealant Backings:

1. Install sealant backings to comply with the following requirements:
2. Install joint-fillers of type indicated or recommended by sealant manufacturer to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.

a. Do not leave gaps between ends of joint-fillers.

b. Do not stretch, twist, puncture or tear joint-fillers.
c. Remove absorbent joint-fillers which have become wet prior to sealant application and replace with dry material.

3. Install bond breaker tape between sealants and joint-fillers, compression seals or back of joints where required to prevent third-side adhesion of sealant to back of joint.

E. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants:

1. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
2. Concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

1. Sound sealant shall not be visible on exposed surfaces.

END OF SECTION 07 92 00

SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: High-performance coatings and special preparation of surfaces.

1. Use high performance coating systems specified in this section to finish components, unless otherwise indicated. Without restricting volume or generality, work to be performed under this section may include, but is not limited to:

   a. Exterior steel
   b. Interior steel
   c. Exterior concrete
   d. Interior concrete
   e. Piping, hangers, and supports
   f. Exposed bare pipes (including color coding)

2. Painting or finishing is not needed for following:

   a. Surfaces or materials specifically scheduled or shown on Drawings to remain unfinished
   b. Items provided with factory finish.
   c. Equipment nameplates, fire rating labels, and operating parts of equipment

3. Materials and products having factory-applied primer shall not be considered factory finished.

1.2 REFERENCE STANDARDS

A. American Society for Testing and Materials:

1. ASTM D16 - Terminology Relating to Paint, Varnish, Lacquer, and Related Products
2. ASTM D522 – Test Methods for Mandrel Bend Test of Attached Organic Coatings
3. ASTM D6386 – Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product
4. ASTM D3359 – Test Methods for Rating Adhesion by Tape Test

B. SSPC: The Society for Protective Coatings:

1. SSPC - Painting Manual, Volume 2: Systems and Specifications.
2. SSPC-Paint 16 - Coal Tar Epoxy-Polyamide Black (or Dark Red).
3. SSPC-SP 2 - Hand Tool Cleaning.
4. SSPC-SP 3 - Power Tool Cleaning.
5. SSPC-SP 5 - White Metal Blast Cleaning.
6. SSPC-SP 6/NACE 3 - Commercial Blast Cleaning.

7. SSPC-SP 7/NACE 4 - Brush-Off Blast Cleaning.
8. SSPC-SP 10/NACE 2 - Near-White Metal Blast Cleaning.
9. SSPC-SP 11 - Power Tool Cleaning to Bare Metal.
10. SSPC-SP13/NACE 6 – Surface Preparation of Concrete

C. National Association of Pipe Fabricators

1. NAPF 500-03-01 Solvent Cleaning
2. NAPF 500-03-02 Hand Tool Cleaning
3. NAPF 500-03-03 Power Tool Cleaning
4. NAPF 500-03-04 Abrasive Blast Cleaning of Ductile Iron Pipe
5. NAPF 500-03-05 Abrasive Blast Cleaning of Cast Ductile Iron Fittings

D. International Concrete Repair Institute

1. ICRI-CSP 2 – Grinding
2. ICRI-CSP 3 – Light Shotblast
3. ICRI-CSP 4 – Light Scarification
4. ICRI-CSP 5 – Medium Shotblast
5. ICRI-CSP 6 – Medium Scarification

1.3 PREINSTALLATION MEETINGS

A. Section 01 31 00 – Project Management and Coordination.

B. Convene minimum two weeks prior to commencing Work of this Section.

C. Schedule a conference and inspection to be held on-site before field application of coating systems begins.

D. Conference shall be attended by Contractor, Owner's Representative, Engineer, coating applicators, and a representative of coating material manufacturer.

E. Topics to be discussed at meeting shall include:

1. A review of Contract Documents and accepted shop drawings shall be made and deviations or differences shall be resolved.
2. Review items such as environmental conditions, surface conditions, surface preparation, application procedures, and protection following application.
3. Establish which areas on-site will be available for use as storage areas and working area

F. Pre-construction conference and inspection shall serve to clarify Contract Documents, application requirements and what work should be completed before coating application can begin.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer information indicating coating materials, manufacturer's name, product name, product number, performance ratings, curing times, mixing, thinning and application requirements.

a. Provide material analysis, including vehicle type and percentage by weight and by volume of vehicle, resin and pigment.
b. Submit manufacturer's Material Safety Data Sheets (MSDS) and other safety requirements.

C. Samples: Submit one color chart/color samples, illustrating colors for selection.

D. Schedule: Contractor shall submit a schedule of items that will receive high-performance coatings per Specification 09 96 00.

E. Color: Contractor shall submit a schedule of colors based on Color System Material Identification.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Manufacturer Instructions: Submit special procedures, perimeter conditions requiring special attention.

H. Quality Assurance Submittals:

1. Certificates:

a. Coatings manufacturer shall certify that coating materials utilized are "non-lead" (less than 0.06% lead by weight in dried film) as defined in Part 1303 of Consumer Product Safety Act.
b. Provide certification that specialized equipment as may be required by manufacturer for proper application of coating materials shall be utilized for work of this Section.
c. Provide manufacturer's certification that products to be used comply with specified requirements and are suitable for intended application.

2. Manufacturer's Instructions:

a. Submit manufacturer's installation procedures which shall be basis for accepting or rejecting actual installation procedures.

I. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: Submit maintenance and cleaning requirements for coatings, repair and patching techniques.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:

1. Furnish 1 gal of each color of each type of coating specified, for Owner's maintenance use.
2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.7 QUALITY ASSURANCE

A. Conform to applicable codes and ordinances for flame, fuel, smoke, and volatile organic compound (VOC) ratings requirements for finishes at time of application.

1.8 QUALIFICATIONS

A. Provide products from a company specializing in manufacture of high-performance coatings with a minimum of 10 years experience.

B. Applicator shall be trained in application techniques and procedures of coating materials and shall demonstrate a minimum of 2 years successful experience in such application.

1. Maintain, throughout duration of application, a crew of painters who are fully qualified to satisfy specified qualifications.

C. Single Source Responsibility:

1. Materials shall be products of a single manufacturer or items standard with manufacturer of specified coating materials.
2. Provide secondary materials which are produced or are specifically recommended by coating system manufacturer to ensure compatibility of system.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Container Labeling: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Inspection:

1. Accept materials on Site in manufacturer's sealed and labeled containers.
2. Inspect for damage and to verify acceptability.

D. Store materials in ventilated area and otherwise according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum Conditions: Do not install materials when temperature is below 35°F or above 110°F.

C. Refer to specific product information sheets for minimum surface temperature requirements. Surface temperatures shall be at least 5°F (3°C) above dew point and in a rising mode.

D. Subsequent Conditions: Maintain above temperature range, 24 hours before, during, and 72 hours after installation of coating.

E. Relative humidity shall be no higher than 85%.

F. For exterior spray application, wind velocity shall be less than 15 mph (25 kph).

G. Atmosphere shall be relatively free of airborne dust.

H. Restrict traffic from area where coating is being applied or is curing.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Include coverage for bond to substrate, and degradation of chemical resistance.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS

A. Manufacturers:

1. Tnemec Company, Inc.
2. Sherwin Williams Company
3. Or Approved Equal.

2.2 COMPONENTS

A. Coating System:

1. Shop Primed: See schedule

2. Surface Preparation: See schedule for SSPC / NACE, NAPF, ICRI, or ASTM standard.

3. Coating Type:

   a. Complete multicoat systems formulated and recommended by manufacturer for intended applications and in indicated thicknesses.
   b. Specified number of coats does not include primer, stripe, or filler coat.

4. Chromium Content as Zinc Chromate or Strontium Chromate: None.
5. Colors: Selected from manufacturer's standard colors based on Color System Material Identification
6. Minimum Dry Film Thickness Per Coat: See schedule.
7. Primer: Per manufacturer’s recommendation.

B. Epoxy Coating:

1. Modified Polyamine Epoxy

   a. Finish: Gloss.
   b. Minimum Solids Content: 100% (mixed).
   c. Vendor Reference
      1) **Tnemec:** Series 435 Perma-Glaze
      2) **Sherwin Williams:** DuraPlate 5900

2. Modified Polyamine Epoxy Mortar

   a. Finish: Gloss.
   b. Minimum Solids Content: 100% (mixed).
   c. Vendor Reference
      1) **Tnemec:** Series 434 Perma-Shield H2S
      2) **Sherwin Williams:** DuraPlate 5900 Mortar

3. Glass Flake Modified Polyamine Epoxy

   a. Finish: N/A
   b. Minimum Solids Content: 82.0 ± 2.0%
   c. Vendor Reference
      1) **Tnemec:** Series 142 Epoxoline
      2) **Sherwin Williams:** Macropoxy 5500 LT

4. Modified Polyamine Epoxy

   a. Finish: N/A
   b. Minimum Solids Content: 82.0 ± 2.0%

c. Vendor Reference
   1) **Tnemec:** Series 141 Epoxoline
   2) **Sherwin Williams:** Macropoxy 5500 LT

5. Surface Tolerant Modified Polyamidoamine Epoxy

   a. Finish: Semi-gloss.
   b. Minimum Solids Content: 84.0 ± 2.0% (mixed).
   c. Vendor Reference
      1) **Tnemec:** Series 135 Chembuild
      2) **Sherwin Williams:** Macropoxy 5500 LT

6. NSF Approved Pure Polyamide Epoxy

   a. Finish: N/A
   b. Minimum Solids Content: 56.0 ± 2.0%
   c. Vendor Reference
      1) **Tnemec:** Series 20 or 20HS Pota-Pox
      2) **Sherwin Williams:** Macropoxy 646 PW

7. Polyamidoamine Epoxy

   a. Finish: N/A
   b. Minimum Solids Content: 67.0 ± 2.0% (mixed).
   c. Vendor Reference
      1) **Tnemec:** L140 Pota-Pox (Interior) & N69 Pota-Pox (Exterior)
      2) **Sherwin Williams**: SherPlate 600 (Interior) & Macropoxy 646 (Exterior)

8. High-Build Epoxy Coating – Pure Polyamide Epoxy

   a. Finish: Satin.
   b. Minimum Solids Content: 56.0% ± 2.0% (mixed).
   c. Vendor Reference
      1) **Tnemec:** Series 66 or 66HS Hi-Build Epoxoline
      2) **Sherwin Williams:** Macropoxy 646 Fast Cure

9. Waterborne Acrylic Epoxy

   a. Finish: Satin.
   b. Minimum Solids Content: 44.0 ± 2.0% (mixed)
   c. Vendor Reference
      1) **Tnemec:** Series 113 H.B. Tneme-Tufcoat
      2) **Sherwin Williams**: Pro Industrial Water Based Epoxy

10. Modified Polyamine Epoxy

    a. Finish: N/A
    b. Minimum Solids Content: 100% (mixed).

c. Vendor Reference
   1) **Tnemec:** Series 201 Epoxoprime
   2) **Sherwin Williams:** General Polymers 3746

11. Modified Polyamine Epoxy

    a. Finish: N/A
    b. Minimum Solids Content: 100% (mixed).
    c. Vendor Reference
       1) **Tnemec:** Series 237 Power-Tread
       2) **Sherwin Williams:** General Polymers 4080 (FasTop 12S)

12. Modified Novolac Epoxy

    a. Finish: N/A
    b. Minimum Solids Content: 100% (mixed)
    c. Vendor Reference
       1) **Tnemec:** Series 239SC Chembloc
       2) **Sherwin Williams:** Cor-Cote HCR

C. Polyurethane Coating:

1. Modified Aromatic Polyurethane Primer

   a. Finish: N/A
   b. Minimum Solids Content: 61.0 ± 2.0% (mixed).
   c. Vendor Reference
      1) **Tnemec:** Series 1 Omnithane
      2) **Sherwin Williams:** Corothane 1 GalvaPac 1K or 2K Zinc Primer

2. Aromatic Urethane, Zinc-Rich Primer

   a. Finish: N/A
   b. Minimum Solids Content: 63.0 ± 2.0% (mixed); Metallic Zinc Content: 83% minimum in dried film. ASTM D 522 Type III Zinc dust.
   c. Vendor Reference
      1) **Tnemec:** Series 91/94-H2O Hydro-Zinc
      2) **Sherwin Williams:** Corothane 1 GalvaPac 1K or 2K Zinc Primer

3. Aliphatic Acrylic Polyurethane

   a. Finish: Gloss.
   b. Minimum Solids Content: 66.0 ± 2.0% (mixed).
   c. Vendor Reference
      1) **Tnemec:** Series 73 Endura Shield
      2) **Sherwin Williams:** Acrolon 218 HS Polyurethane

4. Aliphatic Moisture Cured Urethane

   a. Finish: Semi-gloss.

b. Minimum Solids Content: 92.0 ± 2.0% (clear mixed).
c. Vendor Reference
   1) **Tnemec:** Series 248 Everthane
   2) **Sherwin Williams:** Amorseal Rexthane 1

5. Polyurethane Modified Concrete

   a. Finish: Matte.
   b. Minimum Solids Content: 100%.
   c. Vendor Reference
      1) **Tnemec:** Series 241 MVT Everthane
      2) **Sherwin Williams:** General Polymers FasTop 12S

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Examine areas and conditions under which application of coating systems shall be performed for conditions that will adversely affect execution, permanence, or quality of coating system application.

C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes until moisture content of surface is below following limits:

   1. Masonry Surfaces: 12% maximum
   2. Vertical Concrete Surfaces: 12% maximum
   3. Horizontal Concrete Surfaces: 8% maximum

D. Correct conditions detrimental to timely and proper execution of Work.

E. Do not proceed until unsatisfactory conditions have been corrected.

F. Commencement of installation constitutes acceptance of conditions and responsibility for satisfactory performance.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.

B. Protection:

   1. Take precautionary measures to prevent fire hazards and spontaneous combustion. Remove empty containers from Site.

2. Place cotton waste, cloths and hazardous materials in containers, and remove from Site daily.
3. Provide drop cloths, shields, and other protective equipment.
4. Protect elements surrounding work of this section from damage or disfiguration.
5. As Work proceeds, promptly remove spilled, splashed, or splattered materials from surfaces.
6. During application of coating materials, post Wet Paint signs.
7. During application of solvent-based materials, post No Smoking signs.

C. Clean surfaces of loose foreign matter.

D. Remove substances that would bleed through finished coatings; if removal is not possible, seal surface with shellac.

E. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

F. Existing Painted and Sealed Surfaces:

1. Remove loose, flaking, and peeling paint, and feather edge and sand smooth edges of chipped paint.
2. Clean with mixture of trisodium phosphate and water to remove surface grease and foreign matter.

G. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Surfaces shall be mechanically cleaned to remove passivation and to provide a uniform 1.0 mil anchor profile.

H. Ferrous Metal:

1. Surfaces shall be free of residual deposits of grease, rust, scale, dirt, dust, and oil.

a. Immersion Service: SSPC-SP 10 Near White Blast Cleaning
b. Non-Immersion Service: SSPC-SP 6 Commercial Blast Cleaning.

2. Field Repair of Shop Primed Surfaces:

a. Non-Immersion Service: Remove all dirt, dust, chalk, oil, grease, as well as any other foreign matter by solvent cleaning (SSPC-SP 1) and/or power washing. All areas damaged during transportation, construction or installation shall be cleaned in accordance with SSPC-SP 11 Power Tool Cleaning to Bare Metal or SSPC-SP 6 Commercial Blast Cleaning. All edges shall be feathered. All surfaces shall be clean and dry prior to coating
b. Immersion Service: Remove all dirt, dust, chalk, oil, grease, as well as any other foreign matter by solvent cleaning (SSPC-SP 1) and/or power washing. All areas damaged during transportation, construction or installation shall be cleaned in accordance with SSPC-SP 10 Near White Blast Cleaning. All edges shall be

feathered. The remainder of the intact shop primer shall be cleaned in accordance with SSPC-SP 7 Brush-Off Blast Cleaning to provide a minimum, uniform, anchor profile of at least 1.0 mil. In order to prevent injury to surrounding painted areas, blast cleaning may necessitate use of lower air pressure, small nozzle and abrasive particle sizes, short blast nozzle distance from surface, shielding and masking. If damage is too extensive to touch-up, item shall be re-cleaned and coated or painted. All surfaces shall be clean and dry prior to receiving the specified finish coat(s).

3. For surfaces not shop primed, surfaces shall be cleaned in compliance with specifications of Steel Structures Painting Council as indicated in Schedule of Coating Systems below.

3.3 APPLICATION

A. Comply with MPI - Architectural Painting Manual.

B. Apply primer to each surface, unless specifically not required by coating manufacturer.

C. Apply coating systems in compliance with manufacturer's instructions and using application method best suited for obtaining full, uniform coverage of surfaces to be coated.

D. Apply primer, intermediate, and finish coats to comply with wet and dry film thickness and spreading rates for each type of material as recommended by manufacturer.

1. Application rates in excess of those recommended and fewer numbers of coats than specified shall not be accepted.

E. Number of coats specified shall be minimum number acceptable. Apply additional coats as needed to provide a smooth, even application.

1. Closely adhere to re-coat times recommended by manufacturer. Allow each coat to dry thoroughly before applying next coat. Provide adequate ventilation for tank interior to carry off solvents during drying phase.

F. Employ only application equipment that is clean, properly adjusted, and in good working order, and of type recommended by coating manufacturer.

G. After surface preparation, interior weld seams shall receive a stripe coat applied by brush.

H. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping.

I. Apply coatings to specified thicknesses.

J. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish.

K. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspecting and Testing: Comply with MPI - Architectural Painting Manual.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Collect waste material that may constitute fire hazard, place in closed metal containers, and remove daily from Site.

C. Clean surfaces immediately of overspray, splatter, and excess material.

D. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

E. COLOR SYSTEM MATERIAL IDENTIFICATION

1. A schedule, approved by Engineer and Owner, shall be submitted prior to any material receiving color coatings.

2. The high-performance coating manufacturer shall submit their color selection along with manufacturer’s color numbers.

3.6 SCHEDULE

1. See plans.

END OF SECTION 09 96 00

SECTION 13 31 00 – FIBERGLASS REINFORCED BUILDING ENCLOSURE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pre-engineered shelters
2. Electrical wiring and devices for pre-engineered structures
3. Heating equipment for pre-engineered structures
4. Ventilation equipment for pre-engineered structures
5. Air conditioning equipment for pre-engineered structures

B. Related Requirements:

1. Section 03 30 00 – Cast-in-place concrete: Concrete pad
2. Division 26 – Electrical connections

1.2 REFERENCE STANDARDS

A. ASTM C 518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

B. ASTM D 256 – Standard Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.

C. ASTM D 618 – Standard Practice for Conditioning Plastics for Testing.

D. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.

E. ASTM D 732 – Standard Test Method for Shear Strength Plastics by Punch Tool.

F. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

G. ASTM D 792 – Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

H. ASTM D 1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.

I. ASTM D 2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Certified independent test results of representative wall laminate.

C. Shop Drawings:

1. Critical dimensions, jointing and connections, fasteners and anchors.
2. Materials of construction.
3. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.
4. Color.

D. Manufacturer's installation instructions

E. Structural design calculations, sealed by an independent licensed Professional Engineer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

1.6 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The fiberglass reinforced building enclosure shall be manufactured by:

1. TRACOM, Inc., Alpharetta, GA
2. Or Pre-Approved Equal.

2.2 SYSTEM DESCRIPTION

A. Provide one-piece molded construction FRP shelter of the following type:

1. Size: 12’-0” W x 16’-0” D x 7’-11” H.

2.3 MATERIALS

A. One-piece Molded Composite Construction:

1. General Construction: The shelter shall be provided with a smooth interior and exterior satin finish. The walls and roof shall be integral with smooth radii for all corners. No roof overhang shall be allowed. External section connection flanges shall only be allowed in those instances where the shelter is oversized.
2. Laminate: Isophthalic polyester resin with high performance, chopped, commercial grade glass strand fiber reinforcement with a suitable coupling agent.

a. Minimum glass content: 30%.
b. Exterior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a satin finish lightly textured and free from fiber pattern, roughness, or other irregularities.
c. Exterior laminate: 1/8 inch thick (minimum); chemically bonded to the surface gel coat and encapsulating the foam core.
d. Foam core (2.2.A.2)
e. Interior laminate: 1/8 inch thick (minimum); chemically bonded to the interior gel coat and encapsulating the foam core.
f. Interior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a textured finish, free from exposed glass or other irregularities.
g. Laminate properties:

1)	Tensile strength (ASTM D 638):	14,000 psi
2)	Flexural strength (ASTM D 790):	27,000 psi
3)	Flexural modulus (ASTM D790):	1,000,000 psi
4)	Shear strength (ASTM D 732):	12,000 psi
5)	Barcol hardness (ASTM D 2583):	40
6)	Density / specific gravity (ASTM D792)	93.6 pcf/1.5

3. Core:

a. Rigid closed cell, self-extinguishing (Class 1), polyisocyanurate foam with a density of 2.5 pounds per cubic foot. Foam shall be P250 Elfoam without exception. Lower density foams shall not be acceptable.

1) 1 inch thick with an initial insulating value of R~7.

b. Core properties:

1) Thermal conductivity

a) (ASTM C 518): 0.145 BTU inch/hr/SF/°F

2) Density / specific gravity

a) (ASTM D 1622): 2.5 PCF

3) Shear Strength

a) (ASTM C 273): 25 lb/in2

4) Tensile Strength

a) (ASTM D 1623): 45 lb/in2

5) Compressive Strength (7% deflection/yield)

a) (ASTM D 1621): 35

2.4 COMPONENTS

A. Doors

1. Quantity

a. 72” double door with viewing window.

2. Construction

a. One-piece molded fiberglass construction 78 inches high, 1-3/4 inches thick, and 36” wide (each).
b. Mount door with two T-304 stainless steel laminated strap hinges, 5 inches long. Door must be readily replaceable – the use of continuous piano hinges or fastening methods other than bolting shall not be acceptable.
c. Rubber bulb gasket with flexible lock to retain permanent grip.
d. One-piece, purpose built, 3 inches deep fiberglass drip cap over doors; drip cap to extend 2 inches each side past door. Cut angle shall not be acceptable.
e. Full threshold, heavy duty black vinyl, 4-1/2 inches deep x 1/2 inch high.
f. Schlage stainless steel single-point key locked classroom style ball knob. To facilitate entry and exit from the building, raised or integral door sills shall not be acceptable.
g. Heavy duty stainless steel, dual compression spring cushioned overhead door stop, designed for BHMA L52231 and ANSI A156.16.
h. Provide single-flap neoprene insert style door sweep.

B. Lifting Eyes

1. Provide a minimum of two removable, 3/4 inch – 10 partially threaded, eye bolts with 6 inch shank lengths.

a. Steel (5,200 lbs. work load limit)

C. Mounting Flange

1. 3 inches wide x 1/4 inch thick (minimum) with closed cell neoprene sponge rubber gasket 1-1/4 inches wide x 3/8 inch thick to provide a weather tight seal around the building perimeter.

    a. Internal

2.5 EQUIPMENT

A. Electrical

1. Receptacles: GFCI receptacle 15A 125V, 20 A 125V feed-through, with 5mA +/- 1mA trip threshold.

    a. Interior. As required for the polymer equipment. Number of interior receptacles to be confirmed during submittals.
    b. Exterior: Include two (1) exterior mounted receptacle with extra-duty in-use weatherproof cover.

B. Shutter

1. FRP, gravity operated, 304 stainless steel screen
2. Size: 10”x10”

C. Lighting: See electrical drawings

2.6 CORROSION ENVIRONMENT ACCESSORY PACKAGE

A. Pre-wired (12 gauge THHN in Sch. 40 PVC conduit)

B. Load Center, NEMA 1, 125A, Main Lug, 120/240 VAC, 1 phase, 8 branch

C. Load Center Casing, NEMA 4X, FRP

D. Circuit Breakers, 15A/20A, 1P (for provided electrical only)

E. Duplex outlet, commercial grade, 15 A, GFCI, weatherproof cover

F. Switch, weatherproof, single toggle (light & fan on same switch)

G. Light Fixture, Jelly Jar type, NEMA 4X, A21 bulb accepted, 150W maximum

H. Fan, exhaust, corrosion resistant, 10" 524 CFM, shutter-mounted

I. Heater, 1,500 watt, 304 stainless steel, surface mount, 95 CFM, thermostat

J. Shutter, FRP, gravity operated, 304 S.S. insect screen, 10" x 10"

K. Mounting panel, marine-grade plywood, embedded in-wall, 42" x 48" x ¾" T

L. (2) Hoods, Small, fiberglass, 14" W x 7" D x 14" H (for fan and shutter)

2.7 FINISHES

A. Exterior Color: #2445 Gray Cloud

B. Interior Color: #2445 Gray Cloud

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that the concrete slab is level, true to plane, and of the correct dimensions to receive the structure. Correct all deficiencies before proceeding.

3.2 INSTALLATION

A. Install products in accordance with engineer's instructions, plans, blueprints, local codes, etc. and in a manner consistent with the installation instruction and recommendation of the manufacturer.

3.3 ADJUSTING AND CLEANING

A. Clean surfaces in accordance with the manufacturer's instructions.

B. Remove trash and debris and leave the site in a clean condition.

END OF SECTION 13 31 00

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

B. Summary of work:

The project consists of electrical work in order to increase the overall treatment capacity of the existing facility as shown on the drawings. Major elements of the work include, but are not limited to the following:

1. Provide, install, and test one (1) new 480/277V, 3Ph Panelboard (PP-2)
2. Provide, install, and test one (1) new 125kW diesel Generator. Diesel generator shall include 24-hr rated sub-base fuel tank, weather protection enclosure, electrical connections for block heater and battery charger.
3. Provide, install, and test various standalone adjustable frequency drives, Control Panels, Starters as shown on the drawings.
4. Provide, install, and test various electrical components, such as dry-type transformers, panelboards, etc. as shown on the drawings.
5. Provide all the required modification to existing electrical gears as noted on drawings to accommodate the plant expansion new loads.
6. Provide and install new site lighting around process equipment as shown on the design drawings.
7. Provide and install a complete electrical system to provide power to the new vendor supplied equipment associated with the plant expansion.

1.2 ACTION SUBMITTALS

A. Provide Data For:
1. Electrical service components.
2. Internet service components.
3. Nameplates, signs, and labels.

B. Provide preliminary submittal for sequence of construction 14 days in advance of coordination meeting. Preliminary submittal shall include items listed in special project requirements.

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
b. Z535.4, Product Safety Signs and Labels.

3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL).

1.4 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark or label.

C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the site ambient temperature range.

2.2 EQUIPMENT FINISH

A. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with, light gray color finish as approved by Owner.

2.3 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Letter Height:
1. Pushbuttons/Selector Switches: 1/8 inch.
2. Other electrical equipment: 1/4 inch.

2.4 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

PART 3 - EXECUTION

3.1 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.

C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.2 ANCHORING AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer’s requirements.

3.3 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Homerun circuits shown on Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:
1. Analog control circuits from devices in same general area to same destination.
a. No power or AC discrete control circuits shall be combined in same conduit with analog circuits.

b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, paging system circuits shall be combined with power or Class 1 circuits.
c. Analog circuits shall be continuous from source to destination. Do not add TJB, splice, or combine into a multi-pair cable without authorization of Engineer.
d. Raceways: shall be sized per General Circuit and Raceway Schedule and do not exceed 40 percent fill.
e. Changes shall be documented on Record Drawings.

2. Discrete control circuits from devices in the same general area to the same destination.
   a. No power or analog control circuits shall be combined in same conduit with discrete circuits.
   b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
   c. Raceways shall be sized per the General Circuit and Raceway Schedule and do not exceed 40 percent fill.
   d. Changes shall be documented on Record Drawings.
3. Power circuits from loads in same general area to same source location (such as: panelboard, switchboard, low voltage motor control center).
   a. Lighting Circuits: Combine no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Provide a separate neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   c. All Other Power Circuits: Do not combine power circuits without authorization of Engineer.

3.4 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:
1. Field mark Switchgear, switchboards, motor control centers, and panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
2. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis as basis for warning signs.

B. Equipment Nameplates:
1. Provide a nameplate to label electrical equipment including switchgear, switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
2. Switchgear, motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

3.5 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.6 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming. Includes all electrical gear and cabinets.

B. Touchup Paint:
   1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
   2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.7 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

END OF SECTION

SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes basic materials and methods common to all sections of Division 26

1.2 ACTION SUBMITTALS

A. Product Data For:
1. Control devices.
2. Control relays.
3. Circuit breakers.
4. Fused switches.
5. Nonfused switches.
6. Timers.
7. Fuses.
8. Enclosures: Include enclosure data for products having enclosures.

1.3 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:
1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

1.4 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
b. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy with Improved Formability and Ultra-High Strength.
c. E814 Standard Test Method for Fire Tests of Penetration Firestop Systems.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. Instrumentation, Systems, and Automation Society (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
b. AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
c. C12.1 Code for Electricity Metering

d. C12.6 Phase-Shifting Devices Used in Metering, Marking and Arrangement of Terminals
e. CP 1, Shunt Capacitors.
f. ICS 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
g. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
h. KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)

6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 810, Standard for Capacitors.
   g. 943, Standard for Ground-Fault Circuit-Interrupters.
   h. 1059, Standard for Terminal Blocks.
   i. 1479, Standard for Fire Tests of Penetration Firestops.

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:
1. Type: Molded case.
2. Trip Ratings: 15-800 amps.
3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
4. Suitable for mounting and operating in any position.
5. NEMA AB 1 and UL 489.

B. Operating Mechanism:
1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in open position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a center position when tripped.

C. Trip Mechanism:
1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:
   1. Equal to, or greater than, available fault current or interrupting rating shown.
   2. Equal to rating of existing equipment.
   3. Not less than the following RMS symmetrical currents for the indicated trip ratings:
      a. Up to 100A, less than 250V ac: 14000 amps.
      b. Up to 100A, 250-600V ac: 22,000 amps.
      c. Over 100A: 65,000 amps.
   4. Series Connected Ratings: Do not apply series connected short circuit.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).
   1. Ground fault sensor shall be rated same as circuit breaker.
   2. Push-to-test button.

F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL-listed for equipment ground fault protection).

G. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

H. Connections:
   1. Supply (line side) at either end.
   2. Mechanical wire lugs, except crimp compression lugs where shown.
   3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
   4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
   5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.

I. Enclosures for Independent Mounting:
   1. See Article Enclosures.
   2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
   3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.2 DISCONNECT SWITCHES

A. Disconnect Switches: UL-98 and NEMA KS-1; heavy duty, quick make, quick break type; horsepower and i2t rated. Provide lever type operating handle directly connected to the switch mechanism; rocker types are not acceptable. Include padlocking provisions and nameplate clearly indicating “ON” and “OFF” positions. Equip all switches with a ground lug and, where neutral conductors are scheduled, provide insulated neutral lugs.

B. Fusible Switches: Equip with rejection clips for fuse types noted. Fuses shall be Class R, J, or L where required with 200,000A short circuit rating.

C. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.
2. Lugs removable/replaceable.
3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

D. Enclosures: As indicated on the drawings.

E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

F. Acceptable Manufacturers: Eaton, General Electric/ABB, Square D or Siemens.

G. Hazardous Areas: Where Division 1 or 2 classified areas are indicated, provide switches equal to Crouse-Hinds type FLS.

2.3 FUSES

A. Fuses: Current limiting, non-renewable type, rated 200,000 AIC, with rejection feature; Class J or as required by load for ratings 600 amp and below and Class L for ratings 601 amp and above.

B. Acceptable Manufacturers: Bussmann, Chase-Shawmut, or Littelfuse.

2.4 WIRING DEVICES

A. Wall Switches: NEMA WD 1; FS W S 896; 20 amp, 120/277 volt, specification grade; horsepower rated; quiet type; back and side wiring provisions; toggle handle.

B. Convenience Receptacles: NEMA WD 1; FS W C 596; 15 amp, 125 volt, specification grade; impact resistant nylon face; back and side wiring provisions; grounding screw. Where CR or NEMA 4X is indicated, provide corrosion resistant receptacle, yellow nylon body, one-piece brass contacts. Exception: Provide 5-20R receptacles for branch circuits serving one device.

C. Specific Use Receptacles: NEMA WD 1 or WD 5; type as indicated. For branch circuits serving a single device, match device rating to branch circuit rating.

D. Receptacle, Ground Fault Interrupter: Duplex, specification grade, tripping at 5-milliamps; 125-volt, configuration 5-20R.

E. Device Colors: Gray, unless otherwise selected by the Architect for specific use devices.

F. Indoor Device Plates: Type 302 stainless steel, 0.030 inch thick minimum, satin finish.

G. Indoor Corrosion Resistant (NEMA 4X) Cover Plates: Type 302 stainless steel, specification grade, gasketed, with silicone rubber mat, equal to Pass & Seymour 4515 or 4515FS for toggle switches. Cast aluminum, gasketed, equal to Pass & Seymour CA Series receptacles. For devices which are continuously plugged in, provide cast aluminum, suitable for wet locations while-in-use, equal to Hubbell WP26.

H. Outdoor Weatherproof (NEMA 3R and NEMA 4X) Cover Plates: Stainless steel, specification grade, gasketed equal to Sierra WP Series. For heat tape, instruments, or other devices which are

continuously plugged in, provide die cast aluminum, suitable for wet locations while in use, equal to Hubbell WP26.

2.5 INDIVIDUAL MOTOR STARTERS

A. Manual Starters: NEMA ICS-2; general purpose type; trip-free mechanism; with overload relays. Provide pushbutton operation for integral horsepower sizes, and toggle switch or lever for fractional sizes.

B. Magnetic Starters: NEMA ICS-2; NEMA size 1 minimum; magnetically held contactor with field replaceable coil and contacts; bimetallic or melting alloy overload relay, manually reset. Starter shall be rated in accordance with NEMA size designations; fractional sizes and ratings per IEC recommendations are not acceptable.

C. Magnetic Starter Controls: All controls are 120 volts. Equip each starter with a control power transformer fused on the primary and secondary. Provide starter overload relay auxiliary contacts for red run light, green stop light and amber overload light on the enclosure door. Provide one spare normally open starter auxiliary contact, and door mounted start-stop pushbuttons or hand-off-auto selector switch as indicated.

D. Combination Starters: Molded case circuit breaker rated 22,000 AIC as a minimum.

E. Enclosure: As shown on the drawings.

F. Acceptable Manufacturers: Allen-Bradley, Eaton, General Electric/ABB, Siemens or Square D.

G. Hazardous Areas: Where Division 1 or 2 classified areas are indicated, provide starters equal to Crouse-Hinds types EPC, EMG, EMN, or EFS/EFD.

2.6 CONTACTORS

A. Control Relays: NEMA A600; heavy duty, machine tool type convertible contacts; electrically held 120 volt coil. Equal to Allen-Bradley Bulletin 700 Type P.

B. General Purpose Contactors: NEMA ICS-2; electrically held; 2-wire control; 120 volt coil. Size and number of contacts as indicated.

C. Lighting Contactors: NEMA ICS-2; mechanically held; 3 wire control; 120 volt coil. Size and number of contacts as indicated.

D. Enclosure: NEMA ICS-6; Type 1 unless otherwise noted.

E. Acceptable Manufacturers: General Electric, Square D, ASCO, or Cutler-Hammer.

2.7 CONTROL STATIONS

A. Pushbuttons, Selectors and Pilot Lights: 600 volt, heavy duty, factory sealed.

B. Enclosure: Stainless steel meeting NEMA 4X and NEC Class I, Division 2, Group C and D requirements.

C. Acceptable Manufacturers: Equal to Allen-Bradley Bulletin 800T.

D. Hazardous Areas: Where Division 1 classified areas are indicated, provide control stations equal to Crouse-Hinds EFS/EFD series.

2.8 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:
1. Material: Rolled, mild strip steel, 12-gauge minimum, ASTM A1011/A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

C. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

D. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge minimum.

E. Extruded Aluminum Framing Channel:
1. Material: Extruded from Type 6063-T6 aluminum alloy.
2. Fittings fabricated from Alloy 5052-H32.

F. Nonmetallic Framing Channel:
1. Material: Fire retardant, fiber reinforced vinyl ester resin.
2. Channel fitting of same material as channel.
3. Nuts and bolts of long glass fiber reinforced polyurethane.

G. Manufacturers:
1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

2.9 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrode position process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer’s standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

PART 3 - EXECUTION

3.1 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

3.2 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Unless otherwise shown, install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Unless otherwise shown, install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas.

3.3 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type:
   1. Interior, Wet or Dry (Noncorrosive) Locations:
      a. Raceways: Carbon Steel (Hot-dip galvanized).
      b. Conduits: Carbon Steel (Hot-dip galvanized).
      c. Steel Raceway and Other Systems Not Covered: Carbon Steel (Hot-dip galvanized)..
   2. Interior, Corrosive (Wet or Dry) Locations:
      a. Raceways: Stainless Steel.
      b. Conduits: Stainless Steel.
      c. PVC-Coated Steel Conduit and Other Systems Not Covered: Stainless Steel.
   3. Outdoor, Noncorrosive Locations:
      a. Raceways: Carbon Steel (Hot-dip galvanized), except where mounted on aluminum handrail, then use aluminum framing channel.
      b. Raceway and Other Systems Not Covered: Carbon Steel (Hot-dip galvanized).
   4. Outdoor Corrosive Locations:
      a. Conduits: Stainless Steel.
      b. Raceways: Stainless Steel.
      c. PVC-Coated Steel Conduit and Other Systems Not Covered: Stainless Steel.

C. Paint cut ends prior to installation with the following:
   1. Carbon Steel Channel: Zinc-rich primer.
   2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
   3. Nonmetallic Channel: Epoxy resin sealer.
   4. PVC-Coated Channel: PVC patch.

END OF SECTION

SECTION 26 05 05
CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes all cables and conductors to be used for the connection of equipment covered under section 26.

1.2 ACTION SUBMITTALS

A. Wire and cable descriptive product information.

B. Wire and cable accessories descriptive product information.

1.3 INFORMATIONAL SUBMITTALS

A. Factory Test Report for conductors 600 volts and below.

1.4 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
   2. ASTM International (ASTM):
      a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. B3, Standard Specification for Soft or Annealed Copper Wire.
      c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      d. B496, Standard Specification for Compact Round ConcentricLay-Stranded Copper Conductors.
   3. Electronic Industries Alliance (EIA), Telecommunications Industry Association (TIA): TIA-568-B, Commercial Building Telecommunications Cabling Standard.
   4. Insulated Cable Engineer’s Association, Inc. (ICEA):
      a. S-58-679, Standard for Control Cable Conductor Identification.
      b. S-73-532, Standard for Control Cables.
      c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations 2.5 kV through 765 kV
      b. 386, Separable Insulated Connector Systems for Power Distribution Systems Above 600V.

c. 404, Standard for Extruded And Laminated Dielectric Shielded Cable Joints Rated 2,500 V to 500,000 V.

6. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables - ICEA S-73-532.
   c. WC 70, Standard for Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
   d. WC 71, Standard for Nonshielded Cables Rated 2,001-5,000 Volts for Use in the Distribution of Electric Energy.
   e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
7. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
8. Underwriters Laboratories Inc. (UL):
   a. 13, Standard for Safety Power-Limited Circuit Cables.
   b. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety Flexible Cord and Cables.
   d. 486A-486B, Wire Connectors.
   e. 486C, Standard for Splicing Wire Connections.
   f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   g. 854, Standard for Safety Service-Entrance Cables.
   h. 1072, Standard for Safety Medium-Voltage Power Cables.
   i. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   j. 1569, Metal Clad Cables.
   k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.5 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):
   1. Provide the Work in accordance with NFPA 70. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
   2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark.

B. Terminations and Splices for Conductors above 600 Volts: Work shall be done by Journeyman Lineman with splicing credentials.

PART 2 - PRODUCTS

2.1 CONDUCTORS 600V AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type:
1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper

C. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

D. Flexible Cords and Cables:
1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.2 600V RATED CABLE

A. Building Wire:
1. Thermoplastic Insulated Building Wire: NEMA WC-5.
2. Cross linked polyethylene- insulated.
3. Feeder and Branch Circuits: Single stranded conductor; 98% conductivity copper; 75/90ºC; 600 volt PVC insulated with nylon jacket; type THWN/THHN. Minimum size #12 AWG.
4. Feeder Conductors larger than 250 KCMIL; single stranded conductor copper; 90ºC; 600 volt; flame retardant moisture resistant cross linked polyethylene insulated; type XHHW-2; minimum size 300 KCMIL.
5. Control Circuits: Same as specified above for feeder and branch circuits, except minimum size #14 AWG.

B. Control Cable:
1. Conductors:
a. 14 AWG, seven-strand copper.
b. Insulation: 15-mil PVC with 4-mil nylon.
c. UL 1581 listed as Type THHN/THWN rated VW-1.
d. Single or multi conductor construction.
e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu per hour Vertical Tray Flame Test.
3. Cable Sizes:

No. Of Conductors	Max Outside Diameter (in)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
9	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:

a. Okonite Co.
b. Southwire

C. Multiconductor Power Cable:
1. General:
a. Meet or exceed UL 1581 for cable tray use.
b. Meet or exceed UL 1277 for direct burial and sunlight-resistance.
c. Overall jacket: PVC.
2. Conductors:
a. Class B stranded, coated copper.
b. Insulation: Chemically cross-linked ethylene-propylene or crosslinked polyethylene.
c. UL rated VW-1 or listed Type XHHW-2.
d. Color Code:
1) Conductors, size 8 AWG and smaller, colored conductors, ICEA S-58-679, Method 1, Table 1.
2) Conductors, size 6 AWG and larger, ICEA S-73-532, Method 4.
3. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. Of Current Carrying Conductors	Max. Outside Diameter (in)	Nominal Jacket Thickness (Mils)
12	12	2	0.42	45
		3	0.45	45
		4	0.49	45
10	10	2	0.54	60
		3	0.58	60
		4	0.63	60
8	10	3	0.66	60
		4	0.75	60
6	8	3	0.74	60
		4	0.88	60
4	6	3	0.88	60
		4	1.04	80
2	6	3	1.01	80
		4	1.16	80
1	6	3	1.10	80
		4	1.25	80
1/0	6	3	1.22	80
		4	1.35	80
2/0	4	3	1.32	80
		4	1.53	80
3/0	4	3	1.40	80
		4	1.60	80
4/0	4	3	1.56	80
		4	1.78	110

5. Manufacturers:
   a. Okonite Co.
   b. Southwire

D. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
   1. Outer Jacket: 45-mil nominal thickness.
   2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.

3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC, 600VAC rated.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors, black and red.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

E. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
1. Outer Jacket: 45-mil nominal.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
3. Dimension: 0.32-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand, tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC, 600VAC rated.
   d. Jacket: 4-mil nylon.
   e. Color Code: Triad conductors black, red, and blue.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

F. 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 57 requirements.
1. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
   b. Tinned copper drain wires.
   c. Pair drain wire size AWG 20, group drain wire size AWG 18.
   d. Insulation: 15-mil PVC, 600VAC rated.
   e. Jacket: 4-mil nylon.
   f. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
   g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number of Pairs	Max. Outside Diameter (in)	Nominal Jacket Thickness (Mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers
   a. Okonite Co.
   b. Alpha Wire Co.
   c. Belden

G. Multi-Conductor Adjustable Frequency Drive (AFD and VFD) Power Cable:
1. Conductors:
   a. Class B, stranded coated copper.
   b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW-2.
   c. Grounding Conductors: Insulated stranded copper.
2. Sheath:
   a. UL 1277 Type TC, 90 degrees C.
   b. Continuous shield, A1/polyester foil, drain wires, overall copper braid.
3. Outer Jacket: Polyvinyl chloride (PVC) per UL 1569.
4. Cable Sizes:

Conductor Size (AWG)	Minimum Ground Wire size (AWG)	No. Of Insulated Conductors	Max Outside Diameter (in)	Jacket Thickness (Mils)
12	12	4	0.610	50
10	10	4	0.670	50
8	8	4	0.910	50
6	6	4	1.010	50
4	4	4	1.150	50
2	2	4	1.310	50

5. Manufacturers and Products:

   a. Belden, Series 29500.
   b. Alpha Wire, Series V.
   c. LAPP USA, OLFLEX VFD Slim.

2.3 SPECIAL CABLES

A. Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:
1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-B.2-1 Category 6 requirements.
2. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.

3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
4. NFPA 70 Plenum (CMP) rated, comply with flammability plenum requirements of NFPA 70 and NFPA 262.
5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
6. Manufacturer and Product: Belden; 7852A.

B. Data Highway Cable, Allen-Bradley "Blue Hose."
1. Meet or exceed electrical characteristics of Allen-Bradley Catalog No. 1770-CD.
2. Approved by Allen-Bradley for use with A-B programmable logic controller systems.
3. Outer Jacket: Blue PVC.
4. Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
5. Drain: 55 percent tinned copper braid and drain wire.
6. Dimension: 0.243-inch nominal OD.
7. Conductors:
   a. One pair #20 AWG, seven-strand tinned copper.
   b. Insulation: Polyethylene.
   c. Color Code: Blue and clear.
8. Manufacturers:
   a. Allen-Bradley.
   b. Belden.

C. DeviceNet Round Cable, 600V, Class 1, Two Twisted, Shielded Pairs with a Common Overall Shield:
1. Outer Jacket: PVC.
2. Overall Shield: Tinned copper braid, 18 AWG tinned copper drain wire.
3. Individual Pair Shield: Aluminum foil-polyester tape.
4. Dimension: 0.460-inch nominal OD.
5. Conductors:
   a. 15 AWG stranded tinned copper.
   b. Insulation: FEP.
6. Manufacturer and Product: Belden; 7897A.

D. DeviceNet Flat Cable, 600V, Class 1, Four Conductor Unshielded Network Trunk Cable:
1. Outer Jacket: Thermoplastic Elastomer (TPE).
2. Conductors: Four conductor, unshielded, flat configuration.
3. Manufacturer and Product: Allen-Bradley; 1485C-P1E.

E. Fiber Optic Cable

1. Fiber optic cable shall be optic multimode, loose tube, all-dielectric cable, Siemens, Nordx/CDT, Belden, or approved equal, and meet the following specifications:

Cladding Diameter	125.0 Microns
Core Diameter	62.5 Microns
Attenuation Range	≤0.8 dB/KM at 1300 NM ≤3.1 dB/KM at 850 NM

Bandwidth Range	≥600 Mhz-KM at 1300 NM ≥200 Mhz at 850 NM
Cable Construction	Splitable outdoor cable
Core Type	Hollow core, filled
Materials	
– basic element	PVC, gray
– strain relief	Kevlar fibers and impregnated glass
– outer sheath/cable color	PVC black
Mechanical Characteristics	
– dimensions of basic element	(3.5 ± 0.2) mm dia
– cable dimensions	(6.3 X 9.8) ± 0.4 mm
– cable weight	aprox. 65 kg/km
– permissible tensile load	≤ 500 N (short time)
– bending radii	≥ 100 mm Over flat side only
Permissible Ambient Conditions	
– laying and installation temp.	-5°C to +50°C
– operating temperature	-25°C to +60°C
– storage temperature	-25°C to +70°C

Cable shall be compliant with EIA, ANSI Standards, graded index. All fibers must be color coded for easy identification with all-dielectric construction. All cables shall be of an insulation type rated for the purpose of installation. Where shown on Contract Drawings all fiber optic conduit run shall contain redundant 24 strand fiber optic cables as specified in this section.

2. Connector Type BFOC.

3. Coordinate the exact fiber cable requirement with the SCADA system integrator.

2.4 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.5 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer.
   b. Manufacturers and Products:
      1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

B. Identification Devices:
1. Sleeve:
   a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturers and Products:
      1) Raychem; Type D-SCE or ZH-SCE.
      2) Brady, Type 3PS.
2. Heat Bond Marker:
   a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
   b. Self-laminating protective shield over text.
   c. Machine printed black text.
   d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-On Cable Marker Tags:
   a. Chemical-resistant white tag.
   b. Size: 1/2 inch by 2 inches.
   c. Manufacturer and Product: Raychem; Type CM-SCE.
5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:
1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulug.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Seamless.
   c. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO; ILSCONS.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. UL 486C.
   b. Plated steel, square wire springs.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
4. Self-Insulated, Set Screw Wire Connector:
   a. Two piece compression type with set screw in brass barrel.
   b. Insulated by insulator cap screwed over brass barrel.
   c. Manufacturers:

1) 3M Co.
2) Thomas & Betts.
3) Marrette.

D. Cable Lugs:
1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
b. Manufacturers and Products:
1) Thomas & Betts; Color-Keyed.
2) Burndy, Hydent.
3) ILSCO.
4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
a. Manufacturers and Products:
1) Thomas & Betts; Locktite.
2) Burndy; Quiklug.
3) ILSCO.

E. Cable Ties:
1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:
1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
a. Thomas & Betts; SHRINK-KON.
b. Raychem; RNF-100 and ES-2000.

G. Data Cable Accessories: Terminators, connectors, and junctions necessary for a complete DeviceNet system.

2.6 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:
1. Ideal Co.
2. Polywater, Inc.
3. Cable Grip Co.

2.7 WARNING TAPE

A. As specified in Section 26 05 33, Raceways and Boxes.

2.8 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

B. Conductors Above 600 Volts: Test in accordance with NEMA WC 71 and AEIC CS 6 partial discharge level test for EPR insulated cable.

PART 3 - EXECUTION

3.1 GENERAL

A. Conductor installation shall be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate all conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-centerspacing as required by equipment terminals.

G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

3.2 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:
   1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
   2. 8 AWG and Smaller: Provide colored conductors.
   3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120v 1Ph, 3W	Grounded Neutral	White
	One Hot Leg	Black
	Other Hot Leg	Red
208/120v 3Ph, 4W	Grounded Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120v 3Ph, 4W Delta, Center Tap Ground on 1Ph	Grounded Neutral	White
	Phase A	Black
	High (Wild) Leg	Orange
	Phase C	Blue
240/120v 1Ph, 3W	Grounded Neutral	White
	One Hot Leg	Black
	Other Hot Leg	Red
480/277v 3Ph, 4W	Grounded Neutral	White
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
NOTE: Phase A, B, C implies direction of positive Phase Rotation		

4. Tracer: Outer covering of white with an identifiable colored strip, other than green, in accordance with NFPA 70.

B. Conductors Above 600 Volts: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
   1. Colors:
      a. Grounded Neutral: White.
      b. Phase A: Brown.
      c. Phase B: Orange.
      d. Phase C: Yellow.

3.3 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:
   1. Assign circuit name based on device or equipment at load end of circuit.
   2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:
   1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
   2. Cables and Conductors 2 AWG and Larger:
      a. Identify with marker plates or tie-on cable marker tags.
      b. Attach with nylon tie cord.

3. Taped-on markers or tags relying on adhesives not permitted.

3.4 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.

C. Connections and Terminations:
1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    b. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:
1. Insulate all uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:
1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Cable Protection:
    a. Under Infinite Access Floors: May install without bundling.
    b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2 inch in diameter.
    c. Maintain integrity of shielding of instrumentation cables.
    d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.5 CONDUCTOR ARC AND FIREPROOFING

A. Install arc and fireproofing tape on 5 kV cables throughout their entire exposed length in manholes, handholes, vaults, cable trays, and other indicated locations.

B. Wrap conductors of same circuit entering from separate conduit together as a single cable.

C. Follow tape manufacturer's installation instructions.

D. Secure tape at intervals of 5 feet with bands of tapebinder. Each band to consist of a minimum of two wraps directly over each other.

3.6 UNDERGROUND DIRECT BURIAL CABLE

A. Warning Tape: Install approximately 3 inches above cable, aligned parallel to, and within 12 inches of centerline of the run.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

a. Test wells.
b. Ground rods.
c. Ground rings.
d. Grounding arrangements and connections for separately derived systems.

2. Instructions for periodic testing and inspection of grounding features at test wells and ground rings.

a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

b. Include recommended testing intervals.

1.5 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC)
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper, copper lugs. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:

1. Mechanical type, two pieces with stainless-steel bolts.

   a. Material: Tin-plated aluminum.
   b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Grounding shall be connected back to the grounding grid at the pumping station.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections as required.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system shall be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
4. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Stainless steel, Type 304.
3. Channel Width: Selected for applicable load criteria.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Stainless Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Comply with all applicable Codes' requirements for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
1. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

1.4 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges, Sixteenth Edition.
2. ASTM International (ASTM):
a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.

b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
e. D149, Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.

3. Electronic Industry Alliance (EIA) and Telecommunications Industry Association (TIA): 569, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. National Electrical Contractor's Association, Inc. (NECA):
   a. 101, Standard for Installing Steel Conduit (Rigid, IMC, EMT).
   b. 102, Standard for Installing Aluminum Conduits.
   c. 105, Recommended Practice for Installing Metal Cable Trays.
   d. 111, Standard for Installing Nonmetallic Raceway (RNC, ENT, LFNC).
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C80.1, Specification for Rigid Steel Conduit, Zinc Coated.
   c. C80.3, Specification for Electrical Metallic Tubing, Zinc Coated.
   d. C80.5, Specification for Rigid Aluminum Conduit.
   e. C80.6, Intermediate Metal Conduit (IMC) – Zinc Coated.
   f. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   g. TC 2, Electrical Polyvinyl Chloride (PVC) Plastic Tubing and Conduit.
   h. TC 3, Polyvinyl-Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   i. TC 6, PVC Plastic Utilities Duct for Underground Installation.
   j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   k. VE 1, Metallic Cable Tray Systems.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
   a. 1, Standard for Flexible Metal Conduit.
   b. 5, Standard for Surface Metal Raceways and Fittings
   c. 6, Standard for Electrical Rigid Metal Conduit – Steel.
   d. 6A, Standard for Electrical Rigid Metal Conduit – Aluminum, Bronze, and Stainless.
   e. 50, Standard for Enclosures for Electrical Equipment.
   f. 360, Standard for Liquid-Tight Flexible Steel Conduit.
   g. 514B, Standard for Conduit, Tubing, and Cable Fittings.
   h. 514C, Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
   i. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit.
   j. 651A, Standard for Type EB and A Rigid PVC Conduit and HDPE Conduit.
   k. 797, Standard for Electrical Metallic Tubing.
   l. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
   m. 1242, Standard for Intermediate Metal Conduit.
   n. 1660, Standard for Liquid-Tight Flexible Nonmetallic Conduit.
   o. 1684, Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   p. Standard for Optical Fiber and Communication Cable Raceway.

1.5 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):
1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.
3. PVC-Coated, Rigid Steel Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):
1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized with chromated protective layer.

B. Aluminum Rigid Conduit:
1. Meet requirements of UL 6; ANSI C80.1.
2. Material: aluminum; minimum size ¾-inch.

C. Intermediate Metal Conduit (IMC):
1. Meet requirements of NEMA C80.6 and UL 1242.
2. Material: Hot-dip galvanized with chromated and lacquered protective layer.

D. Electric Metallic Tubing (EMT):
1. Meet requirements of NEMA C80.3 and UL 797.
2. Material: Hot-dip galvanized with chromated and lacquered protective layer.

E. PVC schedule 40 Conduit:
1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

F. PVC tubing (Type EB):
1. Meet requirements of NEMA TC 6 and UL 651A.
2. UL listed for reinforced concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

G. PVC-Coated Rigid Galvanized Steel Conduit:
1. Meet requirements of NEMA RN 1.
2. Material:
a. Meet requirements of NEMA C80.1 and UL 6.
b. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength than PVC.

c. Interior finish: Urethane coating, 2-mil nominal thickness
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to interior or exterior coating.

H. Flexible Metal, Liquid-Tight Conduit:
1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

I. Flexible Metal, Nonliquid-Tight Conduit:
1. Meet requirements of UL 1.
2. Material: Galvanized steel.

J. Flexible, Nonmetalic, Liquid-Tight Conduit:
1. Material: PVC core with fused flexible PVC jacket
2. UL 1660 listed for:
a. Dry Conditions: 80 degrees C insulated conductors.
b. Wet Conditions: 60 degrees C insulated conductors.
3. Manufacturers and Products.
a. Carlon; Carflex or X-Flex.
b. T & B; Xtraflex LTC or EFC.

K. Innerduct:
1. Resistant to spread of fire, per requirements of UL 2024.
2. Smooth or corrugated HDPE.
3. Textile Manufacturer Maxcell.

2.2 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:
1. General:
a. Meet requirements of UL 514B
b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
b. Manufacturers and Products:
1) Appleton; Series BU-1.
2) O-Z/Gedney; Type HB.
3. Grounding Bushing:
a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C, with solderless lugs.
b. Manufacturers and Products:
1) Appleton; Series BU-1.
2) O-Z/Gedney; Type HBLG.
4. Conduit Hub:
a. Material: Malleable iron with integral insulated throat with bonding screw.
b. UL listed for use in wet locations.
c. Manufacturers and Products:
1) Appleton; Series HUB-B.
2) O-Z/Gedney; Series CH

3) Meyers; ST Series.

5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers and Products (For Normal Condition):
      1) Appleton; Form 35 threaded unilets.
      2) Crouse-Hinds; Form 7 or Form 8 threaded condulets.
      3) Killark; Series O electrolets.
      4) Thomas & Betts; Form 7 or Form 8.
   c. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: Assupplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Manufacturers and Products:
      1) Appleton; Series SCC bolt-on coupling or Series EC three-piece union.
      2) O-Z/Gedney; Type SSp split coupling or Type 4 Series, three-piece coupling.
      3) Killark; Series O electrolets.
      4) Thomas & Betts; Form 7 or Form 8.
8. Conduit Sealing Fitting:
   a. Manufacturers and Products:
      1) Appleton; Type EYF, EYM, or ESU.
      2) Crouse-Hinds; Type EYS or EZS.
      3) Killark; Type EY or Type EYS.
9. Drain Seal:
   a. Manufacturers and Products:
      1) Appleton; Type EYD.
      2) Crouse-Hinds; Type EYD or Type EZD.
10. Drain/Breather Fitting:
    a. Manufacturers and Products:
       1) Appleton; Type ECDB.
       2) Crouse-Hinds; Type ECD.
11. Expansion Fitting:
    a. Manufacturers and Products:
       1) Deflection/Expansion Movement:
          a) Appleton; Type DF.
          b) Crouse-Hinds; Type XD.
       2) Expansion Movement Only:
          a) Appleton; Type XJ.
          b) Crouse-Hinds; Type XJ.
          c) Thomas & Betts; XJG-TP.
12. Cable Sealing Fitting:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2 inch or less: Neoprene bushing at connector entry.
    c. Manufacturers and Products:
       1) Appleton; CG-S.
       2) Crouse-Hinds; CGBS.

B. Electric Metallic Tubing:

1. Meet requirements of UL514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Electro zinc-plated inside and out.
4. Raintight.
5. Coupling Manufacturers and Products:
   a. Appleton; Type 95T.
   b. Crouse-Hinds.
   c. Thomas & Betts.
6. Connector Manufacturers and Products:
   a. Appleton; Type ETP.
   b. Crouse-Hinds.
   c. Thomas & Betts.

C. PVC Conduit and Tubing:
1. Meet requirements of NEMA TC 3.
2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit:
1. Meet requirements of UL 514B.
2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
5. Overlapping pressure-sealing sleeves.
6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
7. Manufacturers:
   a. Robroy Industries.
   b. Ocal
8. Expansion Fitting:
   a. Manufacturer and Product: Ocal; OCAL-BLUE XJG.

E. Flexible Metal, Liquid-Tight Conduit:
1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Manufacturers and Products:
   a. Thomas & Betts; Series 5331.
   b. O-Z/Gedney; Series 4Q.

F. Flexible Metal, Nonliquid-Tight Conduit:
1. Meet requirements of UL 514B.
2. Body: Galvanized steel or malleable iron.
3. Throat: Nylon insulated.
4. 1-1/4-Inch Conduit and Smaller: One screw body.
5. 1-1/2-Inch Conduit and Larger: Two screw body
6. Manufacturers and Products: Appleton; Series 7400.

G. Flexible, Nonmetallic, Liquid-Tight Conduit:
1. Meet requirements of UL 514B.

2. Type: High strength plastic body, complete with lock nut, O-ring, threaded ferule, sealing ring, and compression nut.
3. Body/compression nut (gland) design to ensure high mechanical pullout strength and watertight seal.
4. Manufacturers and Products:
   a. Carlon; Type LT.
   b. Thomas & Betts; Series 6300.
   c. O-Z/Gedney; Series 4Q-P.

H. Flexible Coupling, Hazardous Locations:
1. Approved for use in atmosphere involved.
2. Rating: Watertight and UL listed for use in Class I, Division 1 and 2 areas.
3. Outer bronze braid and an insulated liner.
4. Conductivity equal to a similar length of rigid metal conduit.
5. Manufacturers and Products:
   a. Crouse-Hinds; Type ECGJH or Type ECLK.
   b. Appleton; EXGJH or EXLK.

I. Watertight Entrance Seal Device:
1. New construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer and Product: O-Z/Gedney; Type FSK or Type WSK, as required.
2. Cored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Manufacturer and Product: O-Z/Gedney; Series CSM.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 12 unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

H. Gangable boxes are prohibited.

I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Plastic.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

J. Cabinets:
   1. NEMA 250, Type 4X stainless steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC".
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: Galvanized Rigid Steel (non corrosive areas) and PVC Coated GRS (corrosive areas).
2. Concealed Conduit, Aboveground: IMC (non corrosive areas).
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: as indicated on the drawings.

B. Indoors: Apply raceway products as specified below unless otherwise indicated.
1. Exposed, Not Subject to Physical Damage: Galvanized Rigid Steel (non corrosive areas) and PVC Coated GRS (corrosive areas).
2. Exposed, Not Subject to Severe Physical Damage: Galvanized Rigid Steel (non corrosive areas) and PVC Coated GRS (corrosive areas).
3. Exposed and Subject to Severe Physical Damage: Galvanized Rigid Steel (non corrosive areas) and PVC Coated GRS (corrosive areas):
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: IMC (non corrosive areas).
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Galvanized Rigid Steel (non corrosive areas) and PVC Coated GRS (corrosive areas).
7. Boxes and Enclosures: as indicated on the drawings.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size above grade and 1” underground.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm) of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from RNC to GRC before rising above floor.

M. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35-mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:
1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

V. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F (0.06 mm per meter of length of straight run per degree C) of temperature change for PVC conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches (915 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors. Flexible conduit shall be type UA Sealtite with copper bands or engineer approved equal.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line below grade.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High density plastic boxes.

1.2 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.4 INFORMATIONAL SUBMITTALS

A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

D. Source quality-control reports.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

C. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.4 MANHOLE AND HANDHOLE CONSTRUCTION MATERIALS

A. Manholes:

1. Concrete: Where applicable, conform to Division 03 - Cast-In-Place Concrete, for concrete and reinforcing.
    a. Strength: 3000 psi (20.7 Mpa) minimum 28-day compressive strength.
    b. Aggregate for Duct Encasement: 3/8-inch maximum size.
2. Concrete Reinforcement: All underground structures, including duct banks, shall utilize concrete reinforced with rebar. Intent is for rebar details to be in accordance with the requirements of Division 03 – Concrete Reinforcement and Dowelling, and / or electrical details as shown on the Contract Drawings. In the details in Contract Drawings, structure and duct bank rebar shall be #4 steel rebar. Install rebar continuously near all the structure's or duct bank's top and bottom edges and corners, with additional #4 rebar spaced such that maximum spacing between rebars is 18-inches. Additionally, duct banks shall have #4 rebar placed across the top and bottom of the bank, every 18-inches, for the entire length of the duct bank.

B. Handholes:

1. Non Traffic Areas:
    a. Box: Polymer concrete from select-grade aggregates reinforced with fiberglass in combination with a polymer resin system.
    b. Cover: Polymer concrete type with locking bolts and pull slots
    c. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
    d. Size: Minimum size shall be 10" x 17" and Maximum size shall be 30" x 48". When larger enclosure is required, manhole construction shall be used.

2. Traffic Areas:
    a. Box: Reinforced, cast concrete with extension and bottom slab.
    b. Cover: Steel checked plate; H/20 loading with screw down.
    c. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.

2.5 MANHOLES AND HANDHOLESACCESSORIES

A. Cable racks, supports, pulling-in-irons, and hardware shall be hot dipped galvanized steel.

B. Precast concrete manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load. Precast manholes and handholes shall be as manufactured by Old Castle Precast, Inc., or approved equal.

C. Manhole frames and covers shall be cast-iron heavy-duty type for class H-20-wheel loading, and shall be as manufactured by Neenah, or equal. Manhole covers shall be marked Electrical Medium Voltage or Electric Low Voltage as applicable, in addition stamp the manhole covers with minimum 1-1/2-inch high letters and numbers for manhole identifi-

cation. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation. The minimum manhole cover diameter shall be 26".

D. Handhole covers and frames shall be hot dipped galvanized and designed for a Class H-20-wheel load. Handhole covers and hatches shall have Type 316 stainless steel security bolts. Handhole covers shall be marked Electric Medium Voltage or Electric Low Voltage as applicable, in addition stamp the handhole covers with minimum 1-1/2-inch high letters and numbers for handhole identification. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

E. Conduit bell ends shall be installed in all manholes.

F. Manholes and Handholes shall be installed to permit passive drainage of infiltration seepage as detailed on the Drawings. In the absence of such detail, provide 3-inch diameter PVC sleeve at low point of structure extending to a depth approximately 12-inches below the bottom surface of the structure. Provide a finely crushed and packed stone base below the structure to a total depth approximately 24-inches below the structure bottom to permit drainage. Provide drain cover at pipe termination in structure.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities,

underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.

B. Duct for Electrical Branch Circuits: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.

C. Underground Ducts Crossing Paved Paths, Driveways and Roadways: RNC Type EPC-40 PVC, encased in reinforced concrete.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures.

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope duct from a high point between two handholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

H. Terminator Entrances to Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls.

J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.

L. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.

3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

    a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

M. Underground-Line Warning Tape: Bury magnetic underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of ductbank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 12 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of handholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 260543

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 240-V Circuits:

a. Phase A: Black.
b. Phase B: Red.

4. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

5. Color for Neutral: White.
6. Color for Equipment Grounds: Green.
7. Colors for Isolated Grounds: Green with white stripe.

C. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

E. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameter and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameter and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameters of and shrunk to fit firmly around item being identified. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:
1. Tape:
    a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
    b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:
    a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE”.
    c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
3. Tag: Type I:
    a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    b. Width: 3 inches.
    c. Thickness: 4 mils.
    d. Weight: 18.5 lb/1000 sq. ft.
    e. Tensile according to ASTM D 882: 30 lbf and 2500 psi.
4. Tag: Type ID:
    a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    b. Width: 3 inches.
    c. Overall Thickness: 5 mils.
    d. Foil Core Thickness: 0.35 mil.
    e. Weight: 28 lb/1000 sq. ft.
    f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Write-on Tags:
   1. Polyester Tags: 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment.
   2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

H. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

I. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

M. Vinyl Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

P. Self-Adhesive Labels:

1. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

W. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Write-on Tags:

1. Place in a location with high visibility and accessibility.

2. Secure using corrosion resistant cable ties.

Y. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

Z. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

AA. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

BB. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "POWER"
2. "CONTROLS"
3. “SIGNALS”

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.

H. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

I. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

J. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive equipment labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Power-transfer switches.
b. Controls with external control power connections.

M. Equipment Identification Labels:

1. Indoor Equipment: self-adhesive label.
2. Outdoor Equipment: Laminated acrylic or melamine sign.

END OF SECTION

SECTION 26 05 72
OVERCURRENT PROTECTIVE DEVICE SHORT CIRCUIT STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices. The extents of the study shall include the all the electrical equipment associated with the new power distribution system.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Short-circuit study input data, including completed computer program input data sheets.
2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
    b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: the study shall be performed by the firm regularly engaged in plant power system studies and analysis with at least 5 years of relevant experience.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Comply with IEEE 399 and IEEE 551.

B. Analytical features of fault-current-study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Comments and recommendations for system improvements, where needed.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

G. Short-Circuit Study Output:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Calculated asymmetrical fault currents:

1) Based on fault-point X/R ratio.
2) Based on calculated symmetrical value multiplied by 1.6.
3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.

1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.

2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support the short-circuit study:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
8. Motor horsepower and NEMA MG 1 code letter designation.
9. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system study shall include the entire facility.

E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. The calculations shall include the ac fault-current decay from induction motors. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:

1. Electric utility's supply termination point.
2. Incoming switchgear.
3. Low-voltage switchgear.
4. Motor-control centers.
5. Control panels.
6. Automatic transfer switches.
7. Branch circuit panelboards.
8. Disconnect switches.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION

SECTION 260573
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping. The extents of the study shall include the all the electrical equipment associated with the new power distribution system.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: the study shall be performed by firm regularly engaged in plant power system studies and analysis with at least of 5 years of relevant experience.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. The following parts from the Protective Device Coordination Study Report:

1) One-line diagram.
2) Protective device coordination study.
3) Time-current coordination curves.

b. Power system data.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Comply with IEEE 242 and IEEE 399.

B. Analytical features of device coordination study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.

2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

    a. Power utility's overcurrent protective device.
    b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    d. Transformer full-load current, magnetizing inrush current.
    e. Ground-fault protective devices.
    f. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Provide adequate time margins between device characteristics such that selective operation is achieved.
6. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. The study shall be based on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system study shall include the entire facility.

E. Begin analysis at the service, extending down to the system overcurrent protective devices.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. The calculations shall include the ac fault-current decay from induction motors. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Switchgear.
3. Low-voltage switchgear.
4. Motor-control centers.
5. Standby generators and automatic transfer switches.
6. Branch circuit panelboards.

I. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. Use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support coordination study. The list below is a guide.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
9. Maximum demands from service meters.

10. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
11. Motor horsepower and NEMA MG 1 code letter designation.
12. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
13. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Ratings, types, and settings of utility company's overcurrent protective devices.
    c. Special overcurrent protective device settings or types stipulated by utility company.
    d. Time-current-characteristic curves of devices indicated to be coordinated.
    e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    g. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

3.4 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.5 DEMONSTRATION

A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.

2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573

SECTION 26 05 74
OVERCURRENT PROTECTIVE DEVICE ARC FLASH STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment. The extents of the study shall include the all the electrical equipment associated with the new power distribution system.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals **shall** be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: the study shall be performed by the firm regularly engaged in plant power system studies and analysis with at least 5 years of relevant experience.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
2. Operation and Maintenance Procedures: Provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SOFTWARE DEVELOPERS

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

G. Arc-Flash Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of the Engineer.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Electrical Survey Data: Gather and tabulate the following input data to support study.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
5. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
6. Motor horsepower and NEMA MG 1 code letter designation.
7. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.4 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements specified within this section apply to the commissioning of electrical systems.

B. Safety: Ensure work areas are restricted to any non-authorized commissioning professionals. Areas undergoing commissioning shall be taped off and indicated as restricted areas.

C. Sequencing and scheduling:
   1. Perform inspection and electrical tests after equipment here in listed has been installed.
   2. Perform tests with apparatus de-energized whenever feasible.
   3. Inspection and electrical tests on energized equipment shall be:
      a. Scheduled with Engineer and Owner prior to de-energization.
      b. Minimized to avoid extended period of interruption to the operating plant equipment.
   4. Notify Engineer and Owner at least 24 hours prior to performing tests on energized electrical equipment.

1.2 INFORMATIONAL SUBMITTALS

A. Provide the following:
   1. Submit 30 days prior to performing inspections or tests:
      a. Schedule for performing inspection and tests.
      b. List of references to be used for each test.
      c. Sample copy of equipment and materials inspection form(s).
      d. Sample copy of individual device test form.
      e. Sample copy of individual system test form.
   2. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
   3. Operation and Maintenance Data:
      a. In accordance with Division 01, General Requirements.
      b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. ASTM International (ASTM):
      a. D665, Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
      b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
      c. D923, Standard Practices for Sampling Electrical Insulating Liquids.

d. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
e. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
h. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
j. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
k. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop Weight Method.

2. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, Shielded Power Cables 5,000V-4,600V.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Utility Shielded Power Cables Rated 5 through 46 kV.
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators 2.5 kV through 765 kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1): Normal Measurements.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.
   e. 386, Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   f. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
   g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
   h. C2, National Electrical Safety Code.
   i. C37.20.1, Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
   j. C37.20.2, Standard for Metal-Clad Switchgear.
   k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
   l. C62.33, Test Specifications for Varistor Surge-Protective Devices.
4. National Electrical Testing Association (NETA): Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (ATS).
5. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.

c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.
   c. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.4 QUALITY ASSURANCE

A. Testing firm qualifications:
   1. Corporately and financially independent organization functioning as an unbiased testing authority.
   2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
   3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
   4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years testing experience on similar projects.
   5. Technicians certified by NICET or NETA.
   6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
   7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
   8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Tests specified in this section shall be performed in accordance with requirements of Division 01, General Requirements.

B. Tests and inspections shall establish:
   1. Electrical equipment is operational within industry and manufacturer’s tolerances and standards.

2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate protective relays, circuit breakers, fuses power monitoring meters, and other applicable devices in accordance with values established by the short circuit, coordination and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis.

E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

H. Realign equipment not properly aligned and correct unlevelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform Engineer of working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:
1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical Enclosures:
1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch up scratches and mars.
    b. If required due to extensive damage, as determined by Engineer, refinish entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.2 CHECKOUT AND STARTUP

A. Voltage Field Test:
1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
   b. Obtain a written certification from a responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:
1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.3 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

A. Visual and Mechanical Inspection:
1. Insulator damage and contaminated surfaces.
2. Proper barrier and shutter installation and operation.
3. Proper operation of indicating devices.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
   a. Closure attempt of device when door is in OFF or OPEN position.
   b. Opening attempt of door when device is in ON or CLOSED position.
8. Check key interlocking systems for:
   a. Key captivity when device is in ON or CLOSED position.
   b. Key removal when device is in ON or CLOSED position.
   c. Closure attempt of device when key has been removed.
   d. Correct number of keys in relationship to number of lock cylinders.
   e. Existence of other keys capable of operating lock cylinders: Destroy duplicate sets of keys.
9. Check nameplates for proper identification of:
   a. Equipment title and tag number with latest one-line diagram.
   b. Pushbutton.
   c. Control switch.

d. Pilot light.
e. Control relay.
f. Circuit breaker.
g. Indicating meter.

10. Verify that fuse and circuit breaker ratings, sizes, and types conform to those specified.
11. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench and thermographic survey applied to bolted joints.
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
    c. Thermographic survey temperature gradient of 2 degrees C, or less.
12. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature.
14. Control Wiring:
    a. Compare wiring to local and remote control and protective devices with elementary diagrams.
    b. Proper conductor lacing and bundling.
    c. Proper conductor identification.
    d. Proper conductor lugs and connections.
15. Exercise active components.
16. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

B. Electrical Tests:
1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. With breakers open.
    e. With breakers closed.
    f. Control wiring except that connected to solid state components.
    g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Overpotential Tests:
    a. Applied ac or dc voltage and test procedure in accordance with IEEE C37.20.1 and NEMA PB 2.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. Test results evaluated on a pass/fail basis.
3. Current Injection Tests:
    a. For entire current circuit in each section.
    b. Secondary injection for current flow of 1 ampere.
    c. Test current at each device.
4. Control Wiring:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal boards and each device terminal.
5. Operational Test:
    a. Initiate control devices.

b. Check proper operation of control system in each section.

3.4 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:
1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:
1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Each phase of each bus section.
   c. Phase-to-phase and phase-to-ground for 1 minute.
   d. With breakers open.
   e. With breakers closed.
   f. Control wiring except that connected to solid state components.
   g. Insulation resistance values equal to, or greater than, ohmic values
   h. established by manufacturer.
2. Ground continuity test ground bus to system ground.

3.5 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:
1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:
1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.

2) Winding-to-ground.
b. 10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
e. Insulation resistance test results to compare within 1 percent of adjacent windings.

2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.6 LOW VOLTAGE CABLES, 600V MAXIMUM

A. Visual and Mechanical Inspection:
1. Inspect each individual exposed power cable for:
a. Physical damage.
b. Proper connections in accordance with single-line diagram.
c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
d. Color coding conformance with Specifications.
e. Proper circuit identification.
2. Mechanical Connections For:
a. Proper lug type for conductor material.
b. Proper lug installation.
c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
a. Proper shield grounding.
b. Proper terminations.
c. Proper circuit identification.
4. Control Cables For:
a. Proper termination.
b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:
1. Insulation Resistance Tests:
a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
c. Evaluate ohmic values by comparison with conductors of same length and type.
d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low voltage cable tests may be performed by installer in lieu of independent testing firm.

3.7 MEDIUM VOLTAGE CABLES, 15 KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed cable for:
   a. Physical damage plus jacket and insulation condition.
   b. Proper connections in accordance with single-line diagram or approved Submittals.
   c. Proper shield grounding.
   d. Proper cable support.
   e. Proper cable termination.
   f. Cable bends not in conformance with manufacturer's minimum allowable bending radius.
   g. Proper arc and fireproofing in common cable areas.
   h. Proper circuit and phase identification.
2. Mechanical Connections:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturers.
3. Conductors Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.
4. Cables for adjustable frequency drive need to be unterminated from their connection point to prevent static discharge.
5. All cables shall have the numbers and labels left on them when they are unterminated in the case they are to be reused.
6. Any frayed or damaged cable or terminals shall be repaired or replaced.

B. Electrical Tests:
1. Insulation Resistance Tests:
   a. Utilize 2,500-volt megohmmeter for 5 kV conductors.
   b. Test each cable individually with remaining cables and shields grounded.
   c. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   d. Evaluate ohmic values by comparison with conductors of same length and type.
   e. Investigate values less than 50 megohms.
2. Shield Continuity Tests:
   a. By ohmmeter method on each section of conductor.
   b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.
3. Acceptance Tests:
   a. In accordance with IEEE 400, ICEA S-93-639/NEMA WC 74, ICEA S-94-649, and ICEA S-97-682 for insulated conductors.
   b. Each conductor section tested with:
      1) Splices and terminations in-place but disconnected from equipment.
      2) Remaining conductors and shields grounded in accordance with IEEE 400.
   c. Apply maximum test voltage per NETA ATS Table 100.6 based on method (DC, AC, PD or VLF) used.
   d. Measure only the leakage current associated with conductor.
   e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.
   f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48, IEEE 386, or manufacturer's specifications.
   g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.
      1) Increments not to exceed ac voltage rating of conductor.

2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.

h. Raise conductor to specified maximum test voltage and hold for 15 minutes or as specified by conductor manufacturer. Record leakage current at 30 seconds and 1 minute, and at 1-minute intervals, thereafter.

i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.

j. Test results evaluated on a pass/fail basis.

4. New Conductors Spliced to Existing Conductors:

a. Prior to performing splices, high potential dc test new conductor sections.

b. After splicing new conductors to existing conductors, disconnect the existing conductors and perform the following tests:

1) Shield continuity test.

2) Insulation resistance test.

3) High potential test with test voltage not to exceed 60 percent of applied acceptance dc test voltage.

3.8 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

b. Phase-to-phase and phase-to-ground for 1 minute on each pole.

c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

2. Contact Resistance Tests:

a. Contact resistance in microhms across each switch blade and fuse holder.

b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.9 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.

3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:
1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS Table 100.7.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS Table 100.8.

3.10 MEDIUM VOLTAGE AIR CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:
1. Proper cell fit and element alignment.
2. Proper operation of cubicle shutters and racking mechanism.
3. Proper contact condition.
4. Bolt torque level in accordance with NETA ATS, Table 100.12.
5. Perform mechanical operator and contact alignment tests on breaker and it's operating mechanism in accordance with manufacturer's instructions.
6. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operations are correct.
7. Ensure maintenance devices are available for servicing and operating breaker.
8. Check for adequate lubrication on contact, moving, and sliding parts.
9. Check condition of brushes and limit switches on charging and lifting motors.
10. With breaker in TEST position:
    a. Trip and close breaker with control switch.
    b. Trip breaker by manually operating each protective relay.
11. Perform breaker travel and velocity analysis in accordance with manufacturer's instructions; values shall be in accordance with manufacturer's acceptable limits.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 2,500-volt dc megohmmeter for 5-kV circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Overpotential Tests:
   a. Maximum applied ac or dc voltage in accordance with NETA ATS, Table 100.19.
   b. Each pole-to-ground with other poles grounded and contacts closed for 1 minute.
   c. Test results evaluated on pass/fail basis.
4. Minimum pickup voltage tests on trip and close coils.
5. Control Wiring Tests: Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components. Insulation resistance to be 1 megohm minimum.
6. Power factor test on each phase with breaker in both OPEN and CLOSED positions. Compare power factor and arc chute watt loss with adjacent poles or manufacturer's published data.
7. Power factor test on each bushing utilizing conductive straps and hot collar procedures if bushings are not equipped with power factor tap. Power factor and capacitance test results within nameplate rating of bushings.

3.11 MEDIUM VOLTAGE VACUUM CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:
   1. Check for proper element alignment.
   2. Check for proper operation of cubicle shutters and racking mechanism.
   3. Bolt torque level in accordance with NETA ATS, Table 100.12.
   4. Perform mechanical operational tests on breaker and it's operating mechanism in accordance with manufacturer's instructions, plus check:
      a. Pull rod adjustment.
      b. Trip latch clearance.
      c. Overtravel stops.
      d. Wipe and gap setting.
   5. Perform breaker travel and velocity analysis in accordance with manufacturer's instructions; values shall be in accordance with manufacturer's acceptable limits.
   6. Check contact erosion indicators in accordance with manufacturer's instructions.
   7. With breaker in TEST position:
      a. Trip and close breaker with control switch.
      b. Trip breaker by manually operating each protective relay.

B. Electrical Tests:
   1. Insulation Resistance Tests:
      a. Utilize 2,500-volt dc megohmmeter for 5-kV circuit breakers.
      b. Pole-to-pole and pole-to-ground with breaker contacts opened for1 minute.
      c. Pole-to-pole and pole-to-ground with breaker contacts closed for1 minute.
      d. Test values to comply with NETA ATS, Table 100.1.
   2. Contact Resistance Tests:

a. Between the line and load stab of closed contact resistance in microhms across each pole.
b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Overpotential Tests:
   a. Maximum applied ac or dc voltage in accordance with NETA ATS, Table 100.19.
   b. Each pole-to-ground with other poles grounded and contacts closed for 1 minute.
   c. Test results evaluated on pass/fail basis.
4. Minimum pickup voltage tests on trip and close coils.
5. Control Wiring Tests:
   a. Insulation resistance test at 1,000-volts dc on control wiring, except that connected to solid state components.
   b. Insulation resistance to be 1 megohm minimum.
6. Vacuum bottle overpotential integrity test across each vacuum bottle with breaker in OPEN position, in accordance with manufacturer's instructions.
7. Power Factor Test (Each Phase):
   a. With breaker in both OPEN and CLOSED position.
   b. Compare power factor and arc chute watt loss with adjacent poles or manufacturer's published data.
8. Power Factor Test (Each Bushing):
   a. Utilize conductive straps and hot collar procedures if bushings are not equipped with power factor tap.
   b. Power factor and capacitance test results within nameplate rating of bushings.

3.12 PROTECTIVE RELAYS

A. Visual and Mechanical Inspection:
1. Visually check each relay for:
   a. Tight cover gasket and proper seal.
   b. Unbroken cover glass.
   c. Condition of spiral spring and contacts.
   d. Disc clearance.
   e. Condition of case shorting contacts if present.
2. Mechanically check each relay for:
   a. Freedom of movement.
   b. Proper travel and alignment.
3. Verify each relay:
   a. Complies with Contract Documents, approved Submittal, and application.
   b. Is set in accordance with recommended settings from Coordination Study.
4. Any changes required to relay programming shall be furnished by the equipment manufacturer. For the adjustable frequency drive, the drive manufacturer shall provide new settings as required.

B. Electrical Tests:
1. Insulation resistance test on each circuit to frame, except for solid state devices.
2. Test on nominal recommended setting for:
   a. Pickup parameters on each operating element.
   b. Timing at three points on time-current curve.
   c. Pickup target and seal-in units.

d. Special tests as required to check operation of restraint, directional, and other elements in accordance with manufacturer's instruction manual.

3. Phase angle and magnitude contribution tests on differential and directional relays after energization to vectorially verify proper polarity and connections.
4. Current Injection Tests:
   a. For entire current circuit in each section.
   b. Secondary injection for current flow of 1 ampere.
   c. Test current at each device.

3.13 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:
1. Visually check current, potential, and control transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify mechanically:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:
1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
   b. Polarity test.
2. Potential Transformer Tests:
   a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9 for 1 minute on:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.14 METERING

A. Visual and Mechanical Inspection:
1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.15 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:
   1. Equipment and circuit grounds in motor control center, panelboard, switchboard, and switchgear assemblies for proper connection and tightness.
   2. Ground bus connections in motor control center, panelboard, switchboard, and switchgear assemblies for proper termination and tightness.
   3. Effective transformer core and equipment grounding.
   4. Accessible connections to grounding electrodes for proper fit and tightness.
   5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:
   1. Fall-of-Potential Test:
      a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
      b. Main ground electrode system resistance to ground to be no greater than 5 ohm(s).
   2. Two-Point Direct Method Test:
      a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
      b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.16 GROUND FAULT SYSTEM

A. Inspection and testing limited to:
   1. Zero sequence grounding systems.
   2. Residual ground fault systems.

B. Visual and Manual Inspection:
   1. Neutral main bonding connection to assure:
      a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
      b. Ground strap sensing system is grounded through sensing device.
      c. Neutral ground conductor is solidly grounded.
   2. Verify control power has adequate capacity for system.
   3. Manually operate monitor panels for:
      a. Trip test.
      b. No trip test.
      c. Nonautomatic rest.
   4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
   5. Relay check for pickup and time under simulated ground fault conditions.
   6. Verify nameplate identification by device operation.

C. Electrical Tests:
   1. Test system neutral insulation resistance with neutral ground link removed. System neutral insulation resistance minimum 1 megohm.
   2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.

3. Test relay timing by injecting 300 percent of pick-up current or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
4. Test system operation at 55 percent rated control voltage, if applicable.
5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.17 AC INDUCTION MOTORS

A. General: Inspection and testing limited for existing raw water pump motors and new raw water pump No. 5 motor.

B. Visual and Mechanical Inspection:
1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionality and proper operation.
   e. Excessive vibration, in excess of values in NETA ATS Table 100.10.
5. Check operation of space heaters.
6. Check Ohmic valve of RTDs.

C. Electrical Tests:
1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
      1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
      2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes. Measure and record RTD temperature using MPR display during running.
5. Overpotential Tests:
   a. Applied dc voltage in accordance with IEEE 95.
   b. Limited to 4,000-volt motors rated 1,000 hp and greater.
   c. Test results evaluated on pass/fail basis.

3.18 MEDIUM VOLTAGE MOTOR CONTROL CENTERS

A. Visual and Mechanical Inspection:
1. Insulator damage and contaminated surfaces.
2. Proper barrier and shutter installation and operation.
3. Proper operation of indicating devices.
4. Proper overload protection.
5. Blockage of air-cooling passages.
6. Proper operation of drawout elements.
7. Integrity and contamination of bus insulation system.
8. Check door and device interlocking system by:
   a. Closure attempt of device when door is in OFF or OPEN position.
   b. Opening attempt of door when device is in ON or CLOSED position.
9. Check nameplates for proper identification of each:
   a. Equipment title and tag number with latest one-line diagram.
   b. Pushbutton.
   c. Control switch.
   d. Pilot light.
   e. Control relay.
   f. Circuit breaker.
   g. Indicating meter.
10. Verify fuse sizes and types conform to Contract Documents or approved Submittal.
11. Check bus connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints, and thermographic survey:
   a. Ohmic value to be zero.
   b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
   c. Thermographic survey temperature gradient of 2 degrees C, or less per NETA ATS Table 100.18.
12. Check operation and sequencing of electrical and mechanical interlock systems by:
   a. Closure attempt for locked open devices.
   b. Opening attempt for locked closed devices.
   c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature furnished as part of motor control center.
14. Control Wiring:
   a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
   b. Check for proper conductor lacing and bundling.
   c. Check for proper conductor identification.
   d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect magnetic contactors for:
   a. Correct mechanical operations.
   b. Correct contact gap, wipe, alignment, and pressure.
   c. Correct torque of connections.
17. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:
1. Insulation Resistance Tests:

a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.2.
b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
e. Test values to comply with NETA ATS, Table 100.1.

2. Overpotential Tests:
   a. Maximum applied ac or dc voltage in accordance with NETA ATS, Table 100.9.
   b. Phase-to-phase and phase-to-ground for 1 minute for each phase of each bus section.
   c. Test results evaluated on pass/fail basis.
3. Bottle integrity test for vacuum contactors in accordance with manufacturer's procedure.
4. Test by Primary Current Injection:
   a. Overload units at sensors using 300 percent of motor full-load current: Overload trip times to be in accordance with manufacturer's published data.
   b. Check voltage levels at each point on terminal boards and each device terminal.
5. Control Wiring Tests:
   a. Apply secondary voltage on control power and potential circuits.
   b. Check voltage levels at each point on terminal boards and at each device terminal.
   c. Insulation resistance test at 1,000-volts dc on control wiring, except that connected to solid state components: Insulation resistance to be 1 megohm minimum.
6. Test indicating and monitoring devices for proper operation.
7. Perform setup and testing of solid state relays and multifunction protective devices in accordance with manufacturer's instructions.
8. Measure Contact and Power Fuse Resistances:
   a. Contact resistance shall not exceed manufacturer's recommended values.
   b. Resistance of power fuses not to deviate more than 15 percent between identical fuses.

3.19 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:
1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
   a. Closure attempt of device when door is in OFF or OPEN position.
   b. Opening attempt of door when device is in ON or CLOSED position.
8. Check key interlocking systems for:
   a. Key captivity when device is in ON or CLOSED position.
   b. Key removal when device is in OFF or OPEN position.
   c. Closure attempt of device when key has been removed.
   d. Correct number of keys in relationship to number of lock cylinders.
   e. Existence of other keys capable of operating lock cylinders; destroy duplicate sets of keys.
9. Check nameplates for proper identification of:
   a. Equipment title and tag number with latest one-line diagram.

b. Pushbuttons.
c. Control switches.
d. Pilot lights.
e. Control relays.
f. Circuit breakers.
g. Indicating meters.

10. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
11. Verify current and potential transformer ratios conform to Contract Documents.
12. Check bus connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints:
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
13. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
14. Verify performance of each control device and feature furnished as part of motor control center.
15. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
16. Exercise active components.
17. Inspect contactors for:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of all connections.
18. Compare overload heater rating with full-load current for proper size.
19. Compare motor protector and circuit breaker with motor characteristics for proper size.
20. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:
1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
    d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
    e. Test values to comply with NETA ATS, Table 100.1.
2. Current Injection through Overload Unit at 300 Percent of Motor Full Load Current and Monitor Trip Time:
    a. Trip time in accordance with manufacturer's published data.
    b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal boards and each device terminal.

c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components: Insulation resistance to be 1 megohm minimum.

4. Operational test by initiating control devices to affect proper operation.

3.20 BATTERY SYSTEM

A. Visual and Mechanical Inspection:
1. Physical damage and electrolyte leakage.
2. Evidence of corrosion.
3. Intercell bus link integrity.
4. Battery cable insulation damage and contaminated surfaces.
5. Operating conditions of ventilating equipment.
6. Visual check of electrolyte level.

B. Electrical Tests:
1. Measure:
   a. Bank charging voltage.
   b. Individual cell voltage.
   c. Electrolyte specific gravity in each cell.
   d. Measured test values to be in accordance with manufacturer's published data.
2. Verify during recharge mode:
   a. Charging rates from charger.
   b. Individual cell acceptance of charge.
3. Load tests for integrity and capacity; test values in accordance with IEEE 450.

3.21 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:
1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground bus or electrode.

B. Electrical Tests:
1. Varistor Type Arrestors:
   a. Clamping voltage test.
   b. Rated RMS voltage test.
   c. Rated dc voltage test.
   d. Varistor arrestor test values in accordance with IEEE C62.33, Sections 4.4 and 4.9.

3.22 MEDIUM VOLTAGE SURGE ARRESTORS AND SURGE CAPACITORS

A. Visual Inspection:
1. Ground connections to ground bus.
2. Shortest practical jumper connections to line.

B. Electrical Tests:
1. Grounding electrode resistance test in accordance with IEEE 81, Section 8.2.1.5 using three-point fall-of-potential method.
2. Insulation power factor.

3. Insulation resistance.
4. RF noise test using Stodard Noise Test set with applied voltage of 1.18 times maximum continuous operating voltage.
5. Insulation power factor leakage current, watts loss, and insulation resistance tests in accordance with manufacturer's test values. RIV value not to exceed 10 microvolts above background noise.
6. Leakage current and watts loss tests.

3.23 STANDBY AND EMERGENCY GENERATOR SYSTEMS

A. Visual and Mechanical Inspection:
1. Proper grounding.
2. Blockage of ventilating passageways.
3. Proper operation of jack water heaters.
4. Integrity of engine cooling and fuel supply systems.
5. Excessive mechanical and electrical noise.
6. Overheating of engine or generator.
7. Proper installation of vibration isolators.
8. Proper cooling liquid type and level.
9. Operate engine-generator and check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check resistance temperature detectors or generator inherent thermal protectors for functionality and proper operation.
   e. Excessive vibration.
10. Verify voltage regulator and governor operation will cause unit speed and output voltage to stabilize at proper values within reasonable length of time.
11. Proper operation of meters and instruments.
12. Compare generator nameplate rating and connection with one-line diagram or approved Submittal.
13. Verify engine-generator operation with adjustable frequency drives energized and operating under normal load conditions.

B. Electrical and Mechanical Tests:
1. Cold start test by interrupting normal power source with test load consisting of connected building load to verify:
   a. Transfer switch operation.
   b. Automatic starting operation.
   c. Operating ability of engine-generator.
   d. Overcurrent devices capability to withstand inrush currents.
2. Phase rotation tests.
3. Test engine protective shutdown features for:
   a. Low oil pressure.
   b. Overtemperature.
   c. Overspeed.
4. Vibration base-line test on generator sets; levels in accordance with manufacturer's recommendations.

5. Load bank test with reactors and resistors adjusted to 80 percent power factor for each load step. Record voltage, frequency, load current, oil pressure, and engine coolant temperature at 15-minute intervals:
   a. 25 percent applied load for 30 minutes.
   b. 50 percent applied load for 30 minutes.
   c. 75 percent applied load for 30 minutes.
   d. 100 percent applied load for 3 hours.
   e. Load test results to demonstrate ability of unit to deliver rated load for test period.
6. One-Step Rated kW Load Pickup Test:
   a. Perform test immediately after performing load bank test.
   b. Apply rated load, minus largest rated hp motor, to generator.
   c. Start largest rated hp motor and record voltage drop for 20 cycles minimum with high-speed chart recorder or digital storage oscilloscope.
   d. Compare voltage drop with maximum allowable voltage dip for specified starting situation.

3.24 THERMOGRAPHIC SURVEY

A. Provide a thermographic survey per NETA ATS Table 100.18 of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 2 and larger at each:
   1. Medium voltage switchgear.
   2. Switchboard.
   3. Medium and low voltage motor control center.
   4. Panelboard.

B. Provide a thermographic survey of feeder conductors terminating at:
   1. Motors rated 600 hp and larger.
   2. Engine-generators.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading per NFPA 70B, Section 20.17.

E. Do not perform survey on equipment operating at less than 20 percent of rated load. If plant load is insufficient, perform test with supplemental load bank producing rated load on item being measured.

F. Utilize thermographic equipment capable of:
   1. Detecting emitted radiation.
   2. Converting detected radiation to visual signal.
   3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

G. Temperature Gradients:
   1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
   2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.
   3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

H. Provide written report of:

1. Areas surveyed and the resultant temperature gradients.
2. Locations of areas having temperature gradients of 3 degrees C or greater.
3. Cause of heat rise and actions taken to correct the cause of heat rise.
4. Detected phase unbalance.

END OF SECTION

SECTION 26 22 13
LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.

B. Source quality-control reports.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton

B. Schneider Electric

C. GE

D. Acme

E. Engineer's approved equal.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified.

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

E. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

F. Coils: Continuous windings except for taps.

1. Coil Material: Aluminum.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.

G. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated.

1. NEMA 250, Type as shown on Electrical Drawings.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.

D. Taps for Transformers 3 kVA and Smaller: None.

E. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

G. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

H. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

I. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

J. Wall Brackets: Manufacturer's standard brackets.

2.5 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

B. Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, and grounding.
    c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    d. Verify the unit is clean.
    e. Perform specific inspections and mechanical tests recommended by manufacturer.
    f. Verify that as-left tap connections are as specified.
    g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

    a. Measure resistance at each winding, tap, and bolted connection.
    b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. SPD: Surge protective device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard schedules for installation in panelboards.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 FIELD CONDITIONS

A. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand local seismic conditions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.
   a. Wet and Corrosive Areas: NEMA 250, Type 4X Stainless Steel.
2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

F. Incoming Mains Location: Bottom.

G. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.

3. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

J. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 POWER PANELBOARDS

A. Manufacturers:

- Square D
- Eaton
- ABB/ General Electric
- Engineer’s Approved Equal.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit.

G. Branch Overcurrent Protective Devices: Fused switches.

H. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. External Control-Power Source: 120-V branch circuit.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers:

- Square D
- Eaton
- ABB/ General Electric
- Engineer’s Approved Equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers:

- Square D
- Eaton

- ABB/ General Electric

- Engineer's Approved Equal.

B. MCCB: Comply with UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.
   c. Digital display of settings, trip targets, and indicated metering displays.
   d. Multi-button keypad to access programmable functions and monitored data.
   e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
   f. Integral test jack for connection to portable test set or laptop computer.
   g. Field-Adjustable Settings:

      1) Instantaneous trip.
      2) Long- and short-time pickup levels.
      3) Long and short time adjustments.
      4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Breaker handle indicates tripped status.
   c. UL listed for reverse connection without restrictive line or load ratings.
   d. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
   e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
   f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install panelboards and accessories according to NEMA PB 1.1.

C. Comply with mounting and anchoring requirements as required to accommodate local seismic conditions.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box.

F. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

I. Install filler plates in unused spaces.

J. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

K. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Straight-blade convenience receptacles.
2. USB charger devices.
3. GFCI receptacles.
4. SPD receptacles.
5. Toggle switches.
6. Decorator-style convenience.
7. Wall switch sensor light switches with dual technology sensors.
8. Wall switch sensor light switches with passive infrared sensors.
9. Wall switch sensor light switches with ultrasonic sensors.
10. Digital timer light switches.
11. Residential devices.
12. Wall-box dimmers.
13. Wall plates.

1.2 DEFINITIONS

A. Abbreviations of Manufacturers' Names:

1. Cooper: Copper Wiring Devices; Division of Cooper Industries, Inc.
2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
3. Leviton: Leviton Mfg. Company, Inc.
4. Pass & Seymour: Pass& Seymour/Legrand.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

D. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.

E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.3 GFCI RECEPTACLES

A. General Description:

1. 125 V, 20 A, straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.4 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A rated.

2.5 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.05-inch-thick, anodized aluminum.
3. Material for Unfinished Spaces: Anodized aluminum.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.6 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. GFCI Receptacles: Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.2 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections as required.

1. Tests for Convenience Receptacles:

a. Line Voltage: Acceptable range is 105 to 132 V.
b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
c. Ground Impedance: Values of up to 2 ohms are acceptable.
d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
e. Using the test plug, verify that the device and its outlet box are securely mounted.
f. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Electronic Industries Alliance (EIA): 359-A-1, Special Colors.
2. Hydraulic Institute Standards (HIS).
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   c. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. National Electrical Manufacturer's Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. CP 1, Shunt Capacitors.
   c. MG 1, Motors and Generators.
   d. WC 57, Standard for Control, Thermocouple Extensions, and Instrumentation Cables.
5. National Fire Protection Association (NFPA): 79, Electrical Standard for Industrial Machinery.

1.2 DEFINITIONS

A. Terms that may be used in this section:

1. AFD: Adjustable frequency drive.
2. CMOS: Complementary metal oxide semiconductor.
3. CSI: Current source inverter.
4. EMU: Energy monitoring unit.
5. GTO: Gate turn-off thyristor.
6. MPR: Motor protection relay.
7. MTBF: Mean time between failure.
8. PWM: Pulse width modulation.
9. ROM: Read only memory.
10. RTD: Resistance temperature detector.
11. RTU: Remote Telemetry Unit.
12. Rated Load: Load specified for equipment.

13. Rated Speed: Nominal rated (100 percent) speed specified for equipment.
14. TDD: Total demand distortion.
15. THD: Total harmonic distortion.
16. TTL: Transistor transistor logic.

1.3 AFD MANUFACTURER REQUIREMENTS

A. All adjustable frequency drives shall be of the same manufacturer selected as listed under acceptable manufacturers. The Contractor shall also be responsible for coordinating with his various subcontractors to ensure that the same AFD manufacturer is provided in all vendor control panels that are provided as part of this project. AFDs from alternate manufacturers will not be considered.

1.4 SPECIAL PROJECT REQUIREMENTS

A. The Contractor shall be responsible for coordinating the drive requirements with the manufacturer of the load which the AFD shall operate in order to ensure that the correct type of drive (i.e. constant torque or variable torque) is provided for each application. In order to ensure that the Contactor has properly coordinated the specific type of drive to be provided for each particular process, the submittals for all adjustable frequency drives shall include a letter from the manufacturer of the specific load that will be energized from the AFD to indicate if the specific application requires a constant torque drive or a variable torque drive.

B. The Contractor shall be responsible for coordinating with the AFD manufacturer on the actual feeder distances required in order to ensure that the appropriate type of output filters, or dv/dt filters, are provided, where required. In order to ensure that the Contactor has properly coordinated with the AFD manufacturer, all submittals for AFDs shall include a letter from the AFD manufacturer that indicates that they have coordinated with the Contractor on the actual feeder lengths required and that the appropriate type of output filters, or dv/dt filters, are provided as proposed within the submittal.

1.5 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Composite drive/motor efficiency (CE) is defined as ratio of motor shaft kW to drive input kW. AFD system minimum requirements:
   a. At 60-Hz drive output and 100 percent load, CE equals 92 percent.
   b. At 50-Hz drive output and 60 percent load CE equals 89 percent.
   c. At 40-Hz drive output and 30 percent load CE equals 84 percent.
   d. At 30-Hz drive output and 12.5 percent load CE equals 77 percent.
2. Rated Continuous Operation Capacity: All adjustable frequency drives provided shall be sized not less than 1.15 times full load current rating of driven motor, as indicated on motor nameplate, and suitable for continuous operation at continuous overload which may be imposed on motor by driven pump operating over specified speed range. As part of the AFD submittal, the manufacturer shall include the ampacity ratings of the each proposed AFD as well as the motor nameplate FLA for the associated motor.
3. Basis for Harmonic Computations: Using Contract Drawings for current and voltage distortion computations, furnish harmonic filters, line reactors, isolation transformers, or higher pulse converter arrangements required to meet current/voltage distortion limits.
4. Normal and Standby Source Current Harmonic Distortion:
   a. Compute normal and Standby source individual and total current harmonic distortion at the bus of low voltage switchgear SWBD-IPS-1. The bus of switchboard shall be defined at the point of common coupling (PCC1) in accordance with IEEE 519.
   b. Individual current harmonic distortion and total demand distortion expressed as percent of maximum demand load current I_L shall not exceed values specified in Table 1 below:

Table 1	
Individual Harmonic Order (Odd Harmonics)	**Harmonic Current Distortion Percent of Max. Demand Load Current IL**
h <11	4.0
11 h <17	2.0
17 h <23	1.5
23 h <35	0.6
35 h	0.3
Total Demand Distortion (TDD)	5.0

c. Limits specified in Table 1 above are for drives utilizing 6-pulse rectifiers. Should manufacturer propose higher pulse rectifiers, limits for characteristic harmonics listed in Table 1 can be increased accordingly as indicated in IEEE 519 depending on the pulse drive that is proposed.

d. The harmonic analysis for each distribution system shall be performed under each of the possible modes of operation:
   1) Normal mode of operation
   2) Emergency mode of operation

5. Normal and Standby Source Voltage Harmonic Distortion: Compute normal and standby source voltage harmonic distortion at location identified as PCC1. THD shall not exceed 5 percent, and individual voltage harmonic distortion shall not exceed 3 percent.
6. Furnish isolating transformers or series reactors, harmonic filters, or other devices necessary for proper system operation. Furnish necessary devices and circuits to prevent operation of one drive from adversely affecting operation of other drives supplied from same transformer or same bus. The final number and ratings of the harmonic filters required shall be determined by the manufacturer based on the results of the harmonics study specified herein.
7. When isolation transformers are used, design to meet K-factor requirements of drive(s) connected.

B. Design Requirements:

1. Drive system consisting of adjustable frequency controller, drive motor, auxiliary items, and components necessary for complete operating system.

2. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal and emergency conditions.

3. Furnish AFDs rated on basis of actual motor full load nameplate current rating times the service factor.
4. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using pulse-width-modulation (PWM) technique to produce adjustable frequency output.
5. System rated for continuous industrial duty and suitable for use with NEMA MG 1, Design B motors.
6. Incoming Line Circuit Breaker: Provide positive means of disconnecting incoming power, and overcurrent protection for drive system.
7. Incoming Line Reactor: All 6-pulse AFDs shall include a 5 percent input line reactor. Design to minimize harmonic distortion on incoming power feeder.

C. Specific AFD Requirements:

1. Effluent Pumps AFD's:
   a. 6-pulse AFD with 5 percent input line reactor. AFD shall be located within the pumps control panel.
   b. Output filters – Standard.
   c. Feeder Distance between the AFD and the associated motor: ~50 feet.
   d. Ethernet communication with Plant Control System via EtherNet/IP protocol and/or hardwired connections. See Control Diagrams for specific control logic interfaces between the AFDs and the plant control system.
   e. AFD shall be sized a minimum of 1.15 x the motor nameplate FLA.

1.6 SUBMITTALS

A. Action Submittals:

1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.
2. Individual and total harmonic content (voltage and current) reflected in system normal source supply at driven equipment actual load at 70 percent and 100 percent of rated speed at locations specified in Sim-

plified Plant One-Line Diagram and load conditions specified. Use TDD and THD factors as defined in IEEE 519 to designate total harmonic content.

3. Individual and total current and voltage harmonic content reflected in standby power source, at locations specified in this section, at driven equipment actual load at 70 percent and 100 percent of rated speed determined by using actual size and subtransient reactance of standby system obtained from standby source manufacturer. Use TDD and THD factors as defined in IEEE 519 to designate total harmonic content.
4. AFD output pulse maximum peak voltage, pulse rise time, and pulse rate of rise including justification for proposed deviation from specified values. Include motor manufacturer's certification motor insulation will withstand long-term overvoltages caused at motor terminals due to specified output pulse data or proposed deviation from this data.
5. Data on shelf life of "dc link" capacitor.
6. Complete system rating, including nameplate data, continuous operation load capability throughout speed range of 0 percent to 120 percent of rated speed.
7. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list controller special features being supplied.
8. Controller, reactor, harmonic filter, and isolating transformer (if applicable) dimensional drawings; information on size and location of space for incoming and outgoing conduit.
9. Maximum heat dissipation from enclosure.
10. Should separate enclosures and equipment be necessary for filter elements, provide complete dimensional information including location of space for incoming and outgoing conduit, weight, maximum heat loss, and minimum current carrying capacity and recommended wire size for required interconnecting circuits.
11. Layout of controller face showing pushbuttons, switches, instruments, and indicating lights.
12. Complete system operating description.
13. Complete system schematic (elementary) wiring diagrams.
14. Complete system interconnection diagrams between controller, drive motor, and related components or controls external to system, including wire numbers and terminal board point identification.
15. One-line diagram of system, including component ratings.
16. Description of diagnostic features being provided.
17. Descriptive literature for control devices such as relays and timers.
18. Itemized bill-of-materials listing system components.
19. Specific description of provisions, such as filtering and harmonic suppression, being made to ensure proper system operation when system is supplied from either the normal utility source or the standby generation. Additionally, the AFD manufacturer shall coordinate the sizing of the active harmonic filters required to meet the requirements of IEEE 519.

B. Informational Submittals:

1. Statement of Supplier qualifications.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Factory functional test reports.
6. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE 112, Test Method B, showing rated load, rated speed efficiency meeting or exceeding specified values; motors not as specified will be rejected.
7. Field test reports.
8. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
9. Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
12. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.7 QUALITY ASSURANCE

A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

1.8 EXTRA MATERIALS

A. Furnish for each drive unit:

1. Complete set of components likely to fail in normal service.
2. Plug-in subassemblies.
3. Printed circuit boards.
4. SCRs.
5. Potentiometers.
6. Integrated circuits.
7. One complete power bridge and one spare printed circuit card for each modular, plug-in type card in controller.
8. One spare fan for each type AFD package.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. Eaton

C. Allen-Bradley

D. ABB

E. Or approved equal.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: Variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1 motors.
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.

3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 42 kA.
7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 10 seconds.
4. Deceleration: 0.1 to 10 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Surge Suppression: Field-mounted surge suppressors complying with UL 1449 SPD, Type 2.
3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
4. Under- and overvoltage trips.
5. Inverter overcurrent trips.
6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
7. Critical frequency rejection, with three selectable, adjustable deadbands.

8. Instantaneous line-to-line and line-to-ground overcurrent trips.
9. Loss-of-phase protection.
10. Reverse-phase protection.
11. Short-circuit protection.
12. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NC/NO alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified".

B. Provide 3% load reactors when the distance between the VFD and the motor exceeds 50 feet, 5% load reactors when it exceeds 150 feet, and dV/dT filters when it exceeds 250 feet.

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

    a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
    b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

    a. 0- to 10-V dc.
    b. 4- to 20-mA dc.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal (4- to 20-mA dc), which can be configured for any of the following:

    a. Output frequency (Hz).
    b. Output current (load).
    c. DC-link voltage (V dc).
    d. Motor torque (percent).
    e. Motor speed (rpm).
    f. Set point frequency (Hz).

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. Each VFD shall be equipped with EtherNet communication port for interface with the plant SCADA system or with MCC EtherNet switch. The protocol shall be TCP/IP and shall be coordinated with the plant system integrator.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Wet and Corrosive Locations: Type 4X Stainless Steel.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.6 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Unguarded.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

E. Air Conditioner: For NEMA 250, Type 4X; UL 508 component; 120V ac obtained from integral CPT.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall.

B. Seismic Bracing: Comply with requirements as required for local seismic conditions.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFC.

E. Install fuses in control circuits if not factory installed.

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections as required.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as required.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 26 32 13

ENGINE DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 REFERENCES

The equipment covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards of ANSI, NEC, ISO, U.L., IEEE and NEMA.

1.2 WORK INCLUDED

A. The work includes supplying a complete integrated emergency generator system. The system consists of a diesel generator set with related component accessories as specified herein.

B. The Contractor shall provide a full tank of diesel fuel for the completion of all testing.

C. A complete system load test shall be performed after all equipment is installed.

D. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a Manufacturer who has 25 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.

1.3 MANUFACTURERS

A. There shall be one source responsibility for warranty, parts and service through a local representative with factory trained service personnel.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Generator Set
   a. Cummins-Onan
   b. Caterpillar
   c. Kohler.

2. Automatic Transfer Switch (incorporated into main Switchboard gear)

1.4 SUBMITTALS

A. Engine-generator submittals shall include the following information

1. Factory published specification sheet indicating standard and optional accessories, ratings, etc.
2. Manufacturer's catalog cut sheets of all auxiliary components such as Automatic Transfer Switches, battery charger, control panel, enclosure, main circuit breaker, etc.
3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.
4. Weights of all equipment.
5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.
6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, jacket water heater, remote alarm indications.
7. Engine mechanical data including heat rejection, exhaust gas flows, combustion air and ventilation air flows, noise data, fuel consumption, etc.
8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
9. Generator resistances, reactances, and time constants.
10. Generator motor starting capability.
11. Control panel schematics.
12. Oil sampling analysis, laboratory location, and information.
13. Manufacturer's and dealer's written warranty.
14. Letter of guarantee that the proposed generator will be capable of starting and running the loads specified on the drawings.

1.5 WARRANTY

A. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of substantial completion and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified will be rejected in their entirety.

1.6 PARTS AND SERVICE QUALIFICATIONS

A. The engine-generator supplier shall have service facilities within 75 miles of the project site and maintain 24-hour parts and service capability. The distributor

shall stock parts as needed to support the generator set package for this specific project.

B. The dealer shall maintain qualified, factory trained service personnel that can respond to an emergency call within 4 hours of notification, 24 hours per day.

PART 2 - PRODUCTS

1.1 GENERAL REQUIREMENTS

A. The generator set shall be Standby and have a kW rating as shown on the one line diagram. The additional ratings shall be 1800 RPM, 0.8 power factor, 480Y/277 VAC, 3 phase, 4 wire, 60 hertz, including radiator fan and all parasitic loads.

B. All materials and parts comprising the unit shall be new and unused.

1.2 DIESEL ENGINE

A. The engine shall be water-cooled inline or vee-type, four cycle compression ignition diesel. It shall meet specifications when operating on number 2 domestic burner oil. Two cycle engines will not be considered. The engine shall be equipped with fuel, lube oil, and intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, service meter, gear-driven water pump.

B. The complete engine block shall be machined from one casting. Designs incorporating multiple blocks bolted together are not acceptable.

C. The engine shall utilize a gear-type, positive displacement, full pressure lubricating oil pump and water-cooled lube oil cooler. Pistons shall be spray-cooled. Provide oil filters, oil pressure gauge, dipstick and oil drain.

D. Fuel filter and serviceable fuel system components shall be located to prevent fuel from spilling onto generator set batteries.

E. The engine shall be equipped with an isochronous electronic governor to maintain 0% droop from no load to full load and +/- 0.25% steady state frequency variation. The governor shall be equipped with speed adjustment.

1.3 GENERATOR

A. The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling.

B. The insulation material shall meet NEMA standards for Class H insulation and be vacuum impregnated with epoxy varnish to be fungus resistant. Temperature rise of the rotor and stator shall not exceed NEMA class F (130° C rise by resistance over 40° C ambient). The excitation system shall be of brushless construction.

C. The brushless exciter shall be independent of main stator windings (either permanent magnet or auxiliary windings) and shall consist of a three-phase armature and a three-phase full wave bridge rectifier mounted on the rotor shaft. Surge suppressors shall be included to protect the diodes from voltage spikes. Generator shall have the ability to sustain short circuit current of 300% of rated current to allow protective devices to operate.

D. The automatic voltage regulator (AVR) shall maintain generator output voltage within +/- 0.5% for any constant load between no load and full load. The regulator shall be a totally solid state design which includes electronic voltage buildup, volts per Hertz regulation, three phase sensing, over-excitation protection, loss of sensing protection, temperature compensation, shall limit voltage overshoot on startup, and shall be environmentally sealed.

1.4 CIRCUIT BREAKER

A. Provide a generator mounted circuit breaker, molded case or insulated case construction. Breaker shall be sized as shown on the drawings. Breaker shall be Merlin Gerin or equal and utilize a thermal magnetic trip unit and 24 VDC shunt trip. The breaker shall be UL listed with shunt trip device connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box mounted on the side of the generator. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker. Breaker shall include long term, short term instantaneous, and ground fault protection.

1.5 CONTROLS

A. Generator Mounted Control Panel:

1. Provide a generator mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation, adjustable cycle cranking, digital LCD AC metering (0.5% true rms accuracy) with phase selector switch, digital engine monitoring, shutdown sensors and alarms with horn and reset, adjustable cooldown timer and emergency stop push-button. Panel shall incorporate self-diagnostics capabilities and fault logging. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Components shall be housed in a NEMA 1/IP22 enclosure with hinged lid.

2. Provide the following digital readouts on the Generator Mounted Control Panel:

a. Engine oil pressure

b. Coolant temperature

c. Engine RPM

d. System DC Volts

e. Engine running hours

f. Generator AC volts

g. Generator AC amps

h. Generator frequency

3. Control Panel Annunciation - Provide the following indications for protection and diagnostics according to NFPA 110 level 1:

   a. Low oil pressure

   b. High water temperature

   c. Low coolant level

   d. Overspeed

   e. Overcrank

   f. Emergency stop depressed

   g. Approaching high coolant temperature

   h. Approaching low oil pressure

   i. Low coolant temperature

   j. Low voltage in battery

   k. Control switch not in auto. position

   l. Low fuel main tank

   m. Battery charger ac failure

   n. High battery voltage

   o. Generator supplying load

   p. Spare.

4. Generator “Running”, “Common Fault” and “Low Fuel Level” relays with dry, 120VAC, 5 Amp rated contacts.

B. COOLING SYSTEM

1. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110° F ambient air entering the room or enclosure (If an enclosure is specified) without derating the unit and 50/50 anti-freeze mixture. The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

C. FUEL SYSTEM

1. Filter/Separator - In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine.

2. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted.

3. Flexible fuel lines shall be rated for 300 degrees F and 100 PSI.

4. Fuel Tank shall be double wall with Leak Detection.

D. EXHAUST SYSTEM

1. A critical type silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the manufacturer's recommendation.

2. Mounting shall be provided by the contractor as shown on the drawings. The silencer shall be mounted so that its weight is not supported by the engine.

3. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer.

E. STARTING SYSTEM

1. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.

2. Jacket Water Heater: A unit mounted thermal circulation type water heater. The heater watt rating shall be sized by the manufacturer to maintain jacket water temperature at 90 degrees F, and shall be a 120 volt, single phase, 60 hertz.

3. Batteries: A lead-acid storage battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The battery set shall be rated no less than 140 ampere hours and 1000 CCA. Necessary cables and clamps shall be provided.

4. A battery tray shall be provided for the batteries and shall conform to NEC 480-7(b). It shall treated to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over battery electrolyte shall be contained within the tray to prevent a direct path to ground.

5. Battery Charger: A current limiting battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Charger shall have LED annunciation for low DC volts, rectifier failure, loss of AC power, high DC volts. Amperage output shall be as required. Charger shall be wall mounting type in NEMA 1 enclosure, installed in the generator set enclosure.

F. GENERATOR SET ENCLOSURE – SOUND ATTENUATED AND WEATHER PROTECTIVE

1. The complete diesel engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, weather protective enclosure mounted on the fuel tank base.

2. The enclosure shall be constructed of corrosion resistant steel with electrostatically applied powder coated baked polyester paint. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.

3. A dual wall fuel tank base of 24 hour capacity at 100% load shall be provided as an integral part of the enclosure. It shall be contained in a rupture basin with 110% capacity. The tank shall be pressure tested for leaks prior to shipment and have all necessary venting per UL142 standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided.

4. The enclosure shall reduce the ambient noise level at full load to a maximum of 75 dB at 23 feet.

5. Number of doors on enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment and replacements, hose replacements, access to the control panels, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be reinforced for rigidity.

6. Handles shall be key lockable, all doors keyed alike, and hinges shall be zinc die cast or stainless steel. Fasteners shall be zinc plated or stainless

steel. Doors shall be of a lift off design allowing one person to remove door if necessary.

7. Air handling will be sized and designed by the manufacturer for 0.5" static pressure drop through enclosure. Intake openings shall be screened to prevent the entrance of rodents.

8. Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves. Radiator access shall be through a hinged, lockable cover on enclosure. Cooling fan and charging alternator shall be fully guarded to prevent injury.

9. Lifting points shall be provided on base frame suitable for lifting combined weight of base tank, generator set and enclosure.

G. AUTOMATIC TRANSFER SWITCH (INCORPORATED INTO MAIN SWITCHBOARD GEAR)

PART 3 - EXECUTION

1.1 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes. Installation of the system includes but is not limited to pouring a concrete pad for the generator set and automatic transfer switch, receiving and offloading the equipment, providing all labor, permits and material to install the total system.

B. Start-Up and Testing

1. Coordinate all start-up and testing activities with the Engineer and Owner.
2. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:
3. Verify that the equipment is installed properly.
4. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote annunciator, etc.
5. Test all alarms and safety shutdown devices for proper operation and annunciation.
6. Check all fluid levels.
7. Start engine and check for exhaust, oil, fuel leaks, vibrations, etc.
8. Verify proper voltage and phase rotation at the transfer switch before connecting to the load.
9. Connect the generator to building load and verify that the generator will start and run all designated loads in the plant.

10. Perform a 4 hour load bank test at full nameplate load using a load bank and cables supplied by the local generator dealer. Observe and record the following data at 15 minute intervals:
    a. Service meter hours
    b. Volts AC - All phases
    c. Amps AC - All phases
    d. Frequency
    e. Power factor or Vars
    f. Jacket water temperature
    g. Oil Pressure
    h. Fuel pressure
    i. Ambient temperature
11. Operation and Maintenance Manuals
    a. Provide three (3) sets of operation and maintenance manuals covering the generator, switchgear, and auxiliary components. Include parts manuals, final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

1.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

1. Train Owner’s maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.

2. Review data in maintenance manuals.

3. Schedule training with Owner, with at least seven days’ advance notice.

4. Minimum Instruction Period: Four hours.

END OF SECTION

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Coarse aggregate materials.
2. Fine aggregate materials.
3. Rip Rap materials.

B. Related Sections:

1. Section 31 20 00 Earth Moving.
2. Section 31 25 00 Erosion and Sedimentation Control: Slope protection and erosion control.
3. Section 31 50 00 Excavation Support and Protection.
4. Section 32 91 13 Soil Preparation
5. Geotechnical Report

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. Georgia Department of Transportation (GDOT). *Standard Specifications for Highway Construction*, latest edition.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Samples: Submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.

C. Materials Source: Submit name of imported materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work according to the Georgia Department of Transportation, Standard Specifications, Construction of Roads and Bridges, latest edition.

C. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Aggregate Designation: Graded Coarse Aggregates, Graded Fine Aggregates, Rip Rap

1. Conform to the GDOT , *Standard Specifications, Construction of Transportation Systems*, latest edition, Section 800 - Graded Coarse Aggregates.

2. Conform to the GDOT, *Standard Specifications, Construction of Transportation Systems,* latest edition, Section 801 - Graded Fine Aggregates.

3. Conform to the GDOT, *Standard Specifications, Construction of Transportation Systems,* latest edition, Section 805 - Rip Rap.

B. Coarse Aggregate: No.3

1. Percent Passing per Sieve Size:

a.	2 1/2 inches:	100
b.	2 inches:	90 to 100
c.	1 1/2 inches:	35 to 70
d.	3/4 inch:	n/a
e.	1/2 inch:	0 - 5
f.	3/8 inches:	n/a
g.	No. 4:	n/a
h.	No. 8:	n/a
i.	No. 16:	n/a

C. Coarse Aggregate: No.57

1. Percent Passing per Sieve Size:

a.	2 inches:	n/a
b.	1 1/2 inches:	100
c.	1 inch:	95 - 100
d.	3/4 inch:	n/a
e.	1/2 inch:	25 - 60
f.	3/8 inches:	n/a
g.	No. 4:	0 - 10
h.	No. 8:	0 - 5
i.	No. 16:	n/a
j.	No. 100:	n/a

D. Coarse Aggregate: No.67
1. Percent Passing per Sieve Size:

a.	2 inches:	n/a
b.	1 1/2 inches:	n/a
c.	1 inch:	100
d.	3/4 inch:	90 - 100
e.	1/2 inch:	n/a
f.	3/8 inches:	20 - 55
g.	No. 4:	0 - 10
h.	No. 8:	0 - 5
i.	No. 16:	n/a
j.	No. 100:	n/a

E. Coarse Aggregate: No.9
1. Percent Passing per Sieve Size:

a.	1/2 inch:	n/a
b.	3/8 inch:	100
c.	No. 4:	85 - 100
d.	No.8:	10 - 40
e.	No.16:	0 - 10
f.	No.50:	0 - 5

F. Fine Aggregate: No. 10NS (Natural Concrete Sand)
1. Percent Passing per Sieve Size:

a.	3/8 inch:	100
b.	No.4:	95 - 100
c.	No.16:	45 - 95
d.	No.50:	8 - 30
e.	No.100:	1 - 10
f.	No.200:	0 - 3

G. Fine Aggregate: No. 20NS (Natural Mortar Sand)
1. Percent Passing per Sieve Size:

a.	3/8 inch:	100

b. No.4: 100
c. No.16: 90 - 100
d. No.50: 15 - 50
e. No.100: 0 - 15
f. No.200: 0 - 5

H. Fine Aggregate: No. 10SM (Standard Manufactured Concrete Sand)
1. Percent Passing per Sieve Size:

a. 3/8 inch: 100
b. No.4: 95 - 100
c. No.16: 45 - 95
d. No.50: 8 - 30
e. No.100: 1 - 10
f. No.200: 0 - 4

I. Fine Aggregate: No.10FM (Fine Manufactured Concrete Sand)
1. Percent Passing per Sieve Size:

a. 3/8 inch: 100
b. No.4: 95 - 100
c. No.16: 45 - 95
d. No.50: 15 - 42
e. No.100: 8 - 22
f. No.200: 3 - 9

J. Aggregate: Riprap Type I
1. Provide riprap conforming to the gradation classes in the following:
a. Rock Volume (ft^3): 4.2, Rock Approximate Weight (lbs): 700, Percent of Riprap Smaller Than: 100.
b. Rock Volume (ft^3): 1.8, Rock Approximate Weight (lbs): 300, Percent of Riprap Smaller Than: 50 - 90.
c. Rock Volume (ft^3): 0.8, Rock Approximate Weight (lbs): 125, Percent of Riprap Smaller Than: 20 - 65.

K. Aggregate : Riprap Type III
1. Provide riprap conforming to the gradation classes in the following:
a. Rock Volume (ft^3): 1.0, Rock Approximate Weight (lbs): 165, Percent of Riprap Smaller Than: 100.
b. Rock Volume (ft^3): 0.1, Rock Approximate Weight (lbs): 15, Percent of Riprap Smaller Than: 10 - 65.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and inspection services.

B. Coarse Aggregate Material - Testing and Analysis: Perform according to AASHTO T96 or ASTM C131 and AASHTO T11.

C. Fine Aggregate Material - Testing and Analysis: Perform according to ASTM D1557 or AASHTO T180.

D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 - EXECUTION

3.1 INSTALLATION OF RIP RAP

A. All rip-rap shall be embedded in place so that the top surfaces are at the grade established for the surface of rip-rap. The inclusion of objectionable quantities of overburden and rock dust will not be permitted. The rock fragments in rip-rap need not be compacted, but shall be dumped and graded off in a manner to ensure that the larger rock fragments are uniformly distributed and that the small rock fragments serve to fill the spaces between the layer of rip-rap of the specified thickness. Hand placing will be required only to the extent necessary to secure the results specified herein.

B. Unless otherwise specified or shown, rip-rap shall have a minimum thickness of 12”.

C. The Contractor shall maintain the rip-rap until accepted and any material displaced by any cause shall be replaced to the lines and grades shown on the plans.

D. All rip-rap shall be underlain by an approved geotextile fabric to prevent erosion.

3.2 INSTALLATION OF CRUSHED STONE

A. Crushed stone shall be placed in areas shown on the drawings. Stone shall be consolidated by mechanical means.

B. Unless otherwise specified or shown, crushed stone shall have a minimum thickness of 6”.

C. All crushed stone shall be underlain by an approved geotextile fabric to prevent erosion

3.3 STOCKPILING

A. Stockpile materials on site at locations designated by Architect/Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.4 STOCKPILE CLEANUP

A. Leave unused materials in neat, compact stockpile.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 310516

SECTION 311000 – SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Clearing and grubbing.
2. Stripping and stockpiling topsoil.
3. Stripping and stockpiling rock.
4. Removing above- and below-grade site improvements.
5. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction as indicated on the Drawings or as directed by the Owner or Engineer.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction as indicated on the Drawings or as directed by the Owner or Engineer.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs and/or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.6 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Engineer.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor is required to contact the **Utilities Protection Center, Inc. (Know what's below. Call before you dig. Dial 811)** prior to any excavation or construction.

B. Protect and maintain benchmarks and survey control points from disturbance during construction.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation control measures following restoration and stabilization of areas disturbed during construction.

3.3 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, rocks, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

3.7 SITE IMPROVEMENTS

A. Remove existing above-grade and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning trees, shrubs, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air

pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

END OF SECTION 311000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 GENERAL

A. The elevations shown on the Drawings as existing are taken from the best existing data and are intended to provide reasonably accurate information about the existing topographic elevations. The Contractor shall perform field measurements as to the exact quantities of excavation and fill required.

B. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions taken to protect against all hazards. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, Excavations, Trenching, and Shoring, and Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations.

C. Perform all trench excavation and backfilling activities in accordance with the requirements of OSHA (PL 91-596), as amended.

D. The Contractor shall make a thorough investigation of the surface and subsurface conditions of the site for any special construction problems which might arise as a result of nearby watercourses and floodplains.

E. The Contractor shall be responsible for providing all services, labor, equipment, and materials necessary to complete the work on the Drawings and in these Contract Documents.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for: slabs-on-grade, sidewalks, pavements, turf and grasses, and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subbase course and base course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.
9. Excavating well hole to accommodate elevator-cylinder assembly.
10. Excavating and preparation of holding pond bentonite liner for floor and slopes.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation", Section 013233 "Photographic Documentation" for recording pre-excavation and earth-moving progress.

2. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
3. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
4. Section 312319 "Dewatering" for lowering and disposing of ground water during construction.
5. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations to the lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil or other materials as approved by the Engineer used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. in volume or 3/4 cu. yd. in volume for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom.
2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D 1586.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct pre-excavation conference at Project site.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Geofoam.
4. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches (300 mm by 300 mm).
2. Warning Tape: 12 inches (300 mm) long; of each color.

1.7 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698, ASTM D 1557.

B. Blasting plan.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.8 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

1.9 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Engineer.

C. Utility Locator Service: Notify **"Call Before You Dig"** for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls" and Section 311000 "Site Clearing" are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.

5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and zero to 5 percent passing a No. 4 (4.75-mm) sieve.

J. Sand: ASTM C 33/C 33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 HOLDING POND LINER

A. General:

1. Pond shall consist of a compacted soil-bentonite mixture to reduce seepage losses from ponds for water conservation and environmental problems.
2. Bentonite treated soil liners shall comply with all federal, state, and local laws, rules and regulations.
3. Lined structures shall meet all applicable NRCS, ADEM and EPA regulatory standard requirements.
4. Bentonite treated soil liners shall be filter compactable with the natural foundation material on which they are compacted.
5. The bentonite should be high-swelling and free-flowing and have a particle size distribution favorable for uniform application and minimizing of wind drift.
6. The bentonite shall be a sodium bentonite with a free swell of at least 22 mm as measured by ASTM Standard Test Method D5890.

B. Bentonite Application Rates:

1.

Pervious Soil Description	Application Rate (lb/ft^3)
Silts (ML, CL-ML)	0.375
Silty Sands (SM, SC-SM, SP-SM)	0.50
Clean Sands (SP, SW)	0.625

2. At least 12 inches of compacted soil cover shall be placed over the bentonite layer to protect against desiccation cracking, the effects of water surface fluctuations, wave action, surface erosion, erosion from pip inlets, agitation equipment, animals, or items installed through the liner.
3. The minimum thickness of the finished compacted liner shall be 12 inch in all areas.

2.3 PIPE BEDDING CLASSES

A. Class A Bedding shall consist of a continuous concrete arch cradle as determined by the Engineer. Cure concrete 3 days before backfill.

B. Class B Bedding: The pipe shall be bedded with sand or crushed stone bedding material placed on the trench foundation. The bedding shall have a minimum thickness beneath the pipe of 4 inches or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the side to the springline. Initial backfill from the pipe horizontal centerline to a level not less than 12 inches above the top of the pipe and shall be bedding material or carefully placed earth fill, hand equipment compacted to 90% of standard proctor maximum dry density. The final backfill of the soil to ground surface shall be compacted to the specified density per the Earthwork Specifications.

C. Class C Bedding: The pipe shall be bedded in sand or crushed stone bedding material placed on the trench foundation. The bedding shall have a minimum thickness beneath the pipe of 4 inches or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one-sixth the outside diameter of the pipe. Initial backfill between the top of haunching and a point 12 inches above the top of pipe shall be hand equipment compacted to 90% of the standard proctor maximum dry density. The

final backfill of the soil to ground surface shall be compacted to the specified density per the Earthwork Specifications.

D. Pipe Encasement: All pipe under structures or buildings shall be encased to a minimum of depth of 6-inches around the pipe. Encasement shall extend to 2-ft beyond structure. Protect pipe from buoyancy and cure concrete 3 days before backfill. Install concrete in the vertical and horizontal planes. Encasement shall extend up to bottom of slab of building or structure.

2.4 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:

    a. Grab Tensile Strength: 157 lbf (700 N); ASTM D 4632.
    b. Sewn Seam Strength: 142 lbf (630 N); ASTM D 4632.
    c. Tear Strength: 56 lbf (250 N); ASTM D 4533.
    d. Puncture Strength: 56 lbf (250 N); ASTM D 4833.

3. Apparent Opening Size: No. 40 (0.425-mm), No. 60 (0.250-mm), No. 70 (0.212-mm) sieve, maximum; ASTM D 4751.
4. Permittivity: 0.5, 0.2, or 0.1 per second as required/shown on the Drawings, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:

    a. Grab Tensile Strength: 247 lbf (1100 N); ASTM D 4632.
    b. Sewn Seam Strength: 222 lbf (990 N); ASTM D 4632.
    c. Tear Strength: 90 lbf (400 N); ASTM D 4533.
    d. Puncture Strength: 90 lbf (400 N); ASTM D 4833.

3. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.5 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Potable water systems.
5. Pantone Purple: Reclaimed water systems
6. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Potable water systems.
5. Pantone Purple: Reclaimed water systems
6. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

B. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

1. Perform blasting without damaging adjacent structures, property, or site improvements.
2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials include: rock, soil materials, and below existing grade obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 24 inches (600 mm) outside of concrete forms other than at footings.
    b. 12 inches (300 mm) outside of concrete forms at footings.
    c. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
    f. 6 inches (150 mm) beneath pipe in trenches and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation subject to approval by the Engineer.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 24 inches (600 mm) outside of concrete forms other than at footings.
    b. 12 inches (300 mm) outside of concrete forms at footings.
    c. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
    f. 6 inches (150 mm) beneath pipe in trenches and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions in a such a manner to provide ample room for bracing, sheeting, form work, placing subgrade stone, installation of other trades, and dewatering (if required) for construction of the structure. Notify Engineer for inspection of excavation prior to placing subgrade stone or other work.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated neat: gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit.

1. Clearance: 12 inches (300 mm) each side of pipe or conduit or as indicated on the Drawings if different.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones, sharp objects, and loose material along trench subgrade. Provide pipe bedding as shown on the Drawing details or required otherwise.

1. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade unless shown or required otherwise.
2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Excavate for pipe bells for ample depth and width to permit proper joint assembly and relieve the pipe bell of any load.

3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade or subgrade bedding course as shown the Drawings or required otherwise.
4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
5. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 SUBGRADE INSPECTION

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below pavements with a pneumatic-tired compactor and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction**,** repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust or soil erosion/migration due to rainfall events.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of standing water, mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete".

D. Trenches under Roadways: Provide concrete encasement for piping or conduit less than 30 inches below surface of roadways. Encasement shall be a minimum of 4 inches of concrete below and above the pipe or conduit before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete".

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill free of particles larger than 2 inches to a height of 1 foot over the pipe or conduit.

a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 1 foot over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 20 inches below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698, ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.16 HOLDING POND LINER

A. For protection against bentonite dust, personnel onsite during bentonite application and mixing shall wear mask and goggles.

B. The bentonite liner shall be applied with specifically designed spreading equipment.

C. The application should be split so that one-half is applied in one direction and the other half in a perpendicular direction.

D. The bentonite shall be mixed into the soil to a uniform depth of at least 3 inches.

E. The liner should be compacted at the proper water content to at least 90 percent of Standard Proctor Density (specifically excluding use of a sheepsfoot roller).

F. The completed seal should be covered with at least 12 inches of soil in addition to necessary erosion control.

G. The completed liner should be hydrated with fresh water prior to introduction of wastewater and kept at or above the optimum water content until the pond is prefilled.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.18 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Section 334600 "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch (150-mm) thick compacted layers to final subgrade.

3.19 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of standing water, mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698, ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698, ASTM D 1557.

3.20 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of standing water, mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.21 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one (1) test for every 100 feet (30 m) or less of wall length but no fewer than two (2) tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one (1) test for every 150 feet (46 m) or less of trench length but no fewer than two (2) tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.22 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes construction dewatering.

B. Related Requirements:

1. Section 013100 “Project Management and Coordination” for Informational Submittals
2. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
3. Section 013300 “Submittal Procedures” for Action Submittals
4. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of wells and wellpoints; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in dewatering work.

1.7 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
2. The geotechnical report is included Section 003200 “Information Available to Bidders”.

B. Survey Work: Engage a qualified land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.

2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water and debris disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 015000 "Temporary Facilities and Controls," Section 311000 "Site Clearing," during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to required levels for the work to be constructed.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction Entrance/Exits
2. Diversion Channels.
3. PAM
4. Rock Energy Dissipator.
5. Rock Barriers.
6. Sediment Control: including silt fences, inlet protection, etc.
7. Sediment Ponds.
8. Sediment Traps.
9. Silt Fences

B. Related Sections:

1. Section 033000 Cast-In-Place Concrete.
2. Section 055000 Metal Fabrications.
3. Section 310516 Aggregates for Earthwork.
4. Section 312000 Earthmoving.
5. Section 321313 Concrete Paving.
6. Section 329113 Soil Preparation
7. Section 329200 “Turf and Grasses.”

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T88 - Standard Specification for Particle Size Analysis of Soils.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.

C. ASTM International:

1. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).

4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D. Precast/Prestressed Concrete Institute:

1. PCI MNL-116S - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

E. Georgia Erosion and Sedimentation Control Act of 1975:

1. All erosion and control measures shall be designed for a 25 year storm event and installed according to the Manual for Erosion and Sediment Control in Georgia.
2. Storm water discharges shall be in strict compliance with the State of Georgia Department of Natural Resources Environmental Protection Division General Permit No. GAR100001 effective August 1, 2018.

F. The Department of Transportation, State of Georgia, Standard Specifications Construction of Roads and Bridges latest edition.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Product Data: Submit data on joint filler, joint sealer, admixtures, curing compounds, and geotextiles.

C. Submit proposed mix design of each class of concrete for review prior to commencement of Work.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

1.5 QUALITY ASSURANCE

A. Perform Work according to the Department of Transportation, State of Georgia standards.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

PART 2 - PRODUCTS

2.1 ROCK AND GEOTEXTILE MATERIALS

A. Furnish materials according to Department of Transportation, State of Georgia standards.

B. Rock: As specified in Section 310516 Aggregates for Earthwork. Furnish according to Department of Transportation, State of Georgia standards.

C. Geotextile Fabric: Furnish according to Department of Transportation, State of Georgia standards.

2.2 CONCRETE MATERIALS AND REINFORCEMENT

A. Cement: As specified in Section 033000 Concrete.

2.3 PLANTING MATERIALS

A. Seeding and Soil Supplements: As specified in Section 329113 Soil Preparation.

B. Turf and Grasses: As specified in Section 329200 Turf and Grasses.

2.4 POLYACRYLAMIDE (PAM)

A. Only the anionic form of PAM shall be used. PAM and PAM mixtures shall be environmentally benign, harmless to fish, wildlife, and plants.

B. Anionic PAM in pure form shall have less than or equal to 0.05% acrylamide monomer by weight, as established by the FDA and US EPA.

2.5 Mats and Blankets (ECB's)

A. 3:1 Slopes and flatter
   1. ECB must be rated for shear stresses up to 1.55 lbs/sq ft, must weigh at least 0.50 lbs/yd2, and the netting made of biodegradable polypropylene or FibreNet™ material

B. 1.5:1 to 3:1 Slopes
   1. ECB must be rated for shear stresses up to 1.75 lbs/sq ft, must weigh at least 0.73 lbs/yd2, and the netting made of biodegradable polypropylene or FibreNet™ material

C. Acceptable manufacturer
   1. American Excelsior Company, Arlington, TX
   2. Or approved equal

D. Inlet Protection Products
   1. Drop Inlets
      a. Silt Savers

b. Dandy Sacks
2. Curb Inlet
   a. Dandy Curb
   b. Gutter Eel
3. The filter shall be a weighted sediment tube filter with a diameter of 9.5-inches at the ends and tapering to 5 inches in the center. Lengths shall be 6 to 9 feet with a build-in triangular overflow for relief during high-intensity storm events.
   a. Unit Weight: 13 lbs/ft
   b. Interior Filter
   c. Materials: Shredded, recycled tire rubber particles with less than 2% metal and the rubber shall be washed during manufacturing.
   d. Particle Size: ½ inch to ¾ inch particle size
   e. Geotextile Bag
      1) Percent Open Area: 8%
      2) Apparent Opening Size: 30 U.S. Sieve
      3) Grab Tensile Strength: 400 lbs
      4) Flow Rate: 115 gal/min/ft2
      5) Puncture Strength: 125 lbs

E. Fiber Rolls
1. Fiber rolls should be prefabricated rolls or rolled tubes of geotextile fabric. When rolling the tubes, make sure each tube is at least 8 inches in diameter. Bind the rolls at each end and every 4 feet along the length of the roll with jute-type twine

F. Silt Fence
1. The height of a silt fence shall not exceed 36 inches (0.9 m). Storage height and ponding height shall never exceed 18 inches (0.5 m).
2. The standard-strength filter fabric shall be stapled or wired to the fence, and 6 inches (0.2 m) of the fabric shall extend into the trench.
3. Type A Silt Fence
   a. A wire mesh support fence shall be fastened securely to the upslope side of the posts (between the posts and fabric) using heavy duty wire staples at least ½" (12.7mm) long and ¾" wide, tie wires or hog rings. The wire shall extend into the trench a minimum of 6 inches (51 mm) and shall not extend more than 36 inches (0.9 m) above the original ground surface.
   b. Posts shall be 4' long steel that each weigh at least 5.2 lbs.
4. Type B Silt Fence
   a. The spacing between posts shall be a maximum of 6', and the filter fabric shall be stapled or wired directly to the posts.
   b. Posts may be soft wood 2x4, oak 2x2, or steel as indicated for Type A Silt Fence

2.6 PIPE MATERIALS

A. Pipe: Corrugated steel, as specified in the Department of Transportation, State of Georgia, Highways Standards.

2.7 ACCESSORIES

A. Trash Rack: Bars welded to angles and at each intersection of bars, as specified in Section 051200 Misc. Metals.

2.8 SOURCE QUALITY CONTROL (AND TESTS)

A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.

B. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify compacted stabilized soil is acceptable and ready to support devices and imposed loads.

B. Verify gradients and elevations of base or foundation for other work are correct.

3.2 DIVERSION CHANNELS

A. Windrow excavated material on low side of channel.

B. Compact to 95 percent maximum density.

C. On entire channel area, apply soil supplements and sow seed as specified in Section 329200.

D. Mulch seeded areas with hay as specified in Section 329200.

3.3 POLYACRYLAMIDE (PAM)

A. The maximum application rate of PAM in pure form shall not exceed 200 lbs/ace/year. Over application of PAM can lower infiltration rates or suspend solids in water, and, therefore, over application should be avoided.

B. Users of PAM shall obtain and follow all MSDS requirements.

C. The manufacturer or supplier shall provide written application methods for PAM and PAM mixtures. The application shall provide uniform coverage to the target area.

3.4 MATS AND BLANKETS

A. After the site has been shaped and graded to the approved design, prepare a seedbed free from clods and rocks more than 1 inch in diameter, and any foreign matter that will prevent the contact of the mat with the soil surface.

B. Lime, fertilizer, and seed shall be applied in accordance with seeding or other type of planting plan as suggested by the ENGINEER.

C. Erosion control blanket products should be installed in accordance with the manufacturer's recommendations and specifications, including check slots and stapling materials.

D. Anchor product so that a continuous, firm contact with the soil surface/seed bed is maintained. This is best accomplished on slopes by working from the bottom to the top.

3.5 SEDIMENT CONTROL

A. Filter Ring/Rock Filter Ring
1. Mechanical or hand placement of fiber rolls/straw wattles/stone shall be required to uniformly surround the structure to be supplemented.
2. The filter ring may be constructed on natural ground surface, excavated surface, or on machine compacted fill.
3. When placed below a storm drain outlet, it shall be constructed so that it does not allow water to back up into the storm drain.

B. Inlet Protection Products
1. For information on installation, refer to the manufacturers' drawings provided by the distributor. Strict adherence to the manufacturers' suggested installation procedures is required for proper inlet protection.

C. Fiber Rolls
1. On slopes, install fiber rolls along the contour with a slight downward angle at the end of each row to prevent ponding at the midsection. Turn the ends of each fiber roll upslope to prevent runoff from flowing around the roll. Install fiber rolls in shallow trenches dug 3 to 5 inches deep for soft, loamy soils and 2 to 3 inches deep for hard, rocky soils.
2. Determine the vertical spacing for slope installations on the basis of the slope gradient and soil type. A good rule of thumb is:
   a. 1:1 slopes = 10 feet apart
   b. 2:1 slopes = 20 feet apart
   c. 3:1 slopes = 30 feet apart
   d. 4:1 slopes = 40 feet apart
3. For soft, loamy soils, place the rows closer together. For hard, rocky soils, place the rows farther apart. Stake fiber rolls securely into the ground and orient them perpendicular to the slope. Drive the stakes through the middle of the fiber roll and deep enough into the ground to anchor the roll in place. About 3 to 5 inches of the stake should stick out above the roll, and the stakes should be spaced 3 to 4 feet apart. A 24-inch stake is recommended for use on soft, loamy soils. An 18-inch stake is recommended for use on hard, rocky soils.

D. Rock Filter Dam
1. The center of the rock dam should be at least 6" lower than the outer edges of the dam at the channel banks. Side slopes shall be 2:1 or flatter. The top width of the dam should be at least 6'.
2. The dam should not be higher than the channel banks or the elevation of the upstream property line.
3. Set a marker stake to indicate the clean out elevation.

3.6 CONSTRUCTION ENTRANCE/EXIT

A. The entrance/exit must be excavated to a depth of 3” and cleared of all vegetation and roots.

B. If the action of the vehicle travelling over the gravel pad does not sufficiently remove the mud, the tires should be washed prior to entrance onto public rights-of-way. When washing is necessary, it should be done on an area stabilized with crushed stone.

C. A geotextile fabric underliner should be placed the full length and width of the entrance.

3.7 ROCK ENERGY DISSIPATOR

A. Excavate to indicated depth of rock lining or nominal placement thickness as follows. Remove loose, unsuitable material below bottom of rock lining, then replace with suitable material. Thoroughly compact and finish entire foundation area to firm, even surface.

1. Nominal Placement Thickness per NCSA Class:
   a. R7: 36 Inches
   b. R6: 30 Inches
   c. R5: 24 Inches
   d. R4: 18 Inches
   e. R3: 12 Inches

B. Lay and overlay geotextile fabric over substrate. Lay fabric parallel to flow from upstream to downstream. Overlap edges upstream over downstream and upslope over downslope. Provide a minimum overlap of 3 feet. Cover fabric as soon as possible and in no case leave fabric exposed more than 4 weeks.

C. Carefully place rock on geotextile fabric to produce an even distribution of pieces, with minimum of voids and without tearing geotextile.

D. Unless indicated otherwise, place full course thickness in one operation to prevent segregation and to avoid displacement of underlying material. Arrange individual rocks for uniform distribution.

3.8 ROCK BARRIER

A. Determine length required for ditch or depression slope and excavate, compact and foundation area to firm, even surface.

B. Produce an even distribution of rock pieces, with minimum voids to the indicated shape, height and slope.

C. Construct coarse aggregate filter blanket against upstream face of rock barrier to the indicated thickness.

3.9 SEDIMENTATION POND

A. Clear and grub storage area and embankment foundation area site as indicated and specified.

B. Excavate key trench for full length of dam. Excavate emergency spillway in natural ground.

C. Install pipe spillway, with anti-seep collar attached, at location indicated.

D. Place forms, and reinforcing for concrete footing at bottom of riser pipe with trash rack and anti-vortex device. Construction of embankment and trench prior to placing pipe is not required.

E. Mix, place, finish, and cure concrete, as specified in Section 033000.

F. Do not use coarse aggregate as backfill material around pipe. Backfill pipe with suitable embankment material to prevent dam leakage along pipe.

G. Construct rock basin at outlet end of pipe. Place embankment material, as specified.

H. On entire sedimentation pond area, apply soil supplements and sow seed as specified in Section 329200.

I. Mulch seeded areas with hay.

J. Apply PAM.

3.10 SEDIMENT TRAPS

A. Clear site, as indicated.

B. Construct trap by excavating and forming embankments as indicated in the drawings.

C. Place coarse aggregate or rock at outlet as indicated on Drawings.

D. Place geotextile fabric, as specified for rock energy dissipator.

E. When required, obtain borrow excavation for formation of embankment.

F. On entire sediment trap area, apply soil supplements and sow seed as specified in Section 329219.

G. Mulch seeded areas with hay.

3.11 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2:1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.12 FIELD QUALITY CONTROL & INSPECTIONS

A. Section 014000 - Quality Requirements and 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. It is the CONTRACTOR'S responsibility to perform all required inspections in accordance with all Authorities having Jurisdiction.

E. CONTRACTOR is responsible for continually maintaining all temporary erosion control measures until permanent measures are properly installed and performing as required.

3.13 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

C. Do not damage structure or device during cleaning operations.

D. Do not permit sediment to erode into construction or site areas or natural waterways.

E. Clean channels when depth of sediment reaches approximately one-half channel depth.

3.14 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

C. Protect paving from elements, flowing water, or other disturbance until curing is completed.

END OF SECTION 312500

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 31 20 00 “Earthmoving”
2. Section 31 23 19 "Dewatering" for dewatering excavations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

1.4 INFORMATIONAL SUBMITTALS

A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

C. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.5 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Engineer no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Engineer's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
2. The geotechnical report is included elsewhere in Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36, ASTM A 690, or ASTM A 992.

C. Steel Sheet Piling: ASTM A 328, ASTM A 572, or ASTM A 690; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock or Roll-formed corner shape with continuous interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

F. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

G. Tiebacks: Steel bars, ASTM A 722.

H. Tiebacks: Steel strand, ASTM A 416.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 FIELD QUALITY CONTROL

A. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

B. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Division 31 and as required by the geotechnical engineer.
3. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 50 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt patching.
2. Hot-mix asphalt paving.
3. Hot-mix asphalt overlay.
4. Asphalt surface treatments.

B. Related Requirements:

1. Section 02 41 16 "Structure Demolition" and Section 02 41 19 "Selective Demolition" for demolition and removal of existing asphalt pavement.
2. Section 07 92 00 “Joint Sealants”
3. Section 31 05 16 "Aggregates for Earthwork"

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

    a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
    b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.
2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
3. Job-Mix Designs: For each job mix proposed for the Work.

B. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

1. Paving Fabric: 12 by 12 inches minimum.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

B. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

C. Material Test Reports: For each paving material, by a qualified testing agency.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located in accordance with Georgia Department of Transportation (GDOT), standard specifications, latest edition.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Georgia Department of Transportation (GDOT), standard specifications, latest edition.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

D. Materials: Obtain paving materials from the same source throughout.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 ˚F.
2. Tack Coat: Minimum surface temperature of 60 ˚F.
3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
4. Asphalt Base Course: Minimum surface temperature of 40 ˚F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 ˚F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Hot Mix Asphaltic Concrete Construction: GDOT Section 400, ASTM D 946.

B. Aggregate Base Course: GDOT Standards Section 802.

C. Asphalt Binder Course: In accordance with GDOT Standards Section 802.

D. Aggregate Wearing Course: In accordance with GDOT Standards Section 802.

E. Fine Aggregate: In accordance with GDOT Standards Section 802.

F. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.

G. Prime Coat: In accordance with GDOT Standards, ASTM D 2027, AASHTO MC-30, MC-70 or MC-250.

H. Tack Coat: Homogenous, medium curing, liquid asphalt. Conforming with GDOT Standards Section 413.

I. Emulsified Asphalt Slurry: In accordance with GDOT Standards Section 427.

J. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled asphalt shingles or glass from sources and

gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: ASTM D 1073, Grade No. 2 or No. 3.

D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

E. Joint Sealant: ASTM D 6690, Type I, hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Sustainable Design Acceptance

1. Surface Course Limit: Recycled content no more than 20 percent by weight on surface course and 25 on intermediate and base courses.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction Georgia Department of Transportation complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: 8” Graded Aggregate Base (GAB).
3. Binder Course: 3” (330 lb/sy) 19 mm Superpave
4. Surface Course: 2” (165 lb/sy) 12.5 mm Superpave or as directed by engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet, saturated or frozen subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.10 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 PAVING GEOTEXTILE INSTALLATION

A. Apply asphalt binder uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd.

B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

3.6 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 ˚F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 ˚F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, but not less than 94 percent or greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch~~,~~ no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Asphalt Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch of height indicated above pavement surface.

3.10 SURFACE TREATMENTS

A. Slurry Seals: Apply slurry coat in a uniform thickness according to GDOT 427. (**Not Used**)

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 2726.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan and as required by the Georgia Environmental Protection Division.

END OF SECTION 321216

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes Concrete Paving**.** Including the following:

1. Driveways.
2. Curbs and gutters.
3. Walks.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete for general building applications of concrete.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

   a. Concrete mixture design.
   b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete paving Subcontractor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 ºF, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 ºF and not more than 80 ºF at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 ºF at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 and ACI 117 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcing Bars: ASTM A 615, Grade 60 (Grade 420); deformed.

C. Plain-Steel Wire: ASTM A 1064, as drawn galvanized.

D. Joint Dowel Bars: ASTM A 615, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

E. Tie Bars: ASTM A 615, Grade 60 (Grade 420); deformed.

F. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray white Portland cement Type I, Type II, or Type I/II
2. Fly Ash: ASTM C 618, Class F.
3. Slag Cement: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4M Class 1N, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.

3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 4-1/2 percent plus or minus 1-1/2 percent for 1-1/2-inch nominal maximum aggregate size.
2. Air Content: 4-1/2 percent plus or minus 1-1/2 percent for 1-inch nominal maximum aggregate size.
3. Air Content: 5 percent plus or minus 1-1/2 percent for 3/4-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture or plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 4000 psi
2. Maximum W/C Ratio at Point of Placement: 0.50
3. Slump Limit: 4 inches, plus or minus 1 inch.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 ºF, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 ºF, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 - Earth Moving.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction (Control) Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

    a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

    a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand

floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch.

4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.11 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 323113 – CHAIN LINK FENCE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Galvanized coated chain link fencing and accessories for commercial and industrial use.

B. Related Requirements:
1. Section 033000 – Cast-in-Place Concrete

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop drawings: Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.

C. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.

D. Gate Operator: Provide drawings showing layout and typical locations for all equipment that is being supplied.

1.4 WARRANTY

A. Provide Manufacturer's standard 10 year limited warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Products from qualified manufacturers having a minimum of five years experience manufacturing galvanized coated chain link fencing will be acceptable by the architect as equal, if approved in writing, ten days prior to bidding, and if they meet the following specifications for design, size gauge of metal parts and fabrication.

B. Obtain chain link fences and gates, including accessories, fittings, and fastenings, from a single source.

2.2 CHAIN LINK FENCE FABRIC

A. Galvanized wire: Zinc coated Wire, ASTM A 392 - 1.2oz/sf. Wire Spec-A817-83, Class 1.

B. Size: Helically wound and woven to height as indicated on drawings with 2" diamond mesh, 9 gauge, with a wire diameter of 0.148 inch and a breakload of 1,290 lbf.

C. Selvage of fabric twisted at top and knuckled at bottom.

2.3 STEEL FENCE FRAMING

A. Steel pipe - Type I: ASTM F 1083, standard weight schedule 40; minimum yield strength of 30,000 psi (205 MPa); sizes as indicated. Hot-dipped galvanized with minimum average 1.8 oz/ft² (550 g/m²) of coated surface area.

B. Member Sizes
1. End and Corner Post 2.375" od, 3.65 lbs/ft
2. Line (intermediate) Post 1.9" od, 2.72 lbs/ft
3. Rail and Braces 1.66" of, 2.27 lbs/ft

2.4 ACCESSORIES

A. Chain link fence accessories: [ASTM F 626] Provide items required to complete fence system. Galvanize each ferrous metal item and finish to match framing.

B. Post caps: Formed steel or cast malleable iron weather tight closure cap for tubular posts. Provide one cap for each post. Cap to have provision for barbed wire when necessary. "C" shaped line post without top rail or barbed wire supporting arms do not require post caps. (Where top rail is used, provide tops to permit passage of top rail).

C. Top rail and rail ends: Pressed steel per ASTM F626, for connection of rail and brace to terminal posts.

D. Top rail sleeves: 7" (178 mm) expansion sleeve with a minimum .137" wire diameter and 1.80" length spring, allowing for expansion and contraction of top rail.

E. Wire ties: 9 gauge, 0.148", galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge, 0.092", for rails and braces. Hog ring ties of 12-1/2 gauge, 0.0985", for attachment.

F. Brace and tension (stretcher bar) bands: Pressed steel, minimum 300 degree profile curvature for secure fence post attachment. At square post provide tension bar clips.

G. Tension (stretcher) bars: One piece lengths equal to 2 inches (50 mm) less than full height of fabric with a minimum cross-section of 3/16" x 3/4" (4.76 mm x 19 mm). Provide tension (stretcher) bars where chain link fabric meets terminal posts.

H. Tension wire: Galvanized coated steel wire, 6 gauge, 0.192", and diameter wire with tensile strength of 75,000 psi.

I. Truss rods & tightener: Steel rods with minimum diameter of 5/16" (7.9 mm). Capable of withstanding a tension of minimum 2,000 lbs.

J. Barbed wire: [ASTM A 121] Class 3, zinc coated steel wire double-strand, 12-1/2 gauge [0.099"(2.51mm)] twisted line wire with galvanized steel, 4 point barbs spaced approximately 5" (127mm) on center.

K. Barbed wire supporting arms: Pressed steel arms with provisions for attaching 3 rows or barbed wire. Arms shall withstand 250 lb. (113.5kg) downward pull at the outermost end of arm without failure.
1. Provide 45° sloped outward, 3 strands, single arm.
2. Provide intermediate arms with hole for passage of top rail.

L. Nuts and bolts are galvanized.

2.5 SETTING MATERIALS

A. Concrete: Minimum 28 day compressive strength of 3,500 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify areas to receive fencing are completed to final grades and elevations.

B. Ensure property lines and legal boundaries of work are clearly established.

C. Make field measurements and verify locations before installation.

D. Verify areas to assure sufficient space to receive gate in open position, (gate and overhang).

3.2 CHAINLINK FENCE FRAMING INSTALLATION

A. Install chain link fence in accordance with ASTM F 567 and manufacturer's instructions.

B. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30° or more.

C. Space line posts uniformly at 10' on center.

D. Concrete set terminal, line, and gate posts: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter 4 times greater than outside dimension of post, and depths approximately 6 deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post. Slope to direct water away from posts.
1. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" below surface when in firm, undisturbed

soil. Place concrete around posts in a continuous pour, tamp for consolidation. Trowel finish around post and slope to direct water away from posts. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

E. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

F. Bracing: Install horizontal pipe brace at mid-height for fences 6' and over, on each side of terminal posts. Firmly attach with fittings. Install diagonal truss rods at these points. Adjust truss rod, ensuring posts remain plumb.

G. Tension wire: Provide tension wire at bottom of fabric and at top, if top rail is not specified. Install tension wire before stretching fabric and attach to each post with ties. Secure tension wire to fabric with 12-1/2 gauge, 0.0985" hog rings 24" oc.

H. Top rail: Install lengths, 21'. Connect joints with sleeves for rigid connections for expansion/contraction.

I. Center Rails (for fabric height 12' and over). Install mid rails between posts with fittings and accessories.

J. Bottom Rails: Install bottom rails between posts with fittings and accessories.

3.3 CHAINLINK FABRIC INSTALLATION

A. Fabric: Install fabric on security side and attach so that fabric remains in tension after pulling force is released. Leave approximately 2" between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15" on center and to rails, braces, and tension wire at 24" on center.

B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15" on center.

3.4 ACCESSORIES

A. Tie wires: Bend ends of wire to minimize hazard to persons and clothing.

B. Fasteners: Install nuts on side of fence opposite fabric side for added security.

C. Barbed wire: Uniformly space parallel rows of barbed wire on security side of fence. Pull wire taut and attach in clips or slots of each extension.

END OF SECTION 323113

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes planting soils and layered soil assemblies specified by composition of the mixes.

B. Related Requirements:
1. Division 31 - Earthwork
2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.

1.3 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

1.6 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

B. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil.

1. Notify Engineer seven days in advance of the dates and times when the contractor requests samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.9 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Engineer under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by[**one of**] the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

   a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
   b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT SERA-6, including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inchdepth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inchdepth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil Type: Provide offsite topsoil or amend existing, on-site surface soil, with the duff layer, if any, retained; modified to produce viable planting soil. Blend existing, on-site surface soil with the soil amendments and fertilizers required for the topsoil to have the following qualities or provide from offsite as follows:

1. Fertile, friable, naturally occurring. Free of stones, clay, lumps, hardpan, roots, stumps, branches, sticks and other debris larger than one inches in any dimension; free of noxious weeds, grasses, seeds, plants, extraneous matter and any substance harmful to plant growth. Topsoil from open fields will not be accepted.
2. Ph: 5.0 to 7.0
3. Organic Matter: 5% to 10%
4. Sand: 50% to 70%
5. Silt: less than 30%

6. Clay: 10% to 25%
7. Permeability Rate of 5 x 10 <-3> centimeters or greater at 85% compaction.

8. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
9. Unacceptable Properties: Clean soil of the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
3. Form: Provide lime in form of ground dolomitic limestone or calcitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Feedstock: May include sewage sludge.
2. Reaction: pH of 5.5 to 8.

3. Moisture Content: 35 to 55 percent by weight.
4. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 5 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 4 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

   a. Mix lime with dry soil before mixing fertilizer.
   b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is required due to use or as directed by the Engineer.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth of 4 inches, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is required due to use or as directed by the Engineer.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix 4 inches of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 2000 sq. ft. of in-place soil or part thereof.

C. Soil will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.7 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

B. If planting soil or subgrade is over-compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Engineer and replace contaminated planting soil with new planting soil.

3.8 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Sodding.
4. Erosion-control material(s).

B. Related Requirements:

1. Section 329113 “Soil Preparation”

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation."

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for grass and seeds. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
3. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the periods indicated in the seeding and grassing chart or as advised by the turf provider. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality: State-certified seed of grass species as listed.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.2 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.3 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.4 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Invisible Structures, Inc.
b. Presto Products Company.
c. Tenax Corporation - USA.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel,

paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Engineer’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft. or as indicated by the GDOT guidelines.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 SODDING

A. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Engineer prior to delivery time. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   1. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Owner shall mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

D. Turf Post Fertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

   1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Engineer:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 33 01 30.13 - SEWER AND MANHOLE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing of Gravity Sewer Piping:

    a. Low pressure air testing.
    b. Joint Testing
    c. Infiltration testing.

2. Testing for Water Retaining Structures
    a. Exfiltration Testing

3. Testing of pressure piping.
4. Deflection testing of plastic gravity sewer piping.
5. Testing of Manholes:

    a. Vacuum testing.
    b. Exfiltration testing.

B. Related Requirements:

1. Section 33 01 30.61 - Sewer and Pipe Joint Sealing
2. Section 33 01 30.62 - Manhole Grout Sealing
3. Section 33 31 11 - Sanitary Sewerage Gravity Piping

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C1103 – Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
2. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
3. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
4. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
5. ASTM F1417 – Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.
6. ASTM F2164 – Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.

B. American Water Works Association:

1. AWWA C600 - Installation of Ductile Iron Mains and Their Appurtenances.

C. PVC Pipe Association

1. UNI-B-06-Recommended Low-Pressure Air Testing of Installed Sewer Pipe.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gage calibration.
6. Deflection mandrel drawings and calculations.
7. Testing Safety Plan describing safety precautions to be taken during testing.

C. Test and Evaluation Reports: Indicate results of manhole and piping tests.

PART 2 - PRODUCTS

2.1 VACUUM TESTING

A. Equipment:

1. Vacuum pump.
2. Vacuum line.
3. Vacuum Tester Base:
    a. Compression band seal.
    b. Outlet port.
4. Shutoff valve.
5. Stopwatch.
6. Plugs.
7. Vacuum Gage: Calibrated to 0.1 in. Hg.

2.2 JOINT TESTING

1. Vacuum pump.
2. Vacuum line.
3. Joint Tester
4. Shutoff valve.

5. Stopwatch.
6. Plugs.
7. Vacuum Gage: Calibrated to 0.1 in. Hg.

2.3 EXFILTRATION TESTING

A. Equipment:

1. Water
2. Plugs.
3. Pump.
4. Measuring device.

2.4 AIR TESTING

A. Equipment:

1. Air compressor.
2. Air supply line.
3. Shutoff valves.
4. Pressure regulator.
5. Pressure relief valve.
6. Stopwatch.
7. Plugs.
8. Pressure Gage: Calibrated to 0.1 psi.

2.5 INFILTRATION TESTING

A. Equipment: Weirs.

2.6 HYDROSTATIC TESTING

A. Equipment:

1. Hydro pump.
2. Pressure hose.
3. Water meter.
4. Test connections.
5. Pressure relief valve.
6. Pressure Gage: Calibrated to 0.1 psi.

2.7 DEFLECTION TESTING

A. Equipment:

1. "Go, no go" mandrels.
2. Pull/retrieval ropes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that manholes and piping are ready for testing.

C. Verify that trenches are backfilled.

D. Verify that pressure piping thrust restraint system is installed.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for preparation.

B. Lamping of Gravity Pipe:

1. Lamp gravity piping after flushing and cleaning.
2. Perform lamping operation by shining light at one end of each pipe section between manholes.
3. Observe light at the other end showing at least 90% of the full circle pipe from manhole to manhole without obstruction.
4. Pipe not installed with uniform line and grade will be rejected.
5. Remove and reinstall rejected pipe sections.
6. Reclean and lamp until pipe section is installed to uniform line and grade.
    a. All additional cleaning and lamping water will be supplied by the Contractor at no additional cost to the Owner

C. Plugs:

1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Deflection Testing of Plastic Sewer Piping:

1. Conduct deflection test prior to low pressure air test.
2. Perform vertical ring deflection testing on non-rigid piping (thermoplastic, FRP, and acrylonitrile butadiene styrene) after backfilling has been in place for at least 30 days but not longer than 12 months.

3. Allowable maximum deflection for installed plastic sewer pipe is no greater than five percent of original vertical internal diameter.
4. Perform deflection testing using properly sized rigid ball or "go, no go" mandrel.
5. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe, as determined by ASTM standard to which pipe is manufactured; measure pipe diameter in compliance with ASTM D2122. The minimum diameters of mandrels used for the corresponding pipe sizes are: 8" line = 7.6", 10" line = 9.5", 12" line = 11.4".
6. The critical dimensions of the rigid ball or mandrel shall have a +/- 0.01 inch tolerance.
7. Perform testing without mechanical pulling devices.
8. Locate, excavate, replace, and retest piping that exceeds allowable deflection at no additional cost to the Owner.

D. Low-Pressure Air Testing:

1. Test each reach of gravity sewer piping between manholes in accordance with ASTM F1417 and UNI B-6-90.
2. Introduce air pressure slowly to approximately 4 psig.
3. Determine ground water elevation above spring line of piping.
4. For every foot of ground water above spring line of piping, increase starting air test pressure by 0.43 psi.
5. Do not increase pressure above 10 psig.
6. Allow pressure to stabilize for at least five minutes.
7. Adjust pressure to 3.5 psig or to increased test pressure as determined above when ground water is present.
8. Do not make allowance for laterals.
9. The time elapsed for a 0.5 psi drop in air pressure shall be not less than 10 minutes or as specified in ASTM F1417 or UNI B-6-90 whichever is greater.
10. Record drop in pressure during testing period.
11. If air pressure drops more than 1.0 psi during testing period, piping has failed.
12. If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.
13. If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

E. Joint Testing of Pipes Larger than 27" in Diameter
1. For pipes large enough to enter (27" in diameter or larger), individual joints may be pressure tested with a portable tester to 5 psi maximum, with air or water in lieu of low pressure air testing.
2. Joint Testing shall be performed in accordance with ASTM C1103.

F. Exfiltration Testing of Water Retaining Structures:

1. Perform exfiltration testing not exceeding 100 gal. for each inch of pipe diameter for each mile per day for each reach of piping undergoing testing.
2. Perform testing with minimum positive head of 2 feet.

G. Infiltration Testing:
1. All lines below the water table shall be checked for infiltration
2. If at any time prior to expiration of the correction period stipulated in the General Condition, infiltration exists, that is any inflow, and the pipe fails.

3. The Contractor shall locate the leaks and make repairs as necessary to remove the infiltration.

H. Testing of Pressure Piping:

1. PE and HDPE pipe will be tested in accordance with ASTM F2164.

2. Test all other pipe material systems according to AWWA C600 and following:

   a. Hydrostatically test each portion of pressure piping, including valved sections, at 1.5 times working pressure of piping, based on elevation of lowest point in piping corrected to elevation of test gage.
   b. Conduct hydrostatic testing for at least two hours.
   c. Slowly fill with water portion of piping to be tested, expelling air from piping at high points.
   d. Install corporation cocks at high points.
   e. Close air vents and corporation cocks after air is expelled.
   f. Raise pressure to specified test pressure.
   g. Observe joints, fittings, and valves undergoing testing.
   h. Remove and replace cracked pipes, joints, fittings, and valves that show visible leakage.
   i. Retest.
   j. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
   k. Maintain pressure within plus or minus 5.0 psi of test pressure.
   l. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of testing.
   m. Compute maximum allowable leakage using following formula:

      1) L = [**SD x sqrt(P)**]/C.
      2) L = testing allowance, gph.
      3) S = length of pipe tested, feet.
      4) D = nominal diameter of pipe, inches.
      5) P = average test pressure during hydrostatic testing, psig.
      6) C = 148,000.
      7) If pipe undergoing testing contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each pipe size.

3. If testing of piping indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits.
4. Correct visible leaks regardless of quantity of leakage.

I. Manhole Testing:

1. Perform vacuum testing of all manholes. If air testing, test whenever possible prior to backfilling in order to more easily locate leaks.
2. Test manholes with manhole frame set in place.
3. Vacuum Testing:

   a. Comply with ASTM C1244.
   b. Plug pipe openings; securely brace plugs and pipe.

c. Inflate compression band to create seal between vacuum base and structure.
d. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10 in. Hg.
e. Close valve.
f. Manhole Test Duration in Seconds shall be a minimum of 60 or according to ASTM C1244 Table 1a, whichever is longer.
g. Record vacuum drop during test period.
h. If vacuum drop is greater than 1 in. Hg during testing period, repair and retest manhole.
i. If vacuum drop of 1 in. Hg does not occur during test period, manhole is acceptable; discontinue testing.
j. Elapsed time for a pressure change/drop of 1 inch of Hg for a 4ft. diameter manhole shall be: 60 seconds for 10ft. or less in height, 75 seconds for greater than 10ft. but less than 15ft., and 90 seconds for greater than 15ft. but less than 25ft.
k. If vacuum test fails to meet 1 in. Hg drop in specified time after repair, repair and retest manhole at no additional cost to the Owner.
    1) Repair both outside and inside of joint to ensure permanent seal.

J. Water Retaining Structure Testing

1. Exfiltration Testing:

    a. Exfiltration testing shall be performed prior to any specified backfill placement at the footing or wall.
    b. Plug pipes in manhole or structure excluding overflow.
    c. Remove water from manhole or structure.
    d. Observe plugs over period of not less than two hours to ensure that there is no leakage into manhole or structure.
    e. Fill manhole or structure with water within 4 inches of top of cover frame or overflow.
    f. Prior to testing, allow manhole to soak from minimum of four hours for manholes and 24 hours for other structures to maximum of 72 hours.
    g. Inspect the exterior of the wall and footing for damp spots. Damp spots shall be defined as spots where moisture can be picked up on a dry hand, the source of which is from inside the manhole or structure.
    h. After soak period, adjust water level inside the structure to within 4 inches of top of cover frame or overflow.
    i. Measure water level from top of manhole frame or access point.
    j. At end of the 24 hour testing period, again measure water level from the same point; compute drop in water level during testing period.
    k. The exfiltration test is considered satisfactory when drop in water level is less than 0.00947 gallons per foot diameter per foot of depth.

2. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.
3. Repair visible leaks regardless of quantity of leakage.

END OF SECTION 33 01 30.13

SECTION 33 01 30.51 – PUMPING AND BYPASSING

PART 1 - GENERAL

1.1 SUMMARY

A. Under this item, the Contractor is required to furnish all materials, labor, equipment, power, maintenance, fuel, etc. to implement a temporary pumping system for the purpose of diverting flow around the work area throughout the required duration.

B. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

C. Schedule and perform work in manner that does not cause or contribute to incidence of overflows, releases or spills of sewage from sanitary sewer system or bypass operation.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. 33 01 30.13 – Sewer and Manhole Testing

C. 33 05 13 – Manholes and Structures

D. 33 31 00 – Sanitary Utility Sewerage Piping

1.3 QUALITY ASSURANCE

A. Follow national standards and as specified herein.

B. Perform leakage and pressure tests on discharge piping using clean water, before operation.

C. Keep and maintain spare parts for piping on site, as required.

D. Maintain adequate hoisting equipment and accessories for the pump on-site.

1.4 SUBMITTALS

A. The Contractor shall submit to the Engineer a detailed plan and description outlining all provisions and precautions to be taken by the Contractor regarding the handling of existing wastewater flows in all locations requiring bypass pumping. This 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.

B. The plan shall include but not be limited to details of the following:

1. Staging areas for pumps;
2. Sewer plugging method and types of plugs;
3. Number, size, material, location and method of installation of suction piping;
4. Number, size, material, location and method of installation of discharge piping;
5. Bypass pump sizes, capacity, number of each size to be on site and power requirements;
6. Calculations of static lift, friction losses, flow velocity (pump curves showing pump operating range shall be submitted), and bypass pump pipe size;
7. Downstream discharge plan;
8. Thrust and restraint block sizes and locations;
9. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill;
10. Method of noise control for each pump and/or generator;
11. Any temporary pipe supports and anchoring required;
12. Design plans and computation for access to bypass pumping locations indicated on the drawings;
13. Schedule for installation of and maintenance of bypass pumping lines; and
14. Plan indicating selection location of bypass pumping line locations.

1.5 DELIVERY, STORAGE AND HANDLING

A. Transport, deliver, handle, and store pipe, fittings, pumps, ancillary equipment and materials to prevent damage and following manufacturer’s recommendations.

1. Inspect all material and equipment for proper operation before initiating work.

B. Material found to be defective or damaged due to manufacturer or shipment shall be repair as recommended by the manufacturer.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Bypass Pumping System

1. The Contractor shall provide all pipeline plugs and temporary discharge piping to ensure that the total flow of the main can be safely diverted around the section to be repaired.
2. The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One standby pump for each size pump utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.

3. Bypass pumping system shall be capable of bypassing the flow around the work area and of releasing any amount of flow up to full available flow into the work area as necessary for satisfactory performances of work.
4. The Contractor shall make all arrangements for bypass pumping during the time when the main is shut down for any reason. System must overcome any existing force main pressure on discharge.
5. Provide pipeline plugs of adequate size to handle peak flow/head.

B. Performance Requirements

1. It is essential to the operation of the existing sewerage system that there be no interruption in the flow of sewage 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 (back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the sewage flow before it reaches the point where it would interfere with his work, carry it past his work and return it to the existing sewer downstream of his work.
2. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.
3. The Contractor shall provide all necessary means to safely convey the sewage past the work area. The Contractor will not be permitted to stop or impede the main flows under any circumstances.
4. The Contractor shall maintain sewer flow around the work area in a manner that will not cause surcharging of sewers, damage to sewers and that will protect public and private property from damage and flooding.
5. The Contractor shall protect water resources, wetlands and other natural resources.
6. Pumps shall be capable of meeting noise requirements imposed by Owner or governing agency.

2.2 MATERIALS

A. Discharge and Suction Pipes

1. To prevent the accidental spillage of flows, all suction/discharge systems shall be temporarily constructed of rigid 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.

B. Polyethylene Plastic Pipe

1. High density solid wall and following ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-DR) based on Outside Diameter, ASTM D1248 and ASTM D3550.
2. Homogenous throughout, free of visible crack, discoloration, pitting, varying wall thickness, holes, foreign materials, blisters, or other deleterious faults.

C. High-Density Polyethylene (HDPE)

1. Homogenous throughout, free of visible crack, discoloration, pitting, varying wall thickness, holes, foreign materials, blisters, or other deleterious faults.
2. Assembled and joined at site using couplings, flanges or butt-fusion method to provide leak proof joint. Following manufacturer's instructions and ASTM D 2657.

    a. Threaded or solvent joints and connections are not permitted.

3. Fusing shall be conducted by personnel certified as fusion technicians by manufacturer of HDPE pipe and/or fusing equipment.
4. Butt-fused joint shall be truly aligned and contain uniform roll-back beads resulting from use of proper temperature and pressure.

    a. Allow adequate cooling before removal of pressure.
    b. Watertight and have tensile strength equal to that of pipe.

D. Flexible Hoses and Associated Couplings and Connectors

1. Abrasion resistant.
2. Suitable for intended service.
3. Rated for external and internal loads anticipated, including test pressure.

    a. External loading shall incorporate anticipated traffic loadings.

4. When subjected to traffic loading, compose system, such as traffic ramps or covers.

    a. Install system and maintain H-20 loading requirements while in use.

E. Valves and Fittings

1. Determined according to flow calculations, pump sizes previously determined, and system operating pressures.

F. Plugs

1. Plugs shall be selected and installed according to size of line to be plugged, pipe, and manhole configurations, and based on specific site.

2.3 EQUIPMENT

A. Pumps

1. All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps may be electric or diesel powered. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows.

B. Controls

1. The Contractor shall provide the necessary stop/start controls for each pump.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass 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.

B. During all bypass pumping operation, the Contractor shall protect the main and all local sewer lines from damage inflicted by any equipment. The Contractor shall be responsible for all physical damage to the Pumping Station and main and all local sewer lines caused by human or mechanical failure.

3.2 INSTALLATION AND REMOVAL

A. The Contractor shall remove manhole sections or make connections to the existing sewer and construct temporary bypass pumping structures only at the access location indicated on the Drawings and as may be required to provide adequate suction conduit.

B. Plugging or blocking of sewage flows shall incorporate a primary and secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance of work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

C. When working inside manhole or force main, the Contractor shall exercise caution and comply with OSHA requirements when working in the presence of sewer gases, combustible or oxygen-deficient atmospheres, and confined spaces.

D. The installation of the bypass pipelines is prohibited in all saltmarsh/wetland areas. The pipeline must be located off streets and sidewalks and on shoulders of the roads. When the bypass pipeline crosses local streets and private driveways, the contractor must place the bypass pipelines in trenches and cover with temporary pavement. Upon completion of the bypass pumping operations, and after the receipt of written permission from the Engineer, the Contractor shall remove all the piping, restore all property to preconstruction condition and restore all pavement. The Contractor is responsible for obtaining any approvals for placement of the temporary pipeline within public ways from the County.

END OF SECTION 33 01 30.51

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 01 30.61 - SEWER AND PIPE JOINT SEALING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe cleaning and flushing.
2. Plugging.
3. Bypassing sewage.
4. Joint testing.
5. Joint sealing.

B. Related Requirements:

1. Division 5 – Concrete
2. Division 33 – Utilities

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C150 - Standard Specification for Portland Cement.

1.3 SCHEDULING

A. Furnish Work schedule seven (7) days in advance of when sewer piping section is out of service for joint sealing.

1.4 SEQUENCING

A. Sequence for cleaning of sanitary sewer lines shall be as specified on the plans or as directed by Owner/Engineer prior to televising sanitary sewer lines.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit sealant and root growth inhibitor data.

C. Reports:

1. Submit weekly report with daily entries showing:

    a. Location of joints sealed and successfully tested.
    b. Results of air or liquid joint tests before and after sealing joints.
    c. Volume of joint sealant or joint sealant/root treatment additive pumped.
    d. Pounds of acrylamide and N,N'-methylenebisacrylamide mixture used.
    e. Poundsof ammonium persulfate used.
    f. Gallons of root treatment additive material used each day, including gallons of triethanolamine.
    g. Elevation of ground water.
    h. Location of pipe fractures and misalignment.
    i. Location of leaking joints, including non-leaking joints failing air test.
    j. Location of connections discharging continuous flow or incorrectly connected to sewer main.

2. Submit weekly reports on form approved by Architect/Engineer prior to start of testing and sealing.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Prior to starting Work, submit certifications attesting to:

1. Composition and manufacturer of joint sealing material and root treatment additive.
2. Chemical compatibility of sealant material and root treatment additive material.
3. Calibration of meters used to measure joint sealant and root treatment additive and pressure gages are accurate to within 10 gpm and 5 psi respectively.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.
3. Submit qualifications for Contractor

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of repaired joints.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years' documented experience.

B. Applicator: Company specializing in performing Work of this Section with minimum 5 years' documented experience and approved by manufacturer.

C. Contractor: Shall have a minimum 3 year's continuous experience in performing the work described in these specifications.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Protect materials from damage by storing in secure location.

PART 2 - PRODUCTS

2.1 GROUT SEALANT

A. Chemical Grout:

1. Mixture of dry acrylamide and dry N,N'-methylenebisacrylamide in proportions capable of diluting aqueous solutions and, when properly catalyzed, forming stiff gels.
2. Chemical grout capable of tolerating ground water dilution and reacting in moving water.
3. Viscosity of less than 0.0000418 lbf-s/sq. ft., remaining constant until gelation concurs.
4. Reaction time controllable from 10 seconds to 1 hour.

B. Catalyst:

1. Ammonium persulfate.
2. Use in combination with activator.
3. Use of catalyst containing (dimethylamino)propionitrile is prohibited.

C. Activator: Triethanolamine or other compounds of equivalent properties.

D. Inhibitor: Potassium ferricyanide.

E. Root Growth Inhibitor:

1. Dichlorobenzonitrile meeting recommendations of grout manufacturer.
2. Root treatment additive capable of remaining active for minimum of two years.
3. Active ingredient for destroying root intrusions: Sodium methyldithiocarbamate.
4. Root Cell Inhibiting Agent:

a. 2,6-dichlorobenzonitrile (dichlobenil).

b. For each application, disperse root control agent into clear, cool water free of acid, alkali, oxidizing agents, or large amounts of oil or other organic compounds or materials.
c. Use tanks for transportation or storage of makeup water free of material listed above.
d. The Contractor at no additional cost to the Owner shall replace any damaged vegetation so designated by the Engineer. All safety precautions as recommended by the manufacturer shall be strictly adhered to concerning handling and application of the herbicide.

F. Portland Cement: ASTM C150, Type II.

G. Fine Aggregate: ASTM C33 gradation.

H. Packer for Joint Sealing:

1. Bladder:

a. Provide air-impervious, pneumatically inflatable bladder on each end of mounting cylinder.
b. Seal ends of each bladder to cylinder by broad, confining bands.

2. Connect at each end by winch-powered cables.
3. Form positive seal between inflated bladders and interior periphery of sewer pipe and form annular void between inflated end bladders.
4. Design to allow restricted quantity of sewage flow through packer at designated times.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Verify which sewer pipes require joint sealing.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.

B. Pipe Cleaning and Flushing:

1. Perform cleaning of pipe interior to extent necessary to pass equipment and materials required for joint sealing. The Contractor shall clean all sewer segments designated for inspection and/or rehabilitation prior to performing any work. The Contractor shall be solely responsible for his means and methods of sewer cleaning. Cleaning of the sewers shall consist of the dewatering, by-pass pumping, removal of all grease, sand, silt, solids,

tuberculation, rags, roots, cut protruding laterals and other debris from each sewer segment, including sags within any sewer segment and including manholes. Selection of cleaning equipment and the method for cleaning shall be based on the condition and/or pipe material of the sewer segment at the time work commences, and shall comply with this specification.

2. The Contractor shall be solely responsible for safety during the performance of all work. The Contractor shall take satisfactory precautions to protect the sewer segments and appurtenances from damage that might be inflicted upon them by the use of cleaning equipment. Any damage inflicted upon a sewer segment or other public or private property as a result of the Contractor's cleaning operations, regardless of the cleaning method used and regardless of any other circumstance which may contribute to the damage, shall be repaired by Contractor at his sole expense.
3. The Contractor shall not enter into any sewer segment where hazardous conditions may exist until such time as the source of those conditions is identified and eliminated by Contractor and/or Owner. The Contractor shall perform all work in accordance with the latest OSHA confined space entry regulations. The Contractor shall coordinate his work with local fire, police and emergency rescue units.
4. Dumping of raw sewage on private property, in city streets, or into surface or groundwater is not permitted.
5. Passing material from sewer segment to sewer segment shall not be permitted. In the event that sludge, dirt, sand, rocks, grease, roots and other solid or semisolid material or debris resulting from the cleaning operations are observed and/or detected by the Owner/Engineer as passing to downstream sewer segment(s), The Contractor shall be responsible for cleaning such downstream sewer segment(s) at no additional cost to the Owner.
6. The Contractor shall be responsible for the handling, hauling and disposal of all debris, silt, and accumulated solids removed from the sewer. All debris, silt and solids removed by the Contractor shall be disposed of at a facility licensed for the handling and disposal of such materials in accordance with all appropriate codes, rules and regulations for the handling and disposal of such materials. Under no circumstances shall the removed sewage or solids be dumped onto streets or into ditches, catch basins, storm drains, sanitary or combined sewer manholes, or otherwise improperly disposed. If sewage is unintentionally spilled, discharged, leaked or otherwise deposited in the open environment, The Contractor shall be responsible for any clean-up and disinfection of the affected area(s). The Contractor shall comply with all Local, State and Federal regulatory requirements regarding spills. Improper disposal of sewage or solids removed from the sewers may subject the Contractor to fines imposed by the OWNER or other regulatory entities. In addition, the Contractor may be subject to civil and/or criminal penalties for improper disposal of removed materials under the law.
7. If the cleaning of an entire sewer pipe section cannot be successfully performed from one manhole, the equipment shall be re-setup on the other manhole and cleaning again attempted. If successful cleaning still cannot be performed or the equipment fails to traverse the entire manhole section, the cleaning effort will be abandoned at the Owner's and/or Engineer's approval. Sewer line repairs shall then be made at the discretion of the Engineer.

C. Plugging:

1. Conditions Requiring Plugging of Pipes:

a. Depth of flow within sewer pipe is greater than 20 % of inside diameter of sewer pipe.
b. Exposing complete inside periphery of sewer pipe is required to conduct inspection, sealing, or testing.

2. Repair damage resulting from plugging sewer piping.

D. Bypassing Sewage:

1. Bypass sewage when plugging cannot control flows.
2. Install and operate pump to manage bypassing of peak sewage flow rate.
3. Provide standby pump of equal or greater capacity at bypass location.
4. Provide safety precautions including barricades, lights, and flaggers as specified in Section 01 50 00 - Temporary Facilities and Controls.

3.3 APPLICATION

A. Root Control:

1. Roots shall be removed in the sections where root intrusion is a problem. Special precautions should be exercised during the cleaning operation to assure complete removal of visible roots from the joint area. All roots shall be removed.
2. Apply chemical root control agent by foaming or soaking according to conditions in piping under treatment.
3. Foam Application:

a. Agent: Solution containing not less than 24 % by weight of anhydrous vapam (sodium methyldithiocarbamate) and not less than 1.7 % by weight of dichlobenil (2,6-dichlorobenzonitrile); containing surfactant capable of producing foam able to transmit pressure of 30 psig and yielding 20 gal. of foam for each gallon of solution.
b. Foam Concentration: Deliver foam to pipe to yield approximately 20 gal. of foam for each gallon of 5 % solution.

4. Soaking Application:

a. Agent: Aqueous solution containing 28 % by weight or more of anhydrous vapam (sodium methyldithiocarbamate) and 1 % by weight or more of dichlobenil (2,6-dicholorobenzonitrile) active layer of foam on contacted surfaces.
b. Application:

1) Fill entire pipe with freshly prepared and well-mixed solution containing not less than 1 percent by volume of chemical agent specified above.
2) Fully charge for soaking period of 1 hour or not less than 30 minutes and replenish solution to maintain its level above upper end of section under treatment and concentration at 1 % by volume of root control agent.
3) Following specified soaking period, pass solution downstream to treat additional segments of piping, add additional root control agent to maintain

concentration of solution at 1 %, and charge each segment for designated soaking period by addition of solution.

B. Joint Sealing:

1. Seal joints that fail pre-sealing test.
2. Monitor and record actual maintenance pressures when grouting and testing joints.
3. Pass sealing materials from dual independent pumping system through instantaneously controlled system and read flow meter to annular void in packer through dual hose systems.
4. When sealant material injected into joint exceeds 15 gal. in 8 inch pipe, stop injection. Do not resume sealing of joint until other joints in manhole run are sealed.
5. Reclean and repeat sealing process until positive seal is achieved.
6. Clean joint after sealant material has set.
7. Examine joint repair for visible defects using TV camera and fix defects prior to testing of post-joint seal.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Pre-Sealing Joint Test: Air test each joint between manholes as follows:

1. Conduct pre-sealing test as specified for post-sealing test.
2. Record failure of pre-sealing test in weekly report.
3. Notify Architect/Engineer when pre-sealing test passes. Record passing tests in weekly report and discontinue joint sealing and post-sealing test sequence for passed joint.
4. Use pressure meters accurate to within 5 psi.
5. Use flow meters accurate to within 10 gpm.

D. Post-Sealing Joint Test:

1. Perform visual inspection of joint.
2. Apply positive air pressure in void area to raise void pressure 150% psig above maximum ground water pressure and allow to stabilize due to temperature effect.
3. Complete air pressure stabilization.

    a. Test Pressure: Not less than maximum ground water pressure nor more than 7.5 psig above maximum ground water pressure at initiation of test procedure.

4. Record initial test pressure, stabilized test pressure, and period of time required to have 1.0 psig pressure drop from stabilized test pressure.
5. Minimum Test Duration:

    a. Pipe Diameter 8 inches: Zero minutes, 18 seconds.
    b. Pipe Diameter 10 inches: Zero minutes, 28 seconds.

c. Pipe Diameter 12 inches: Zero minutes, 40 seconds.
d. Pipe Diameter 15 inches:1 minute, 3 seconds.
e. Pipe Diameter 18 inches:1 minute, 31 seconds.
f. Pipe Diameter 21 inches:2 minutes, 4 seconds.
g. Pipe Diameter 24 inches:2 minutes, 16 seconds.
h. Pipe Diameter 27 inches:2 minutes, 42 seconds.

6. When pressure drop exceeds 1.0 psi from stabilized test pressure during minimum time specified above, joint has failed.
7. Discontinue test when minimum time has been completed and 1.0 psi pressure drop has not occurred from stabilized test pressure; in this circumstance, joint has satisfactorily passed test.
8. Use the following procedure for sealed joint failing air test:

a. Visually inspect.
b. Reseal.
c. Visually inspect.
d. Retest until successful test is obtained or sealant limit is attained.

E. Final Acceptance:

1. Acceptance of this portion of the work shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the Engineer's representative.
2. If cleaning is deemed unsatisfactory, the Contractor shall re-clean and re-inspect the sewer line until cleaning is shown to be satisfactory.

END OF SECTION 33 01 30.61

SECTION 33 01 30.62 - MANHOLE GROUT SEALING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manhole interior cleaning.
2. Manhole sealing.

B. Related Requirements:

1. Section 33 01 30.61 - Sewer and Pipe Joint Sealing: Testing and sealing of sewer pipe joints.

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C150 - Standard Specification for Portland Cement.

1.3 SCHEDULING

A. Schedule Work of this Section to coincide with joint sealing.

B. Furnish Work schedule when sewer piping section is out of service for joint sealing.

1.4 SEQUENCING

A. Section 01 10 00 - Summary: Requirements for sequencing.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit product data on grout or sealant.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements

D. Test and Evaluation Reports: Indicate vacuum and exfiltration testing results.

E. Manufacturer Instructions: Submit detailed instructions on application requirements, including storage and handling procedures.

F. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of sealed manholes.

1.7 QUALITY ASSURANCE

A. Perform Work according to this specification and those referenced herein and/or federal, state, local, or other controlling regulations.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

B. Contractor: Company specializing in performing Work of this Section with minimum three (3) years documented experience and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products per manufacturer.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Protect materials from damage by storing in secure location.

PART 2 - PRODUCTS

2.1 GROUT SEALANT

A. Chemical Grout:

1. Mixture of dry acrylamide and dry N, N-methylenebisacrylamide in proportions capable of diluting aqueous solutions and, when properly catalyzed, forming stiff gels.
2. Make solution at concentrations as recommended by manufacturer.
3. Able to tolerate ground water dilution and react in moving water.
4. Viscosity of less than 0.000041771 lbf-s/sq. ft., remaining constant until gelation concurs.

5. Reaction time controllable from 10 seconds to 1 hour.

B. Catalyst: Use ammonium persulfate in combination with activator; use of catalyst containing (dimethylamino) propionitrile is prohibited.

C. Activator: Triethanolamine or other compounds of equivalent properties.

D. Inhibitor: Potassium ferricyanide.

E. Root Growth Inhibitor:

1. Dichlorobenzonitrile meeting recommendations of grout manufacturer.
2. Root treatment additive capable of remaining active for minimum of two years.
3. Active ingredient for destroying root intrusions: Sodium methyldithiocarbamate.
4. Root Cell Inhibiting Agent:

a. 2,6-dichlorobenzonitrile.
b. For each application, disperse root control agent into clean, cool water free of acid, alkali, oxidizing agents, or large amounts of oil or other organic compounds or materials.
c. Use tanks for transportation or storage of makeup water free of material listed above.

F. Portland Cement: ASTM C150, Type II.

G. Fine Aggregate: ASTM C33 gradation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Verify which manholes require grouting.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Manhole Interior Cleaning:

1. Clean each defective or fouled manhole interior with high-velocity water jet to remove grease, dirt, sludge, and roots.
2. Cut remaining roots flush with manhole interior.
3. Flush foreign material cleaned from interior of manhole; remove and properly dispose of material off Site.

4. If leaks are not readily identifiable upon completion of cleaning operation, use blower to dry manhole interior for positive identification of leaks and sweep areas.

3.3 APPLICATION

A. Grout Sealing:

1. Drill hole at each identifiable leakage point from inside manhole extending through sidewall of manhole.
2. Insert metal rod through hole to determine if exterior void space exists.
3. Fill exterior void spaces with chemical grout mix, pumping into void space until refusal is recorded by rise in pressure on pump pressure gauge.
4. Ensure that hole through manhole wall is kept open and free of chemical grout; plug hole and allow one hour for chemical grout to set.
5. Upon completion of grouting, pump manhole sealant until refusal at minimum pressure of 3.0 psig through probe-type injection equipment.
6. Deposit sealant from interior surface of set chemical grout through drilled hole to inside surface of manhole.
7. Upon setting of manhole sealant, remove excess material protruding into interior of manhole.

B. Testing:

1. Perform manhole testing per Section 33 01 30.13 - Sewer and Manhole Testing.

END OF SECTION 33 01 30.62

SECTION 33 05 05.31 - HYDROSTATIC TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Hydrostatic testing of pressure piping.

B. Related Requirements:

1. Section 33 31 23 - Sanitary Sewerage Force Main Piping: Pipe materials and accessories normally encountered with municipal sanitary sewage force mains.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gage calibration.

C. Test and Evaluation Reports: Indicate results of piping tests.

D. Qualifications Statement:

1. Submit qualifications for applicator.

1.4 QUALITY ASSURANCE

A. Perform Work according to applicable standards.

1.5 QUALIFICATIONS

A. Applicator: Company specializing in performing Work of this Section with minimum three years' experience.

PART 2 - PRODUCTS

2.1 HYDROSTATIC TESTING

A. Equipment:

1. Pressure pump.
2. Pressure hose.
3. Water meter.
4. Test connections.
5. Pressure relief valve.
6. Pressure Gage: Calibrated to 0.1 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that piping is ready for testing.

C. Verify that trenches are backfilled.

D. Verify that pressure piping thrust restraints have been installed.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Testing of Pressure Piping:

1. Test system according to AWWA C600 and following:

a. Hydrostatically test each portion of pressure piping, including valved section, at 1.5 times working pressure of piping, based on elevation of lowest point in piping corrected to elevation of test gage.
b. Conduct hydrostatic testing for at least two hours.
c. Slowly fill with water portion of piping to be tested, expelling air from piping at high points.
d. Install corporation cocks at high points.
e. Close air vents and corporation cocks after air is expelled.
f. Raise pressure to specified test pressure.
g. Observe joints, fittings, and valves undergoing testing.
h. Remove and renew cracked pipes, joints, fittings, and valves that show visible leakage.

i. Retest.
j. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
k. Maintain pressure within plus or minus 5.0 psi of test pressure.
l. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of testing.
m. Compute maximum allowable leakage using following formula:

1) L = [**SD x sqrt(P)**]/C.
2) L = testing allowance, gph.
3) S = length of pipe tested, feet.
4) D = nominal diameter of pipe, inches.
5) P = average test pressure during hydrostatic testing, psig.
6) C = 148,000.
7) If pipe undergoing testing contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each pipe size.

2. If testing of piping indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits.
3. Correct visible leaks regardless of quantity of leakage.

END OF SECTION 33 05 05.31

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 05 13 - MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete and modular precast concrete for manholes and structures, cover rings or frames, covers, anchorage, and accessories for sanitary sewer or storm sewer.
2. Masonry work as required for installation of manhole cover rings and inverts.
3. Doghouse manhole connections to existing sanitary sewer or storm sewer lines.
4. Bedding and cover materials.

B. Related Specification Sections:

1. Section 03 30 00 - Cast-in-Place Concrete
2. Section 31 05 16 - Aggregates for Earthwork
3. Section 31 20 00 – Earth Moving
4. Section 33 01 30.62 - Manhole Grout Sealing
5. Section 33 05 16.13 - Precast Concrete Utility Structures
6. Section 33 41 13 - Public Storm Utility Drainage Piping

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale).
4. ASTM C55 - Standard Specification for Concrete Building Brick.
5. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
6. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
7. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
8. ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for manhole covers, component construction, features, configuration, and dimensions.

C. Shop Drawings:

1. Indicate manhole or structure locations and elevations.
2. Indicate sizes, penetrations, and elevations of piping.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Design Data: Submit load calculations for buoyancy forces as required for Restrained Precast Manholes, data shall include the footing for restrained manholes.

1.4 QUALITY ASSURANCE

A. Perform Work according to NPCA (National Precast Concrete Association) standards or NRMCA standards for cast in place concrete.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

D. Storage:

1. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
2. Repair property damaged from materials storage.

1.7 AMBIENT CONDITIONS

A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry Work.

B. Cold Weather Requirements: Comply with ACI 530/530.1 when grouting or pouring concrete.

PART 2 - PRODUCTS

2.1 MANHOLES AND STRUCTURES

A. Manufacturers:

1. Armorcast Products Company
2. Hanson Pipe & Precast
3. Monarch Products, Inc.
4. Oldcastle Precast, Inc.
5. Or approved equal.

B. Manhole and Structure Sections:

1. Description: Reinforced precast concrete conforming to ASTM C478 with gaskets conforming to ASTM C923.

2. Manhole bottom sections shall be precast by the manufacturer and shall be supplied with a rubber gasket joint by which the base section is connected to the slab or the manhole bottom may be cast monolithically with the base section.
3. Joints for Precast Manholes and Structures:

   a. Joints between manhole sections shall be provided with a double joint sealant. An O ring rubber gasket meeting all requirements of ASTM C443. A flexible plastic butyl sealant in rope form, Sherman M-30 Flex Tyte, shall also be installed as recommended by the manufacturer Joints shall be water tight.
   b. Leakage Testing: Shall be conducted for each precast structure or manhole in accordance with ASTM C1244 – Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test prior to backfill.

C. Cast-in-Place Manhole and Structure Sections: Provide concrete and reinforcing steel as specified in Section 03 30 00 - Cast-in-Place Concrete

D. Clay Brick Units:

1. ASTM C32, Grade SS or SM solid units for use in building inverts and adjusting manhole top ring and cover.

E. Mortar and Grout:

1. Shall be a 3:1 sand-cement (Type S) mix
2. Use non-shrink grout for grouting ends of pipe into and out of the manhole

F. Reinforcement:

1. As specified by ASTM C478 for precast manholes and structures.
2. As specified in Specification Section 03 30 00 for cast-in-place manholes and structures.

G. Construction:

1. The base and vertical sections shall be cylindrical with tongue and groove joints.
2. Top cone sections shall be concentric or eccentric with tongue and groove joints.

H. Clear Inside Dimensions:

1. Diameter: 48 inches or as indicated on the plan drawings

I. Design Depth:

1. As specified or shown on the plan drawings

J. Clear Cover Opening Top of Cone Section:

1. Diameter: 24 inches or as indicated on the drawings

K. Invert: Each precast concrete manhole shall have the invert monolithically with the base section unless shown or called for otherwise. The invert channel and benches shall be formed with smooth surfaces and have a pocket at each end of the invert for the pipe to enter the manhole and butt up against the flow channel of the invert. The invert slope through the manhole shall be a minimum 1.2 inch drop across the manhole unless shown or called out otherwise on the plan drawings.

L. Pipe Entry: Furnish openings as shown on the drawings.

1. Manufacturers:
   a. Fernco
   b. Or Approved Equal
2. All manholes shall be provided with a flexible sleeve through which all pipe connections are made into the manhole. Each flexible sleeve shall consist of a high quality synthetic rubber terminating in a flange cast into the manhole walls or by a compression joint made in the manhole wall. The flexible sleeves shall protrude out from the manhole and shall be of adequate size to accommodate the sewer pipe. After installation of the pipe within the sleeve, a watertight joint shall be made by securing the sleeve over the pipe with a stainless steel strap, clamp, draw bolt and nuts. The banded boot connections shall be installed to provide compliance with ASTM C923. The couplings shall be tightened by use of a 60 in/lb. torque wrench.

M. Steps:

1. Manufacturers:
   a. M. A. Industries
   b. Or Approved Equal
2. Rungs/Safety Steps: Shall be 1/2 inch diameter grade 60 steel rod encased in copolymer polypropylene and withstand a load of 800 lbs and pull-out force of 400 lbs and meet OSHA requirements
3. Formed integral with manhole sections
4. Diameter: 1 inch or approved equal
5. Width: Tread 16 inches and spaced at 15 inches on center vertically, set into manhole or structure

N. Intermediate Platforms: As required by Federal, State, or Local codes or shown on the plan drawings.

1. Construction:

a. Shall consist of a standard precast concrete flat top section with 2' diameter opening that aligns with the lower manhole section steps, platform shall include tongue and grove configuration on both sides to allow for installation of the manhole sections

2.2 RINGS/FRAMES AND COVERS

A. Manufacturers:

1. Neenah Foundry, U.S. Foundry, Castings Inc.
2. McKinley Iron Works, Inc.
3. Or Approved Equal

B. Description:

1. Construction: ASTM A48, Class 30B cast iron.
2. Ring/Frame:

a. Cast iron ring shall be heavy duty having a machined flat bearing surface with integral lip that fits down into the manhole cone section. Ring shall have a minimum of four bolt holes in the base flange for anchoring to the cone section.
b. Ring and cover shall be bolt down type where called for and/or as shown on the plan drawings.
c. Beneath the manhole frame shall be installed a flexible plastic butyl gasket meeting all requirements of AASHO-M198.
d. Ring shall have a minimum clear opening of not less than 22 inches.

3. Cover Design: Cast into the top of the manhole cover shall be the name of the city and state where it is to be installed, the words "SANITARY SEWER", and the year of installation. Details of the casting shall be submitted for approval by the ENGINEER. Cover shall have the same heavy duty rating as the ring/frame.

2.3 RISER RINGS

A. Manufacturers:

1. Parson Environmental Products, Inc.
2. Turner Manhole Risers
3. Or Approved Equal

B. Riser Rings:

1. Thickness: 4 inches to 6 inches

a. Material: Precast concrete.
b. Comply with ASTM C478

2. Thickness: less than 4 inches

a. Material: Cast iron.
b. Comply with AASHTO M306.

3. Rubber Seal Wraps:

a. Wraps and Band Widths: Conform to ASTM C877, Type III.
b. Cone/Riser Ring Joint: Minimum 3 inches overlap.
c. Frame/Riser Ring Joint: 2 inches overlap.
d. Additional Bands: Overlap upper band by 2 inches

C. Accessories:

1. Joint Sealant: Comply with ASTM C990
2. Bolts:

a. Stainless Steel: Comply with ASTM F593.
b. Galvanized: Comply with ASTM F1554.

2.4 MATERIALS

A. Cover and Bedding:

1. Bedding: Fill Type as specified in Section 31 05 16 - Aggregates for Earthwork
2. Cover: Fill Type as specified in Section 31 05 16 - Aggregates for Earthwork

2.5 ACCESSORIES

A. Foundation Slab: For manhole depths greater than 15 feet or as indicated on the plan drawings.

1. Cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete
2. Top Surface: Level or as shown on the plan drawings.

B. Strap Anchors: For manhole inside drop pipe or other purpose as shown or called out for on the plan drawings

1. Shape: Bent stainless steel 304L.
2. Size: As shown or called for on the plan drawings
3. Anchor Bolts: stainless steel 316L, size as shown or called for on the plan drawings.

C. Interior Manhole Coating System

1. Abrasive all sand blast areas to be coated to a minimum CSP5

2. Active leaks to be corrected via injection of resin and coatings manufacturer representative to confirm adequate conditions prior to coating interior.

3. Coatings system to conform to the following schedule:
   a. High Risk Locations-
   - Prime coat-Tnemec Series 218 applied up to ½" OR Series 217 applied ½" to 4"

     1)

D. Bituminous Exterior Manhole Coating:

1. Description: Coating shall be a two-part component, self-priming, chemically cured, coal tar epoxy protective coating. Coating shall from the bottom slab or base section to the surface grade elevation, unless shown otherwise.

E. Geotextile Filter Fabric:

1. AASHTO M288, for subsurface drainage.
2. Fabric:

   a. Class 1 for Non-woven, non-biodegradable.
   b. Class 2 for Woven, non-biodegradable

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are properly sized and located.

B. Verify that built-in items are in proper location and are ready for roughing into Work.

C. Verify correct size of manhole and structure excavation.

3.2 PREPARATION

A. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

B. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

C. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.

D. Inspect precast concrete manholes and structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate for manholes and structures as specified in Section 31 20 00 - Earthmoving
2. Provide clearance around sidewalls of manhole or structure for construction operations
3. If groundwater is encountered, provide dewatering procedures/measures as necessary for installation of manhole or structure in a compacted excavation not holding water. Place geotextile fabric and stone as required.
4. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation, as approved by Engineer.
5. All manholes shall be vacuum tested prior to backfill as required in Part 3 of this section. After a satisfactory vacuum test has been completed, the manhole shall be backfilled. Another visual inspection of the manhole shall then be conducted to verify that no damage occurred during the backfilling.

B. Foundation Slab:

1. Place foundation slab and trowel top surface level.
2. Place manhole sections plumb and level and anchor to foundation slab when shown on the drawings or as required for buoyant force resistance.

C. Install manholes and structures supported at proper grade and alignment on crushed stone bedding (minimum 8 inch thickness) or as indicated on Drawings.

D. Backfill excavations for manholes and structures as specified in Section 31 20 00 - Earthmoving.

E. Form and place manhole or structure plumb and level, to correct dimensions and elevations.

F. Paint exterior with two coats of bituminous interior coating at rate of per coating manufacturer.

G. Set cover frames and covers level to correct elevations without tipping.

H. Precast Concrete Manholes and Structures:

1. Lift precast components at lifting points designated by manufacturer.
2. When lowering manholes or structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
3. Set precast structures, bearing firmly and fully on crushed stone bedding, compacted as specified in Section 310516- Aggregates for Earthwork or on other support system as indicated on the plan drawings.
4. Assembly:

    a. Assemble multi-section manholes and structures by lowering each section into excavation.
    b. Install rubber gasket and butyl sealant rope in the joints between precast sections.
    c. Lower, set level, and firmly position base section before placing additional sections.

5. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.
6. Verify that installed manholes or structures meet required alignment and grade.
7. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with non-shrink grout using hydraulic cement.

I. Cast-in-Place Concrete Manholes and Structures:

1. Prepare crushed stone bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.
2. Place and cure concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.
3. Set frames and covers to correct elevations shown on the plan drawings and properly anchor to manhole or structurer top. Where manholes are constructed in paved areas, the top surface of the frame and cover shall be set such that the top surface of the cover conforms to the exact slope, crown, and grade of the existing or proposed pavement.

J. Doghouse Manholes and Structures:

1. Stake out location and burial depth of existing sewer line in area of proposed manhole or structure.
2. Carefully excavate around existing sewer line to adequate depth for foundation slab installation.
3. Protect existing pipe from damage.
4. Remove unsuitable material as necessary and replace with granular fill compacted to 95 percent maximum density, compaction shall be 100% maximum dry density if manhole is located in a pave roadway.
5. Prepare crushed stone bedding or other support system, as indicated on Drawings, to receive foundation slab as specified for precast manholes and structures.
6. Install doghouse manhole or structure around existing pipe according to applicable Paragraphs in this Section.
7. Grout pipe entrances as specified in this Section.
8. Saw cut top half of pipe flush with interior of manhole or structure.
9. Build invert by grouting base of manhole or structure to achieve a sloped bench to top edge of cut pipe and trowel smooth.

K. Sanitary Manhole Drop Connections:

1. Drop connections shall be constructed as shown on the plans and consist of a "Memphis" tee, or tee with a spigot on the branch, drop pipe extending from the sewer to the invert of the manhole, and an elbow at the base. The drop connection shall be encased in concrete or in a brick box filled with sand.

L. Castings:

1. Set frames using mortar and masonry and/or as indicated on the drawings.
2. Lay concrete brick in full bed of mortar and completely fill joints.
3. If more than one course of concrete brick is required, stagger vertical joints.
4. Set frame and cover to the grade or elevation as shown or called for on the plan drawings.

3.4 FIELD QUALITY CONTROL

A. Test concrete manhole and structure sections as specified in Division 33.

B. Vertical Adjustment of Existing Manholes and Structures:

1. If required, adjust top elevation of existing manholes and structures to finished grades as indicated on Drawings.
2. Frames, Grates, and Covers:

a. Carefully remove frames, grates, and covers cleaned of mortar fragments.
b. Reset to required elevation according to requirements specified for installation of castings.

END OF SECTION 33 05 13

SECTION 33 05 16.13 - PRECAST CONCRETE UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete utility structures.
2. Drainage system catch basins.
3. Drainage system inlets.
4. Pipe Headwalls.
5. Pipe Flare End Section
6. Frames and covers.
7. Access hatches.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete
2. Division 31 – Earthwork
3. Division 33 – Utilities

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO HB-17 - Standard Specifications for Highway Bridges.
2. AASHTO M306 - Standard Specification for Drainage, Sewer, Utility, and Related Castings.

B. American Concrete Institute:

1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
3. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A48 - Standard Specification for Gray Iron Castings.
3. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
4. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

6. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
7. ASTM A497 - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
8. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
9. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
10. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
11. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
12. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
13. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
14. ASTM C33 - Standard Specification for Concrete Aggregates.
15. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
16. ASTM C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
17. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
18. ASTM C150 - Standard Specification for Portland Cement.
19. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
20. ASTM C192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
21. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
23. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
24. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
25. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
26. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
27. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
28. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
29. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
30. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
31. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
32. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
33. ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars.
34. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

35. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
36. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
37. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
38. ASTM C1433 - Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.
39. ASTM C1504 - Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts and Storm Drains.

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.4 - Structural Welding Code - Reinforced Steel.

E. National Precast Concrete Association:

1. NPCA Plant Certification Program.
2. NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit data for frames and covers, steps, component construction, features, configuration, and dimensions.

C. Shop Drawings:

1. Indicate structure locations, elevations, sections, equipment supports, piping, conduit, sizes and elevations of penetrations, and block-outs/knockouts.
2. Indicate design, construction and installation details, typical reinforcement and additional reinforcement at openings.

D. Submit concrete mix design for each different mix.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for custom fabrications.

G. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Qualifications Statements:

1. Submit qualifications for manufacturer.

1.4 QUALITY ASSURANCE

A. Obtain precast concrete utility structures from single source.

B. Perform structural design according to ACI 318.

C. Perform Work according to NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

D. Conform to following material and fabrication requirements:

1. Single Cell Box Culverts: ASTM C1433.
2. Other Structures: ASTM C913.

E. Perform welding according to following:

1. Structural Steel: AWS D1.1.
2. Reinforcing Steel: AWS D1.4

F. Perform Work according to National Precast Concrete Association (NPCA) standards.

G. Design precast concrete members under direct supervision of a Professional Structural Engineer experienced in design of precast concrete. Drawings shall bear the stamp of the P.E.

1.5 QUALIFICATIONS

A. Manufacturer: Certified by NPCA Plant Certification Program prior to and during Work of this Section.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

C. Welders and Welding Procedures: AWS qualified within previous 12 months for employed weld types.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Do not deliver products until concrete has cured **5** days or has attained minimum **75** percent of specified 28-day compressive strength.

C. Inspection: Accept precast structures on Site in manufacturer's original packaging and inspect for damage.

D. Comply with precast concrete manufacturer instructions for unloading, storing, and moving precast structures.

E. Lift structures from designated lifting points.

F. Storage:

1. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
2. Repair property damaged from materials storage.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Design structures for minimum loads conforming to ASTM C857 and ASTM C890.

B. Roof Live Load: Comply with following loading conditions, including impact load:

1. Heavy Traffic:

a. ASTM C857, A-16.
b. Maximum 16,000 lb. each wheel.

2. Medium Traffic:

a. ASTM C857, A-12.
b. Maximum 12,000 lb. each wheel.

3. Light Traffic:

a. ASTM C857, A-8.
b. Maximum 8,000 lb. each wheel.

4. Walkway Traffic:

a. ASTM C857, A-0.3.
b. Maximum 300 psf.

2.2 PRECAST CONCRETE UTILITY STRUCTURES

A. Manufacturers:

1. Armorcast Products Company
2. Hanson Pipe and Precast
3. Manarch Products, Inc.
4. Old Castle Precast, Inc.
5. Or Approved Equal

B. Precast Concrete Utility Structures: Reinforced precast concrete.

1. As shown on the Drawings

2.3 FRAMES AND COVERS

A. Manufacturers:

1. Barry Pattern & Foundry Company
2. EJ Iron Works
3. Neenah Foundry, U.S. Foundry, Castings Inc.
4. McKinley Iron Works, Inc.
5. Or Approved Equal

B. Description:

1. Construction: ASTM A48, Class 30B cast iron or other material as shown on the plan drawings.
2. Frame for cover: Shall be cast in place by the precast concrete manufacture or blocked-out for field installation of frame per dimensions required for the opening.

2.4 ACCESS HATCHES

A. Manufacturers:

1. The Bilco Company.
2. U.S.F. Fabrication.
3. Halliday Products.
4. Or Approved Equal.

B. Access Hatch:

1. All access hatches shall be double or single leaf as shown on the drawings. Automatic doors shall be equipped with a minimum of two stainless steel hinges with stainless steel pins. Each door leaf shall also have spring operators with a positive hold open arm that engages automatically in full open position, and a non-corrosive release handle. Doors shall open with a maximum lift force of 9 lbs. When closed, doors shall not protrude above the operating surface in which they are installed. Include slam lock feature with removable key.
2. When subject to vehicular traffic, cover shall be reinforced to support an AASHTO H-20 wheel load with a maximum deflection of 1/150th of the span.
3. Door leaves shall be 1/4-inch aluminum checkered plate reinforced with structural aluminum channels, capable of withstanding 300 pounds per square foot uniform load with minimal deflection for non-vehicular loading service. When subject to vehicular traffic, cover shall be reinforced to support an AASHTO H-20 wheel load with a maximum deflection of 1/150th of the span.
4. The gutter frame provided shall be of 1/4-inch aluminum with an anchor flange around the perimeter. Frame shall incorporate a 1 ½" threaded drain fitting and neoprene gasket.

5. The drain coupling shall be located in an appropriate corner of each channel frame away from the access steps. Contractor shall attach and route Sch 80 PVC pipe from drain port to daylight away from structure. If daylight is not ready accessible within 10-ft, then contractor shall terminate piping into ½ cubic yard of #57 stone wrapped with filter fabric. Piping shall project through walls with sleeve and Link-Seal in a water-tight (leak-proof) installation.
6. Factory finish shall be mill finish.
7. Hardware shall be stainless steel.
8. Any surface or portion of the frame contacting concrete shall receive a bituminous coating.
9. The door shall open to 90 degrees and lock automatically in that position. A vinyl grip handle shall be provided to release and close the cover with one hand.
10. Doors, which are to receive flooring, shall be smooth plate. Doors which will not receive flooring shall be checkered plate

2.5 MATERIALS

A. Concrete: As specified in Section 03 30 00 – Cast-In-Place Concrete.

B. Admixtures: As specified in Section 03 30 00 – Cast-In-Place Concrete.

C. Concrete Reinforcement: As specified in Section 03 30 00 – Cast-In-Place Concrete.

2.6 FABRICATION

A. Fabricate precast concrete utility structures conforming to ACI 318 and NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

B. Fabricate precast concrete utility structures with knock-out panels, embedded items (frames, etc.), and openings to size and configuration as indicated on Drawings.

C. Construct forms to provide uniform precast concrete units with consistent dimensions.

D. Clean forms after each use.

E. Reinforcing:

1. Install reinforcement by tying or welding to form rigid assemblies.
2. Position reinforcement to maintain minimum ½ inch cover.
3. Secure reinforcement to prevent displacement while placing concrete.

F. Position and secure embedded items to prevent displacement while placing concrete.

G. Deposit concrete in forms and consolidate concrete without segregating aggregate.

H. Provide initial curing by retaining moisture using one of following methods:

1. Cover with polyethylene sheets.
2. Cover with burlap or other absorptive material and keep continually moist.

3. Apply curing compound according to manufacturer instructions.

I. Provide final curing according to manufacturer's standard.

J. Remove forms without damaging concrete.

K. Tension reinforcement tendons as required to achieve design load criteria.

L. Exposed Ends at Stressing Tendons: Fill recess with non-shrink grout, trowel flush.

2.7 MIXES

A. Concrete:

1. Design Mix shall be as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.8 FINISHES

A. Reinforcing Steel, Wire and Wire Fabric, Concrete and Steel shall be as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.9 ACCESSORIES

A. Membrane Curing Compound: ASTM C309, Type 2, Class A.

B. Steps:

1. Formed steel-reinforced polypropylene rungs.
2. Diameter: 3/4 inch.
3. Width: 10 inches, minimum.
4. Spacing: 15 inches o.c. vertically or as indicated on Drawings.

C. Inserted and Embedded Items:

1. Structural Steel Sections:

a. Comply with ASTM A36.
b. Finish: As shown or called for on the plans or in related specification sections

D. Bearing Pads:

1. High density plastic, Vulcanized elastomeric compound molded to size, Neoprene (Chloroprene), or Tetrafluoroethylene (TFE); Shore A Durometer; 1/8 inch (3 mm) thick, smooth both sides.

E. Joint Sealants and Joint Gaskets:

1. Gasket Joints for Circular Concrete Pipe:

a. ASTM C443.
b. Gaskets: Oil-resistant rubber.

2. External Sealing Bands:

a. Comply with ASTM C877.
b. Material: Type I, rubber and mastic.

3. Preformed Joint Sealants for Concrete Pipe and Box Sections: Comply with ASTM C990
4. Elastomeric Joint Sealants:

a. Comply with ASTM C920.
b. Material: Polyurethane.
c. Grade NS, Class 35.

F. Pipe Entry Connectors: Comply with ASTM C923.

G. Grout:

1. Cement Grout: Portland cement, sand, and water mixture with stiff consistency to suit intended purpose.
2. Non-Shrink Grout:

a. Description: Premixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing agents.
b. Conform to ASTM C1107.
c. Minimum Compressive Strength: 2,400 psi in 48 hours, and 7,000 psi in 28 days.

H. Bituminous Coating:

1. Manufacturers:

a. Carboline Company; a subsidiary of RPM International
b. Duron, Inc.
c. Laurence, C.R. Co., Inc.
d. Or Approved Equal

2. Description: Provide damproofing on the exterior side of structures in the field where structure will be below grade. Coating shall be a two-component, self-priming, chemically cured, coal tar epoxy protective coating.

I. Touch-Up Primer for Galvanized Surfaces:
1. As specified in Section 09 96 00 – High-Performance Coatings

2.10 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:

1. Perform following tests for each 100 cu. yd. of concrete placed with minimum one set of tests each week:

    a. Slump: Comply with ASTM C143.
    b. Compressive Strength: ASTM C31 and ASTM C39.
    c. Air Content: Comply with ASTM C231 or ASTM C173.
    d. Unit Weight: Comply with ASTM C138.

2. Make test results available to Engineer/Owner upon request.

C. Inspection:

1. Visually inspect completed precast structures for defects.
2. Repair defects on surfaces exposed to view to achieve uniform appearance.
3. Repair honeycomb by removing loose material and applying grout to produce smooth surface flush with adjacent surface.
4. Repair of major defects not allowed

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are properly sized and located.

C. Verify correct size and elevation of excavation.

D. Verify that subgrade and bedding are properly prepared, compacted, and ready to receive Work of this Section.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Mark each precast structure by indentation or using waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

D. Do not install structures if Site conditions induce loads exceeding weight capacity of structures.

E. Inspect precast concrete structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Install underground precast utility structures according to ASTM C891.

B. Lift precast concrete structures at lifting points designated by manufacturer.

C. When lowering structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.

D. Install precast concrete base to elevation and alignment as indicated on Drawings.

E. Install precast concrete utility structures to elevation and alignment as indicated on Drawings.

F. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members

G. Maintain temporary bracing in place until final support is provided. Protect members from staining

H. Provide temporary lateral support to prevent bowing, twisting, or warping of members

I. Adjust differential camber between precast members to tolerance before final attachment

J. Install bearing pads

K. Level differential elevation of adjoining horizontal members with grout to maximum slope of 1:12

L. Assembly of Multi-section Structures:

1. Lower each section into excavation.
2. Clean joint surfaces.
3. Install watertight joint seals according to manufacturer instructions using gasket joints, external sealing bands, preformed joint sealants, elastomeric joint sealants, grout, as required.

M. Remove knockouts or cut structure to receive piping without creating openings larger than required to fit pipe; fill annular space with grout.

N. Pipe Connections:

1. Connect pipe to structure and seal watertight.
2. Cut pipe flush with interior of structure.

O. Base/Foundation slab:

1. Grout to achieve slope to exit piping.
2. Trowel smooth.
3. Contour to form continuous drainage channel as indicated on Drawings.

P. Paint exterior with two coats of bituminous interior coating at rate of per coating manufacturer for each coat.

Q. Frame and Cover and Access Hatch:

1. Set level, without tipping, to elevations as indicated on Drawings.
2. Set cover and access hatch 3 inches above finished grade for structures located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.
3. Connect drain from access hatch frame to storm drainage system.

R. Touch up damaged galvanized coatings.

S. Backfill excavations for structures as specified in Division 31.

3.4 ERECTION TOLERANCES

A. Erect members level and plumb within allowable tolerances

B. Conform to PCI MNL-116S.

C. Design and erect to the following tolerances:

1. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch/10 feet and 3/8 inch in 100 feet, non-cumulative.
2. Maximum Offset from True Alignment between Members: 1/4 inch.
3. Maximum Variation from Dimensions Indicated on Reviewed Shop Drawings: Plus or minus 1/8 inch.

D. Exposed Joint Dimension: 3/8 inch plus or minus 1/4 inch.

E. When members cannot be adjusted to conform to design or tolerance criteria, cease work and advise. Execute modifications as directed

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Perform vacuum test and exfiltration test as specified in Division 33.

3.6 WATER RETAINING STRUCTURE TESTING

1. Exfiltration Testing:

a. Exfiltration testing shall be performed prior to any specified backfill placement at the footing or wall.
b. Plug pipes in manhole or structure excluding overflow.
c. Remove water from manhole or structure

d. Observe plug over a period of time not less than two (2) hours to ensure there is not leakage into the manhole or structure.
e. Fill manhole or structure with water within 4 inches of top of cover frame of overflow.
f. Prior to testing, allow manhole to soak from a minimum of four hours for manholes and 24 hours for other structures to a maximum of 72 hours.
g. Inspect the exterior of the wall and footing for damp spots. Damp spots shall be defined as spots where moisture can be picked up on a dry hand, the source of which is from inside the manhole or structure.
h. After soak period, adjust water level inside the structure to within 4 inches of top of cover frame or overflow.
i. Measure water level from top of manhole frame of access point.
j. At end of the 24-hour testing period, again measure water level from the same point; compute drop in water level during testing period.
k. The exfiltration test is considered satisfactory when drop in water level is less than 0.00937 gallons per foot diameter per foot depth.

2. If unsatisfactory testing results are achieved, repair manhole or structure and retest until results meet criteria.
3. Repair visible leaks regardless of quantity of leakage.

END OF SECTION 33 05 16.13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 05 26 - UTILITY IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipeline marker posts.
2. Ribbon tape for placement above direct-buried utility.
3. Trace wire for placement above direct-buried utility.

B. Related Requirements:
1. Section 33 31 11 – Public Sanitary Utility Sewerage Gravity Piping
2. Section 33 31 23 - Sanitary Sewerage Force Main Piping

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog information for each product required.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged valves.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

PART 2 - PRODUCTS

2.1 PIPELINE MARKER POSTS

A. Description:

1. Material: High-density polypropylene.
2. Diameter: 3-1/2 inches.
3. Length: 72 inches.
4. Color: White.
5. Embedment: T-anchor.

B. Visibility Enhancer:

1. Material: Polyethylene.
2. Length: 24 inches.
3. Diameter: 3-3/4 inches.
4. Color: As required by utility.
5. Text: As required by utility.

2.2 RIBBON TAPE

A. Description:

1. Reef Industries Terra Tape Standard
2. Material: 100% virgin pigmented polyolefin film, brightly colored, continuously printed.
3. Minimum Size: 6 inches wide by 4 mils thick.
4. Manufactured for direct burial service.
5. Imprint: In large letters with message printed at least every 30 inches; Sanitary Sewer Gravity **"CAUTION SEWER LINE BURIED BELOW"**; Reuse Water Lines **"CAUTION REUSE WATER LINE BURIED BELOW"**; Sewer Force Main Lines **"CAUTION SEWER FORCE MAIN BURIED BELOW"**

2.3 TRACE WIRE

1. Description:

a. Conductor: No.12 AWG HS-CCS high strength copper clad steel tracer wire.
b. Covering: 30 mils of Green HMWPE insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipeline Marker Posts: As recommended by manufacturer.

B. Ribbon Tape:

1. Tape shall be installed a minimum of 24 inches above the top of the pipe for its full length.
2. If multiple pipes occur in common trench, locate ribbon tape above centerline of trench.

C. Trace Wire:

1. Attach locator wire to the top of pipe every 5 feet with duct tape.
2. All wire splices shall be made using copper wire “U” bolt assemblies and then wrapping with electrical tape.

END OF SECTION 33 05 26

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 31 00 - SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC Pipe
2. Ductile Iron Pipe
3. Ductile Iron Fittings
4. Concrete Pipe
5. HDPE Pipe
6. HDPE Fittings
7. Plug Valves
8. Gate Valves
9. Accessories

B. Standards

1. Standards: Supply all products and perform all work in accordance with applicable American Society of Testing and Material (ASTM), American Water Works Associations (AWWA), American National Standards Institute (ANSI), or other recognized standards.
2. Latest revisions of all standards are applicable.

C. Related Sections

1. Division 01 Specifications
2. 31 23 16.13 Excavation & Trenching
3. 33 01 30.13 Sewer and Manhole Testing
4. 33 05 13 Manholes and Structures

1.2 SUBMITTALS

A. Product Data: Manufacturer information indicating pipe material to be used, and pipe accessories.

B. Manufacturer's Certificate: Products meet or exceed specified requirements.

C. Certified mill certificate showing conformance to all requirements specified herein.

D. Manufacturer Instructions: Special procedures required to install specified products.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. General arrangement and dimensional drawings.

G. Laboratory Approval – Ductile Iron Pipe shall be tested by an independent laboratory, approved by the Engineer, in accordance with AWWA C151.

1.3 QUALITY ASSURANCE

A. Perform Work according to applicable GAEPD, OSHA, AWWA, and ASTM standards.

B. All pipes shall be first quality, with smooth interior and exterior surfaces, free from cracks, blisters, "honeycombs," and other imperfections, and true theoretical shapes and forms throughout the full length.

C. All pipes shall be subject to the inspection of the Engineer at the pipe plant, trench, or other points of delivery, for the purpose of culling and rejecting pipe, independent of the laboratory test which does not conform to the requirements of these specifications. Such pipe shall be marked by the Engineer, and the Contractor shall remove it from the project site upon notice of its rejection being received.

PART 2 - PRODUCTS

2.1 PVC PIPE

A. General

1. All PVC pipe and fittings shall be clearly marked as to size, ASTM, Company, SDR or DR, and date of manufacture. No pipe shall be accepted that is more than 120 days old when delivered to the job site.
2. Pipe shall be manufactured of PVC having a cell classification of 12454 or 12364 as defined in ASTM D 1784. Additives and fillers including but not limited to stabilizers, antioxidants, lubricants, colorants, etc. shall not exceed 10 parts by weight per 100 parts of PVC resin in the compound.
3. A certified mill certificate showing conformance to all requirements specified above shall be provided to the Engineer with each shipment of pipe delivered to the job site.
4. All PVC pipe shall be green in color and stenciled "SANITARY SEWER."
5. PVC pipe shall not be used in locations where the pipe has a cover less than four feet, where crossing creek or ravine bottoms where the pipe may be exposed, or where sewers are laid under railroads, powerline easements, or roadway rights of way unless noted in Drawings.

B. PVC Pipe for Gravity Sewers

1. PVC pipe for gravity sewers shall be manufactured in accordance with ASTM D 3034 for 4" through 15" SDR 35 minimum and F679 for 18" through 36" 46PS/115PS sewer pipe as indicated on the drawings.
2. Joints shall be of the rubber gasket slip on type conforming to ASTM D 3212 under both pressure and vacuum. The bell shall be an integral part of the pipe with the same strength. Spigot ends shall be beveled.
3. Elastomeric gaskets shall meet the requirements of ASTM F477. Gaskets shall be locked in, NAPCO, HARCO, or approved equal.

4. PVC pipe material at different depth of burial, as defined from the final ground surface to the bottom of the pipe, shall conform to the following schedule:

    a. 4’ to 15’ SDR 35 with a minimum pipe stiffness of 46 PSI
    b. 15’ to 20’ SDR 26 with a minimum pipe stiffness of 115PSI
    c. > 20’ use Ductile Iron or other alternate material, as directed by the Engineer.

5. Transitions from PVC pipe to Ductile Iron pipe shall be made only at manholes unless noted on Drawings.

C. PVC Pipe for Low Pressure Sewer

1. PVC pipe for force mains shall conform to the requirements of AWWA C900. Pipe shall be green in color and marked with the nominal pipe size, PVC dimension ratio, AWWA pressure class, AWWA designation number (AWWA C900), manufacturer’s name and labeled “Sewer Force Main”.
2. The pressure rating shall be selected based upon the design requirements of the system. The minimum wall thickness shall be DR 18, Class 150.
3. Pipe shall be Type I, Grade I and shall be manufactured from virgin material.
4. All gaskets shall meet ASTM F477 standards.
5. PVC joints shall be restrained where specified on the drawings.

    a. Restrained joints shall be provided by a clamping ring and an additional ring designed to seat on the bell end of the pipe. The rings shall be connected with T-Head bolts or rods.
    b. Restraining devices shall provide full (360°) support around the circumference of the pipe. No point loading shall be permitted. Restraint of mechanical joint fittings shall be provided by a clamping ring installed on the PVC pipe and connected to the mechanical joint fitting with T-Head bolts or rods.
    c. Restraining devices shall be EBAA Series 1600 or approved equal.
    d. For PVC lines smaller than 4 inches, use thrust blocks or additional restraint as shown on Drawings.
    e. The use of solvent weld PVC pipe and fittings in low pressure sewer mains is prohibited.

2.2 DUCTILE-IRON PIPE

A. General

1. Pipe laying lengths shall be provided in 18 or 20 feet nominal lengths with allowable trim pipe lengths in accordance with AWWA C151 and special shorter lengths provided as required by the Drawings.
2. All ductile iron pipes and fittings, installed in a trench conditions shall receive a shop-applied bituminous coating 1-mil thick, minimum in accordance with AWWA C151/ANSI A21.51.
3. All exposed pipe and fittings shall be provided with a shop prime and painted as specified.
4. Where flexible joint iron pipe is called for on the plans, it shall conform to the same specifications as ductile iron. The joints shall be of the ball and socket type either bolted or keyed and, if of the bolted type, the bolts and nuts shall be made of stainless steel. The

trench in which this pipe is installed shall be excavated to a depth that will provide a cover of not less than 3' over the top of the pipe when it is in place.

5. All ductile iron sewer main pipes shall be color coded green by painting a 3" green stripe along the crown of the pipe barrel.

B. Joints:

1. Provide ductile iron pipe with push-on joints conforming to ANSI A21.11/AWWA C111, latest revision.
2. Joints shall be restrained where indicated on the drawings. Use American Fast-Grip® Gaskets, or approved equal for restrained joints. Provide a boltless, integral restraining system rated for the design pressure in accordance with the performance requirements of ANSI/AWWA C111/A21.11, unless noted otherwise on the Drawings.
3. Gauge pipe ends (spigot end, bell, and socket) for all pipe with suitable gauges at sufficiently frequent intervals to ensure compliance to the standard dimensions of ANSI/AWWA C151/A1.5, latest addition. Manufacturer must have a recommended ovality tolerance for 18 inches and larger size pipe. Each end of each pipe 18 inches and larger shall be measured and approved by manufacturer's quality assurance inspector to meet such out of round tolerances. Provide manufacturer's certification that ovality has been measured and controlled in accordance with manufacturer's standard.

C. Flanged Joint Pipe

1. Provide flange fittings as required for above ground applications or exposed piping in vaults.
2. Flanges conforming to AWWA C110 can be joined with Class 125 B16.1 flanges shown in ANSI B16.1 but not with Class 250 B16.1 flanges.
3. Flange joints should be fitted so that the contact faces bear uniformly on the gasket. The joint should be made with relatively uniform bolt stress.
4. Bolts and nuts shall be type 316 stainless steel, conforming to ASTM A 193, Grade B8M, for bolts and ASTM A 194, Grade 8M, for nuts.
5. Set flange bolts beyond finger tightness with an indicating torque wrench to insure equal tension in all bolts. Tighten bolts such that those 180 degrees apart or directly opposite are torqued in sequence.
6. Provide at minimum one (1) restrained dismantling joint or flange coupling adaptor for disassembly in each linear run of flanged piping.

2.3 DUCTILE-IRON FITTINGS

A. Ductile iron fittings shall be provided in locations as shown on the plans or in locations deemed necessary by the Engineer. Ductile iron fittings 12" and smaller shall be rated for 350 psi working pressure and fittings larger than 12" shall be rated for 250 psi working pressure.

B. Fittings shall be manufactured in accordance with AWWA C153 and provided with mechanical joints. All fittings shall be provided with a thin cement lining in accordance with AWWA C104 unless noted otherwise on plans. If DIP is to be epoxy lined, all fittings shall be epoxy lined in lieu of cement lining.

C. Use Tee-head or non-hex head bolts and hex head nuts for joint makeup and gasket seating, bolts and nuts shall be carbon steel coated with corrosion inhibiting fluoropolymer composite

material. Mechanical joint fittings shall be furnished with sufficient quantities of accessories as required for each joint. All mechanical joints shall be restrained.

D. Ductile Iron fittings with retainer glands shall be provided.

E. Concrete thrust block/restraints shall be 2500 psi concrete poured in place against undisturbed soil at each fitting location.

F. Where 90 degree deflections occur along the route of the force main, two (2) 45 degree bends shall be used where possible.

2.4 POLYETHYLENE PIPE

A. All polyethylene pipe and fittings shall be molded from Virgin PE4710 High Density Polyethylene Pipe (HDPE) resins in accordance with the requirements of ASTM D3035 and manufactured to comply with ASTM F714.

B. Unless otherwise specified, the nominal size and DR shall be as shown on the Drawings. HDPE fittings shall be fully pressure rated.

C. Gravity Sewer - Profile wall polyethylene pipe and fittings for gravity sewers shall be of the spiral wound type. The pipe shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D-1248. The pipe shall be provided with rubber gasket joints that meet the non-pressure requirements of ASTM F477. Special heavy wall pipe sections having a smooth outside wall shall be supplied for all manholes and connections to other types of pipe.

D. Pressure Mains – HDPE pipe and fittings shall have a nominal DIPS (ductile iron pipe size) outside diameter per ASTM F714. Pipe sections shall be joined on the job site above ground into continuous length by the butt-fusion method in accordance with ASTM F2620, and be performed in strict accordance with the manufacturer's recommendations. Butt-fusion fittings shall comply with ASTM D3261.

E. HDPE pipe shall be joined to ductile iron valves and fitting with a DIPS size MJ adapter kit. Pipe stiffeners shall be used to maintain roundness of the pipe. MJ adapter and stiffeners shall be installed in strict accordance with the manufacturer's recommendations.

F. Pipe shall be supplied in lengths not less than 40 feet long, of the size and wall thickness as shown on the plans. The combined soil pipe system shall be reviewed and approved by the pipe manufacturer to ensure an installation limiting maximum deflection of the pipe to less than five percent of base diameter, when both soil and maximum water loads are applied. The pipe shall be handled and installed in strict accordance with the recommendations of the manufacturer.

2.5 VALVES

A. Gate Valves

1. Manufacturers:

a. Mueller Co
b. American
c. Or Approved Equal

2. Description:

a. Comply with AWWA C509.
b. Body: Ductile iron.
c. Seats: Resilient.
d. Style:

1) Buried service: Mechanical joint ends in accordance with AWWA C111.
2) Above ground service: Flanged ends with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

e. Stem:

1) Type: Non-rising.
2) Material: Bronze.

f. Operation:

1) 2-inch operating nut for buried applications
2) Handwheel for above ground applications
3) Opening Direction: Counterclockwise.

3. Provide gate valves smaller than 3 inches in diameter that are all bronze, threaded, meeting the requirements of Federal Specification WW-V-54C, as manufactured by Crane, or Walworth, or equivalent, and suitable for the service required.

B. Plug Valves

1. Manufacturers:

a. Milliken
b. Henry Pratt Company
c. DeZurick
d. Val-Matic
e. Or Approved Equal

2. Description:

a. Type:

1) Non-lubricated
2) Eccentric
3) 90 Degree Turn
4) Resilient faced Plug

3. Working Pressure: 175 psig for valves through 12” and 150 psig for valves for 14” through 72”.
4. Ports:

a. Configuration: Rectangular.
b. Minimum Port Area: 100 percent of nominal pipe area for valves.

5. Stem Bearings: Self-lubricating.
6. Stem Seals:

a. Type: V-ring.
b. Material: Neoprene.

7. Packing and Gland: Accessible and externally adjustable.
8. End Connections:

a. Buried service: Mechanical joint ends in accordance with AWWA C111.
b. Above ground service: Flanged ends with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

9. Operation:

a. 2-inch operating nut for buried applications.
b. Handwheel for above ground applications.
c. Opening Direction: Counterclockwise.

10. Materials:

a. Body:

1) Cast iron, ASTM A126 Class B.
2) Lining: As recommended by valve manufacturer for service conditions.

b. Plug:

1) Ductile iron, ASTM A126 Class B.
2) Lining: Synthetic viton compound of a minimum of 70 durometer hardness.

c. Seats: 1/8", welded, 90% pure Nickel.
d. Stem: Type 316 stainless steel.
e. Stem Bearings: Type 316L stainless steel.
f. Seals: Buna-N.
g. Connecting Hardware: Type 316 stainless steel.
h. Plugs shall be on top when open and on pressure side when closed.

C. Check Valves

1. Manufacturers:

a. GA Industries, Inc.
b. Henry Pratt Company
c. Kennedy Valve Company
d. Or Approved Equal

2. Description:

a. Comply with AWWA C508.
b. Minimum Working Pressure: 200 psig for 2" - 12" and 150 psig for 14" - 30".
c. Check valves 6 inches and larger: Furnish with adjustable air cushion chambers.
d. Type: Swing, resilient seated with outside lever and adjustable weight.
e. Mounting: Horizontal or vertical.
f. End Connections: Integral flange ends shall be ANSI B16.1 Class 125, suitable for horizontal or vertical installation.

3. Materials:

a. Body and Cover: Ductile iron, ASTM A536.
b. Disc, Disc Arm: Ductile iron, ASTM A536
c. Body Seat: Replaceable, Type 316 ASTM A276 with Buna-N renewable seat ring
d. Shaft: Type 303 Stainless Steel ASTM A582
e. Disc Seat: Buna-N
f. Lever and Counterweight: Ductile Iron, ASTM A536
g. Hinge Pin and Key: Type 316 Stainless Steel
h. Rubber Components: Buna-N
i. Connecting Hardware: Type 304 stainless steel.

4. Finishes: As specified in Section 09 96 00 High-Performance Coatings.

D. Air Vacuum Valves
1. Manufacturers:

a. ARI Flow Control Accessories
b. Or Approved Equal

2. All air release and vacuum valves shall be sized per the manufacturer and approved by the engineer prior to installation based on the owner's preferences and the anticipated line pressures.
3. Wastewater air and vacuum valves shall permit unrestricted passage of air during filling of the distribution piping. The valve body shall be stainless steel with stainless steel screws, unless indicated (stainless steel) in the plan set. The float and all internal metal parts shall be stainless steel, and the valve shall be designed so that the venting mechanism does not come into contact with sewage. The air and vacuum combination valves for sewage shall be ARI Model D-020 or equal. The valve shall have a NPT inlet sized by the manufacturer and shall be fitted with a back flushing device.
4. The air release valve shall be installed as shown in details.
5. No galvanized nipples shall be used.
6. Install Air Vacuum valves as shown on plans.

2.6 MATERIALS

A. Bedding and Cover:

1. Bedding:

a. Ductile Iron Pipe – Type 2 or Type 3 Trench per AWWA C151 as required.
b. PVC/HDPE – Type 2 Trench per AWWA C151

2. Cover: Provide a minimum of 4 feet of cover unless shown otherwise on Drawings.
3. Soil Backfill from Above Pipe to Finish Grade:

    a. Subsoil with no rocks greater than 6 inches in diameter, frozen earth, or foreign matter.
    b. Back-fill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe.

2.7 ACCESSORIES

A. Polyethylene Encasement

1. Where indicated on the drawings ductile iron pipe shall be wrapped in 6 mil polyethylene encasement in accordance with AWWA C105. All fittings shall be wrapped in 6 mil polyethylene encasement extending 6" beyond the connection.

B. Zinc Coating: Where indicated on the drawings, ductile iron pipe for buried service shall be coated with a layer of arc-sprayed zinc. The mass of the zinc applied shall be 200 g/m^2 of pipe surface area. A finishing layer topcoat shall be applied to the zinc. The mean dry film thickness of the finishing layer shall not be less than 3 mils with a local minimum not less than 2 mils.

1. The zinc coating system shall conform to ISO 8179 standard.
2. All pipe shall be manufactured and zinc coated in the United States at the pipe manufacturer's facility.

C. Protective Lining: The Contractor shall provide interior protective lining where indicated on the drawings or specified below.

1. Ductile iron pipe and fittings shall receive an epoxy lining of the interior surface where indicated on the drawings. The interior protective liner shall be an amine cured novalac epoxy applied to a dry film thickness of 40 mils minimum, and shall be Protecto 401™ Ceramic Epoxy or approved equal. Ductile iron pipe to be lined shall not be cement mortar lined.

D. Pipe Weights

1. Unless otherwise noted in the Specifications, all gravity sewer pipe installed with less than three diameters of cover over the top of the pipe barrel shall be provided with concrete weights to prevent flotation.
2. The weights shall be spaced at ten feet centers, with each weight weighing not less than 800 pounds. The weights may be constructed of a cast iron bolt on design, or they may be of the concrete cast in place type for below ground installations. Cast in place weights shall each contain two No. 3 rebars bent over and around the pipe barrel to provide adequate tensile strength to the upper part of the weight. Above ground portions of concrete weights shall be neatly formed and rubbed upon completion of the work.

E. Trench Plugs

1. Provide trench plugs where shown on drawings and at all creek crossings.

2. Trench plug consists of an impervious clay or concrete ditch check installed on the downstream side of all stream crossings. Ditch check shall be constructed for a length of 3 feet as measured along the centerline of the pipe and the full width of the trench excavation.
3. Backfill shall exhibit the characteristics of a "GC" soil rating as classified by the unified soil classification system (ASTM D2487) and shall have a coefficient of permeability no greater than .001 cm/sec.
4. The material utilized may vary from the above requirements if approved by Engineer; however, in any case the contractor shall furnish an approved independent testing facility utilizing the above methods.
5. The minimum percentage of compaction for the backfill shall be 95% proctor density (ASTM D1557).

F. Tracer Wire

1. Insulated copper wire shall be installed on all non-metallic pipe force mains. The wire shall be 10 gauge stranded type TW copper marker wire with electronically continuous joints with blue or purple thermoplastic insulation recommended for direct burial. The marker wire shall be brought up to all in-line valves and at 500' increments along the forcemain alignment to be readily available to system operators. All wire connections and splices shall be connected with underground wire nuts, tied, and tightly taped with insulated electrical tape. All costs associated with the installation of the marker wire shall be included in the price bid for the pipe.

G. Detection Tape

1. Green metallic detection tape shall be provided for all PVC pipes.
2. Detection tape shall be composed of a solid aluminum foil encased in a protective plastic jacket. Tape shall be marked "CAUTION SEWER MAIN BURIED BELOW."
3. Tape shall be permanently printed with no surface printing allowed. Tape width shall be a minimum of 3-inches and have a minimum thickness of 5 mil.
4. Tape shall be marked "CAUTION SEWER MAIN BURIED BELOW."
5. All tracer wire termination points will use a test station. Test stations shall be Lite Duty Snakepit test station (LD14*TP) green in color, as manufactured by Copperhead industries LLC, Rhino TracerPed Triview Green (P692TGI), or equal.

H. Valve Boxes

1. Manufacturers:

   a. Mueller Co
   b. Ford Meter Box Company, Inc.
   c. Sigma
   d. Or Approved Equal

2. Description

   a. Material: Cast iron
   b. Type: One Piece

      1) Material: Cast iron.

2) Provide 6-inch Class 200 PVC riser

c. Installation: Support valve box and PVC riser on minimum of 2 cement bricks. Install tracer wire on outside of riser pipe and loop inside of valve box.

3. Lid Inscription: SEWER

I. Pressure Gauges

1. Gauges shall be furnished as shown on the drawings. Gauges shall be bourdon tube type, with bronze movement, plexiglass covers and shall be 4½ inches in diameter with not less than 90 percent glycerin filled cast phenolic cases. Each gauge shall have a range such that the normal operating pressure shall be approximately at half the range. The gauges shall be provided with diaphragm protectors and ¼ inch NPT liquid flushing connection with brass lever handle blow-off pet cock. The diaphragm and surfaces exposed to the liquid shall be of stainless steel. Gauges shall be calibrated in pounds per square inch.

PART 3 - EXECUTION

3.1 GENERAL

A. Watertight Construction – It is imperative that all sewers and manholes be built watertight and that the Contractor rigidly adheres to the specifications for material and workmanship. After completion, the sewers or section thereof will be tested and gauged; and if infiltration is observed, the sewer will be rejected.

B. Inspection – All work done and materials furnished shall be subject to the inspection of the Engineer and the Inspector, and all improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the worksite upon notice being received from the Engineer of the rejection of such materials. The Engineer shall have the right to mark rejected materials and to distinguish them as such.

3.2 EXAMINATION

A. Verify that trench cut is ready to receive Work.

B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.3 PREPARATION

A. Perform trenching operations per Section 31 23 16.13

B. Protect and support existing sewer lines, utilities, and appurtenances in accordance with Section 31 23 16.13 and the Occupational safety and health act (OSHA) of 1970 (PL 91-596), as amended.

C. Utilities:

1. Coordinate with other utilities and the Engineer to eliminate interference.
2. Notify Engineer if crossing conflicts occur.

3.4 INSTALLATION

A. The Contractor shall assume responsibility for all materials and equipment stored, protection of his product and compliance with all federal, state and local safety regulations.

B. Care shall be takin in loading, transporting, and unloading to prevent damage to pipe or fittings. Pipe or fittings shall not be dropped. All pipe and fittings shall be examined before laying, and the Engineer notified of any defect. No piece shall be installed which is defective. Only outside slings shall be used for lifting. Under no conditions shall lifting be from interior surfaces. The Contractor shall be responsible for all materials furnished by him and shall replace all such material found defective in manufacture of damaged in handling after deliver at no additional cost to the Owner.

C. Gravity sewer pipes, structures and manholes shall be installed and tested as specified to the grades, elevations, alignments, and orientations shown on the drawings within the following tolerances:

1. Pipe center line horizontal position at any point:	±0.50 feet
2. Pipe center line horizontal position difference between any two joints (maximum):	0.10 feet
3. Elevations of bases, openings, appurtenances, and tops of any structure or manhole (except pipe invert elevations):	±0.10 feet
4. Horizontal orientation (rotation) of any structure or manhole or any pipe penetration face:	±2.0 degrees

D. Under no circumstances should installation of sewer pipes, structures, and manholes to the tolerances specified herein results in a reverse grade. Any pipe, structures, and manholes outside of these tolerances or at an inverse grade shall be removed and replaced with correct work. Materials may be reinstalled only as approved in writing by the Engineer. Otherwise, removed pipe and manholes shall be removed from the site and replaced at no additional cost to the Owner.

E. All PVC gravity sewer pipe shall be laid in strict accordance with ASTM 2321, and only crushed stone bedding as described elsewhere in these specifications shall be used

F. All HDPE Force mains shall be installed in accordance with the requirements of ASTM D2321. Class IV and Class V materials shall not be used in the pipe zone.

G. All ductile iron pipe and fittings shall be installed in conformance with AWWA C600.

H. A laser beam device shall be used to ensure correct horizontal and vertical alignment for all gravity sewer pipe. The laser beam shall be of a type approved by the Engineer. Each laser beam shall be calibrated at the factory before being used for this work. At 30 day intervals, each laser beam device shall be field checked and recalibrated if necessary by the manufacturer and a certificate authenticating its accuracy provided to the Engineer.

I. Before the pipe is placed in position, the bottom of the trench shall be uniformly graded and bedding stone placed so that the pipe will have a bearing for its full length. As each section of pipe is set in place a small excavation shall be made to provide a place for the bell.

J. All sewer pipe shall be laid upgrade with the spigots pointing downgrade. The pipe and specials shall be so laid in the trench that after the sewer is completed the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer.

K. All pipe shall be carefully examined for cracks or other defects, and no pipe shall be laid which is found defective. If any pipe is found to be defective after being laid, it shall be removed and replaced with sound pipe without further charge.

L. The interior of the pipe shall be carefully freed of all dirt and superfluous material of every description as the work proceeds.

M. No pipe shall be laid on blocking of any kind except by express permission of the Engineer, and then only at manholes or other structures where temporary blocking may facilitate installation of the pipe. After installation of the pipe, such blocking shall be carefully removed, and all voids left by the blocking shall be filled with selected materials and tamped.

N. The bell of each joint shall be wiped clean before the gasket is inserted in it and the gasket covered with lubricant meeting the requirements of AWWA C111 before the pipe sections are jointed together.

1. No joints shall be made where surfaces of pipe and bell to be joined have been soiled by earth in handling until such soiled surfaces are so thoroughly cleaned by brushing and wiping that all traces of the earth are removed.
2. The surfaces of pipe to be joined, as well as the gaskets, shall be cleaned and lubricated. Whatever lubricating agent is used, it shall not be injurious or detrimental to the gasket.

O. After each joint is installed, the gasket shall be checked for proper position prior to installation of the succeeding length of pipe.

P. Where pipe laying is suspended at the lunch hour, at night, during inclement weather or at any other time, the open end of the pipe line shall be provided with a tight-fitting plug-in order to prevent the entrance of dirt, mud and animals.

Q. The Contractor shall be responsible for removing and cleaning any foreign debris that enters the sewer system.

R. Wye-branches shall be installed in the line opposite every house, and in other locations if so directed by the Engineer. Any omission of these appurtenances shall be corrected by the Contractor without additional cost to the Owner. The Contractor shall maintain a complete and accurate record showing the location of each wye-branch installed. The locations will be given as a distance upgrade from each manhole. The written record may be kept on the cut sheet provided by the Engineer and shall be given to him on completion of each line. The record shall state whether the wye-branch is facing right or left when looking up grade and if riser pipe is installed, the amount shall be recorded. In each instance the Contractor will make every effort to install the wye-branch at the location requested by the property owner.

S. Backfill trench as shown on the Drawings and in accordance with Section 31 23 16.13 of these specifications.

1. Unless otherwise shown on the Drawings, ductile iron pipe shall be installed in a Type 4 standard laying condition per AWWA C151.

T. All disturbed areas along the pipeline shall be grassed as soon as possible after backfilling operations have been completed.

1. The maximum length of area disturbed before soil stabilization techniques will be required shall be 500 feet.
2. Seeding and Restorations shall be per Section 32 92 19 of these specifications.

3.5 OBSTRUCTIONS

A. Each building, wall, fence, pole, bridge, railroad, driveway or other property or improvement encountered is to be carefully protected from all injury, and in the event that any of the foregoing are damaged or removed during the progress of the work the same shall be repaired or replaced within a reasonable time, and before final acceptance of the work shall be returned to as good condition as before the work started. Special care must be exercised in trenching under or near railroads in order to avoid or minimize delays and the danger of injury resulting therefrom, and the Contractor must use care in all phases of the construction work, for he will be held liable for damages caused by carelessness.

B. In excavating, backfilling and laying pipe care must be taken not to remove, disturb or injure any water or sewer pipes or other conduits or structures. If necessary, the Contractor, at his own expense, shall sling, shore up and maintain such structures in operation, and within a reasonable time shall repair any damage done to them. Before final acceptance of the work, he shall return all such structures to as good condition as before the work started.

C. Unless otherwise specifically addressed on the drawings, sewers shall be laid at least ten (10) feet horizontally from any existing or proposed potable water main. The distance shall be measured edge to edge.

D. Sewers crossing potable water mains shall be laid to provide a minimum vertical separation of eighteen (18) inches between the outside of the potable water main and the outside of the sewer. This shall be the case where the potable water main is either above or below the sewer. Whenever possible, the potable water main shall be located above the sewer main. Where a new sewer line crosses a new potable water main, a full length of pipe shall be used for both the sewer line and potable water main and the crossing shall be arranged so that the joints of each line shall be as far as possible from the point of crossing and each other. Where a potable water main crosses under a sewer, adequate structural support shall be provided for the sewer line to prevent damage to the potable water main while maintaining line and grade.

E. When necessary, the Contractor shall give sufficient notice to the interested utility of his intention to remove or disturb any pipes, conduits, etc., and shall abide by their regulations governing such work. In the event that any subsurface structure becomes broken or damaged in the prosecution of the work, the Contractor shall immediately notify the proper authorities, and shall be responsible for all damage to persons or property caused by such breaks. Failure of the

Contractor to promptly notify the affected authorities shall make him liable for any needless loss or for interference with the normal operation of the utility.

F. When pipes or conduits providing service to adjoining buildings are broken during the progress of the work, the Contractor shall repair them at once at his own expense, or if required by the utility involved, shall pay the utility the proper charges for having such repairs made by the utility's own forces. Delays, such as would result in buildings being without service overnight or for a needlessly long period during the day, will not be tolerated, and the Owner reserves the right to make repairs at the Contractor's expense without prior notice. Should it become necessary to move the position of a pipe, conduit or structure it will be done by the Contractor in strict accordance with the instructions given by the Engineer or utility involved.

G. The Contractor shall notify all utilities involved of his intention to excavate in the locations specified and request that any underground utilities be located in advance of the construction work. Where ordered by the Engineer, the Contractor shall uncover subsurface obstructions in advance of construction so that the method of avoiding them may be determined before pipe laying reaches the obstruction.

3.6 CONNECTIONS TO EXISTING SANITARY SEWERS OR MANHOLES

A. Connections to gravity sewers shall be made by core drilling a hole (no sledge hammer) in the wall of the existing structure of the proper size to insert the required rubber boot, and a length of sewer pipe into the hole, filling around pipe and boot with non-shrink vinyl-based grout or water plug, and troweling the inside and outside surfaces of the joint to a smooth finish. The bottom of the manhole shall be rebuilt and formed as necessary to fit the invert of the sewer as shown on the drawings for new manholes. High-early strength cement mortar mixed with an approved non-shrink epoxy grout shall be used to minimize interruptions in sewer service. The Contractor shall perform any work needed to temporarily block or divert waste flows to complete the connection without spillage of the waste.

B. All existing connections to shall be tightly plugged and blocked to prevent the entrance of construction debris (cement, rocks, mud, silt, flushing water, etc.). The discharge of these materials to the Sanitary Sewer System during construction is prohibited. It is the Contractor’s responsibility to secure and plug the system during the construction period to prevent entrance of unexpected rainwater, mud, and silt.

3.7 PIPELINES UNDER PAVEMENT

A. Where sewers are to be laid under pavement, and the installation of casing pipe or the use of cast iron pipe inserted in a bored hole is not required or specified, the Contractor will be permitted to cut and replace this pavement. In the event that subsurface operations result in injury or damage to the pavement, the necessary repairs shall be made by the Contractor at no additional cost to the Owner. In the event of the pavement on either side of the pipe line cracking or otherwise becoming disturbed or broken due to Contractor's operations, he shall repair or replace same at his own expense and without additional compensation.

B. In the event of the State Highway Department requiring a bond or certified check to guarantee the replacement of highway paving, the Contractor shall furnish this security at his own expense.

C. Where pipelines are to be laid underneath paved sidewalks, the Contractor will be required to install them by; means of tunneling, and where it becomes necessary to cut and replace the sidewalk it shall be replaced as soon as practicable after the trench has been backfilled and tamped. The replaced surface shall be 12 inches wider than the width of the trench; the excess width being equally distributed on both sides.

D. The Contractor will receive no additional compensation for laying sewers under pavement unless this item of work is set up as a separate item in the Proposal.

3.8 TRAFFIC CONTROL

A. It shall be the responsibility of the Contractor for all traffic control along any portion of the job. Where required, all necessary flagmen, traffic cones and traffic control plans shall be in place on both County roads and State highways to meet road department specifications.

B. Traffic control plan shall be in conformance with the Manual on Uniform Traffic Control Devices. In the event actual physical conditions warrant additional traffic control devices, they shall be installed in conformance with the M.U.T.C.D. as directed by the Georgia Department of Transportation District Engineer.

C. It should be noted that work for this project takes place along a very busy section of four-lane highway. The contractor shall be familiar with the project area prior to bid and implement an effective traffic control plan in accordance with the M.U.T.C.D.

3.9 FIELD QUALITY CONTROL

A. Test Pipe per Section 33 01 30.13

B. Compaction Testing per Section 31 23 16.13

C. As each section of the work is completed it shall be thoroughly cleaned and all excess mortar, earth, brick or other foreign matter removed. Before acceptance of the work the system as a whole shall be cleaned and inspected and a full circle of light shall show in all sewer between manholes.

D. The Contractor will be responsible for supplying the Engineer with accurate record drawings per Section 01 78 39 at the conclusion of the project. The Contractor will be responsible for keeping “asbuilt” drawings current throughout the duration of the project. Pay requests will not be approved unless “asbuilt” drawings are accurate and are kept current with the work that has been performed.

E. Final CCTV Inspection: The Contractor shall perform a detailed closed-circuit television inspection in accordance with ASTM standards, in the presence of the Owner after installation of all new sewer pipes. A digital copy of the final inspection shall be provided to the owner and to the engineer. All costs associated with the final CCTV Inspection shall be included in the price bid for pipe.

3.10 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

B. Wherever possible, topsoil shall be removed from all areas to be disturbed by construction, and stockpiled. Land exposure shall be minimized in terms of area and time. All exposed areas subject to erosion shall be covered as quickly as possible by the grassing and seeding specified elsewhere or by mulching or vegetation. Natural vegetation shall be retained whenever possible.

C. Reasonable care shall be taken during construction to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.

END OF SECTION 33 31 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 41 13 - PUBLIC STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Storm drainage piping.
2. Piping accessories.
3. Drainage structures.
4. Bedding and cover materials.
5. Pipe support systems.
6. Concrete encasement and cradles.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete
2. Section 03 60 00 - Grouting
3. Division 31 – Earthwork.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
2. AASHTO M86 - Standard Specification for Nonreinforced Concrete, Sewer, Storm Drain, and Culvert Pipe.
3. AASHTO M170 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
4. AASHTO M196 - Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
5. AASHTO M206 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.
6. AASHTO M207 - Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
7. AASHTO M252 - Standard Specification for Corrugated Polyethylene Drainage Pipe.
8. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
9. AASHTO M294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.
10. AASHTO T180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM A123 - Standard Specification for Zinc Hot-Dip Galvanized Coatings on Iron and Steel Products.
2. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
3. ASTM B745 - Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
4. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
5. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
6. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
7. ASTM C506 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.
8. ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
9. ASTM C1103 - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
10. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
11. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
12. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
13. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
14. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
15. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
16. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
17. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
18. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
19. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
20. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
21. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
22. ASTM F667 - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.

1.3 COORDINATION

A. Section 01 31 00 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with termination of storm sewer, trenching, connection to public storm sewer.

1.4 PREINSTALLATION MEETINGS

A. Section 01 3 100 - Project Management and Coordination: Requirements for preinstallation meeting.

B. Convene minimum seven days prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data indicating pipe size, pipe material, pipe accessories, storm drain structures, and location as shown on the plan drawings.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Field Quality-Control Submittals: Submit results of Contractor-furnished tests and inspections for storm sewer installation as shown on the plan drawings.

1.6 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of storm sewer installation.

C. Identify/note uncharted utilities.

1.7 QUALITY ASSURANCE

A. Perform Work according to the contract specifications for this project and as shown on the plan drawings.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:

1. Store materials according to manufacturer instructions.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
4. Do not place pipe flat on ground; cradle to prevent point stress.

D. Protection:

1. Keep UV-sensitive materials out of direct sunlight.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Ductile-Iron Piping:

1. Pipe:

a. Comply with ASTM A746, Class 52 or above.
b. Type: Extra heavy Service.
c. Inside Nominal Diameter: As shown on the plan drawings
d. Ends: Bell and spigot, Plain, and as shown on the plan drawings.

2. Fittings: Ductile iron.
3. Joints:

a. Comply with ASTM A746.
b. Joint Devices: Rubber gasket.

B. Concrete Piping:

1. Pipe:

a. Comply with ASTM C14, AASHTO M86, Class 3.
b. Material: Nonreinforced concrete.
c. Inside Nominal Diameter: As shown on the plan drawings.
d. Ends: Bell and spigot, Plain, as shown on the plan drawings.

2. Fittings: Concrete.
3. Joints:

a. Comply with ASTM C443.
b. Gaskets: Rubber compression.

C. Reinforced Concrete Piping:

1. Pipe:

a. Comply with ASTM C76, AASHTO M170, ASTM C506, AASHTO M206, AASHTO M207, Class III, with Wall Type A or B.
b. Reinforcement: Mesh.
c. Inside Nominal Diameter: As shown on the plan drawings.
d. Ends: Bell and spigot.

2. Fittings: Reinforced concrete.
3. Joints:

a. Comply with ASTM C443.
b. Gaskets: Rubber compression.

D. Plastic Piping:

1. Pipe:

a. Material: PVC.
b. Comply with ASTM D2729, D2680.
c. Inside Nominal Diameter: As shown on the plan drawings.
d. Ends:

1) Style: Bell and spigot.
2) Type: Solvent sealed.

2. Fittings: PVC.
3. Joints:

a. Type: Solvent weld.
b. Comply with ASTM D2855.
c. Solvent Cement: Comply with ASTM D2564.

E. Plastic Piping:

1. Pipe:

a. Material: PVC.
b. Comply with ASTM D3034 SDR 35 & SDR 26: 4” – 15”, ASTM F679 PS46 & PS115: 18” – 36”.
c. Inside Nominal Diameter: As shown on the plan drawings.
d. Joints: Comply with ASTM D3212
e. Style: Bell and spigot with rubber-ring sealed gasket joint.
f. Lengths: 14 and/or 20 feet

2. Fittings: PVC.
3. Joints:

a. Comply with ASTM D3212.
b. Gaskets: Rubber-ring tight.

F. Plastic Piping:

1. Pipe: Polyethylene Single Wall

    a. Material: Corrugated polyethylene.
    b. Comply with AASHTO M252 Pipe: 3" – 10", AASHTO M294 Pipe: 12" – 60".
    c. Type: Perforated: Class I, Class II, or Smooth interior.
    d. Inside Nominal Diameter: 4" – 60".
    e. Laying Lengths: Per manufacturer

2. Fittings: Polyethylene.
3. Joints: Comply with ASTM D3212.
4. Gaskets: Comply with ASTM F477

G. Plastic Piping:

1. Pipe: Polyethylene Dual Wall

    a. Comply with ASTM F2648, AASHTO M252 pipe sizes 4" – 10", AASHTO M294, ASTM F2306 and ASTM F2648 pipe sizes 12" – 60".
    b. Material: Corrugated polyethylene.
    c. Type: Perforated: Class I, Class II, or Smooth interior.
    d. Inside Nominal Diameter: **4" – 60".**

2. Fittings: Polyethylene.
3. Joints: Comply with ASTM **D3212.**
4. Gaskets: Comply with ASTM F477

2.2 DRAINAGE STRUCTURES

A. Description: As specified in Section 330513.00 Manholes and Structures

B. Materials: Precast concrete; Cast-in-place concrete.

C. Manholes:

1. Size: 48, 60, or 72 inch inside diameter as shown on the plan drawings.
2. Concentric or Eccentric conical top, or Flat top; as shown on the plan drawings**.**
3. Covers: Water tight, Cast iron, or HDPE Plastic inscribed with STORM SEWER as shown on the plan drawings or specified herein.

D. Inlets Drop, Yard, Curb & Gutter:

1. Size: As shown on the plan drawings and/or specified herein
2. Grating:

    a. Cast iron ASTM A48.

2.3 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. Description: Reinforced concrete, as specified in Section 033000 - Cast-in-Place Concrete.
2. Compressive Strength: 4,000 psi at 28 days, reinforced concrete, and air-entrained, rough-troweled finish or as called for on the plan drawings.

2.4 MATERIALS

A. Bedding and Cover:

1. Bedding: as specified in Section 310516 - Aggregates for Earthwork, or as shown on the plan detailed drawings.
2. Cover: as specified in Section 310516 - Aggregates for Earthwork, or as shown on the plan detailed drawings.
3. Soil Backfill from above Pipe to Finish Grade: as specified in Section 310513 - Soils for Earthwork.

B. Subsoil: No rocks more than 6 inches in diameter, no frozen earth, or foreign matter.

2.5 MIXES

A. Grout: As specified in Section 036000 – Grouting.

B. Concrete Encasements and Cradles:

1. As specified in Section 033000 - Cast-in-Place Concrete or called for on the plan drawings.

2.6 FINISHES

A. Steel: As called for on the plan drawings or specified in these contract specifications.

B. Galvanizing:

1. Comply with ASTM A123.
2. Hot-dip galvanized after fabrication.

C. Galvanizing for Nuts, Bolts, and Washers: Comply with ASTM A153.

2.7 ACCESSORIES

A. Pipe Support Brackets: Galvanized, Unfinished structural steel coated with bituminous paint, or 304 Stainless Steel as shown or called for on the drawings.

B. Geotextile Filter Fabric:

1. Comply with AASHTO M288 for subsurface drainage.
2. Class 2, non-biodegradable.
3. Non-woven

4. 7 ounce fabric as manufactured by US Fabrics.

C. Pipe Markers: As specified in Section 331116 – Site Water Utility Distribution Piping.

D. Drainage Structures:

1. Catch Basins, Inlets, Manholes, Headwalls, and End Sections: As specified in Section 330513.00 - Manholes and Structures, Section 330516.13 - Precast Concrete Utility Structures.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that trench cut or excavation base is ready to receive Work.

C. Verify that excavations, dimensions, and elevations are as indicated on the plan drawings.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Correct over-excavation with compacted fine aggregate, coarse aggregate, or lean concrete. Notify Inspector or Engineer prior to filling over-excavation.

C. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

3.3 INSTALLATION

A. Excavation and Bedding:

1. Excavate pipe trench as specified in Division 31.
2. Hand trim excavation for accurate placement of piping to indicated elevations.
3. Dewater excavations to maintain dry conditions to preserve final grades at bottom of excavation.
4. Provide sheeting and shoring as specified in Division 31.
5. Level materials in continuous layers not exceeding compacted depth of 8 inches.
6. Maintain optimum moisture content of bedding material to attain required compaction density.
7. Install pipe on compacted subgrade meeting bedding requirements.
8. Cradle bottom 20 percent of diameter to avoid point load.
9. Compact subgrade and backfill as specified in Division 31.
10. Place geotextile fabric as indicated on Drawings

B. Piping:

1. Install pipe, fittings, and accessories according to ASTM D2321.
2. Seal joints watertight.
3. Place pipe on minimum -deep bed of compacted subgrade meeting bedding requirements.
4. Lay pipe to slope gradients as indicated on Drawings.
5. Connect piping to drainage structures.
6. Install aggregate at sides and over top of pipe.
7. Backfilling and Compaction:

    a. As specified in Division 31.
    b. Do not displace or damage pipe while compacting.

8. Pipe Markers: As specified in Section 331113 – Site Water Utility Distribution Piping.

C. Drainage Structures:

1. Catch Basins, Inlets, Manholes, and: As specified in Section 330516.13 - Precast Concrete Utility Structures

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Maximum Variation from Indicated Pipe Slope: 1/8 inch in 10 feet.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Request inspection by Engineer prior to and immediately after placing aggregate cover over pipe.

D. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
2. Compaction Tests:

    a. Comply with ASTM D1557, ASTM D698, AASHTO T180, ASTM D6938.
    b. Testing Frequency: Every 3 feet of vertical elevation at 100 feet horizontal intervals, or as stipulated by the Engineer.

3. Infiltration Test:

    a. As specified in Section 330130.13 - Sewer and Manhole Testing.

4. Deflection Test:

   a. As specified in Section 330130.13 - Sewer and Manhole Testing.

3.6 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 41 13

SECTION 400506 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe penetrations.
2. Restrained joints.
3. Braided flexible connections.
4. Expansion joints.
5. Expansion loops.
6. Sleeve-type couplings.
7. Wall sleeve.

B. Related Requirements:

1. Section 055000 - Metal Fabrications
2. Section 099600 – High-Performance Coatings
3. Division 40 – Process Integration

C. Conform to the requirements of Section 400513 – Common Requirements for Process Piping

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

2. AWWA C227 Bolted, Split-Sleeve Restrained and Nonrestrained Couplings for Plain-End Pipe.

B. American Welding Society:

1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

C. ASME International:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.
2. ASME B31.3 - Process Piping.
3. ASME B31.9 - Building Services Piping.
4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding, Brazing, and Fusing Qualifications.

D. ASTM International:

1. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
3. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
4. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

E. Expansion Joint Manufacturers Association, Inc.:

1. EJMA Standards.

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 1479 - Fire Tests of Through-Penetration Firestops.
3. UL 2079 - Tests for Fire Resistance of Building Joint Systems.

PART 2 - PRODUCTS

2.1 PIPE PENETRATIONS

A. Flashing:

1. Metal Flashing:

a. Material: Galvanized steel.
b. Thickness: 26 gage.

2. Metal Counterflashing:

a. Material: Galvanized steel.
b. Thickness: 22 gage.

3. Flexible Flashing Materials:

a. Material: Butyl sheet, PVC sheet, or Compatible with service conditions.
b. Thickness: 47 mils.

4. Caps:

a. Material: Steel.
b. Minimum Thickness: 22 gage, and 16 gage at fire-resistive elements.

B. Sleeves:

1. Sleeves for Pipes through Non-fire-rated Floors:

a. Material: 304 stainless steel.
b. Thickness: 0.0625 inch minimum

2. Sealant:
a. As specified in Section 079200 - Joint Sealants.

C. Mechanical Sleeve Seals:

1. Manufacturers:

a. Flexicraft Industries, PipeSeal
b. GPT (Link-Seal)
c. Or Approval Equal

2. Description:

a. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
b. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.2 RESTRAINED JOINTS

A. Flange Adapter (Set Screws)
1. Manufacturer:
a. EZ Flange Adapter (EBAA Iron, Inc.)
b. Uni-Flange, series 400 (0R series 420)
c. Ford Meter Box Company, Inc. (Nappco, Inc.)
d. Star Pipe Series 400
e. Or Approved Equal.
2. Description:
a. The uniflange assembly shall be used only in instances shown on the drawings. If the CONTRACTOR proposes to use uniflanges at other locations, he shall first obtain approval from the ENGINEER.
b. The uniflange shall consist of a Ductile Iron ASTM A536 Grade 65-45-12 flange with ANSI B16.1 Class 125 & 250 or ANSI B16.5 Class 150 & 300 drillings.
c. The standard gasket of Buna S for water and wastewater shall be supplied.
d. The uniflange class shall be suitable for the pressure service. (2”-12” = 250 psi, 14”-24” = 150psi, >24” = 100 psi)

B. Flange Adapter-Restrained
1. Manufacturer:
a. SERIES 2100 MEGAFLANGE adapter, as produced by EBAA Iron, Inc.,
b. StarFlange Series 3200
c. Or Approved Equal.

2. Description:
   a. Restrained flange adapters may be used in lieu of threaded, or welded, flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
   b. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
   c. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
   d. Megaflanges shall be fully restrained and shall incorporate a wedge style grip in lieu of set screws.
   e. Allowable working pressures shall have a minimum as follows: 3"-16" = 350psi, 18"-24" = 250 psi, 30"-48" = 150psi.

C. Adapter with Wedge Restraints for Mechanical Joint pipe.
1. Manufacturer:
   a. Uni-Flange Series 1400, by Ford Meter Box Company
   b. StarGrip 3000 by Star Pipe Products
   c. Megalug Series 1100 by EBBA Iron Sales, Inc.
   d. Or Approved Equal.
2. Description:
   a. Restraint for standardized mechanical joints shall be incorporated into the design of the follower gland and shall impart multiple points of wedge action against the pipe, increasing its resistance as the pressure increases.
   b. The restrained joint shall incorporate a wedge style restraint system, in lieu of set screws. Restraints with set screws will not be acceptable.
   c. The assembled joint shall maintain its flexibility after burial and shall maintain its integrity by a controlled and limited expansion of each joint during the wedging action.
   d. Restraining glands shall be manufactured of high strength ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12.
   e. Wedges shall be contoured to properly fit on the pipe, and shall be manufactured of ductile iron, heat treated to a minimum hardness of 370 BHN. Dimensions of the glands shall be such that they can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53 of latest revision.
   f. Twist-off heads shall be incorporated in the design of the wedge actuating screws to ensure proper torque.
   g. The mechanical joint restraining device shall have a water working pressure rating of 250 psi minimum with a safety factor of at least 2:1 against separation when tested in a dead-end situation
   h. Allowable working pressures shall be as follows: 3"-16" = 350psi, 18"-36" = 250psi.

2.3 BRAIDED FLEXIBLE CONNECTIONS

A. Manufacturers:

1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal.

B. Steel Piping:

1. Inner Hose: Corrugated stainless steel as indicated.
2. Exterior Sleeve: Braided or stainless steel as indicated.
3. Pressure Rating: Minimum 150 psig at 50 degrees F and sufficient for service condition.
4. Fittings: Flanged, Threaded with union, or As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4inch on each side of installed center line.

C. Copper Piping:

1. Inner Hose: Corrugated Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: Minimum 150 psig at 70 degrees F and sufficient for service condition.
4. Fittings: Threaded with union, Soldered, or As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4 inch on each side of installed center line.

2.4 EXPANSION JOINTS

A. Manufacturers:

1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal

B. Performance and Design Criteria:

1. Bellow Design: According to Section C of EJMA Standards.

C. Stainless-Steel Compensator Type:

1. Pressure Rating: 50 psig WOG at 250 degrees F for aeration air piping, all others shall be 200 psig WOG at 250 degrees F.
2. Maximum Compression: 1-3/4 inches.
3. Maximum Extension: 1/4 inch.
4. Joint: Flanged, Threaded, or As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Application: Aeration air piping 4-inch and larger or steel piping 3 inches and smaller.

D. External Ring-Controlled Stainless-Steel Bellows Type:

1. Pressure Rating: 200 psig WOG at 250 degrees F.

2. Maximum Compression: 1-1/4 inches.
3. Maximum Extension: 3/8 inch.
4. Maximum Offset: 5/16 inch.
5. Joint: Flanged.
6. Size: Use pipe-sized units.
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inches and larger.

E. Double-Sphere Rubber Type:

1. Body: Neoprene and nylon.
2. Working Pressure: 150 psig.
3. Maximum Temperature: 200 degrees F.
4. Maximum Compression: 1 inch.
5. Maximum Elongation: 5/8 inch.
6. Maximum Offset: 1/2 inch.
7. Maximum Angular Movement: 30 degrees.
8. Joint: Tapped steel flanges, Galvanized flanges, or Galvanized unions.
9. Size: Use pipe-sized units.
10. Accessories: Control rods.
11. Application: Steel piping 2 inches and larger.

F. Bronze Compensator Type:

1. Description: Bronze with anti-torque device, limit stops, and internal guides.
2. Pressure Rating: 200 psig WOG at 250 degrees F.
3. Maximum Compression: 3 inches.
4. Maximum Extension: 1/4 inch.
5. Size: Use pipe-sized units.
6. Application: Copper piping.

2.5 EXPANSION LOOPS

A. Provide expansion loops as indicated on Shop Drawings.

2.6 SLEEVE-TYPE COUPLINGS

A. Manufacturers:

1. Dresser Piping Specialties
2. Fernco Inc.
3. US Pipe Fabrication

B. Description:

1. Comply with AWWA C219.
2. Middle Ring: Steel.
3. Followers: Steel.

4. Gaskets:

   a. Material: Buna-N, EPDM, or Compatible with service conditions.
   b. Comply with ASTM D2000.

5. Bolts: Steel.

C. Finishes:

1. Buried Couplings: Factory epoxy coated.

2.7 WALL SLEEVE

A. Manufacturers:

1. Water Works Supply Corporation.
2. American
3. Or Approved Equal.

B. Description:

1. Wall and floor pipe penetrations of ductile iron piping systems shall be made by means of a sleeve capable of being bolted directly to the formwork to prevent misalignment. Seal of annular space shall be by means of a confined rubber gasket, so as not to be affected by vibration and capable of withstanding up to 100 psig. Sleeve shall be manufactured from Ductile Iron with an integrally cast water stop.

2.8 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Section 099600 – High-Performance Coatings.

2.9 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

1. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Shop Drawings.

C. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.

D. Verify that openings are ready to receive sleeves.

E. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 inches from pipe ends.

F. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Cleaning: Thoroughly clean end connections before installation.

C. Close pipe and equipment openings with caps or plugs during installation.

D. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to ASME B31.3 for process piping and ASME B31.9 for building services piping.

B. Coating: Finish piping appurtenances as specified in Section 099600 – High-Performance Coatings for service conditions.

C. Pipe Penetrations:

1. Flashing:

a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
b. Flash floor drains with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
c. Fasten flashing to drain clamp device.

2. Sleeves:

a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
b. Set sleeves in position in forms and provide reinforcement around sleeves.
c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
d. Extend sleeves through floors 1/2 inches above finished floor level and calk sleeves.
e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with insulation and calk airtight.
f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
g. Install stainless-steel escutcheons at finished surfaces.

D. Firestopping:

1. Placement: Place intumescent coating in sufficient coats to achieve rating required.
2. Fire-Rated Surfaces:

a. Seal opening at floor, wall, partition, ceiling and roof.
b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
c. Size sleeve, allowing minimum of 1 inch void between sleeve and building element.
d. Pack void with backing material.
e. Seal ends of sleeve with UL-listed, fire-resistive silicone compound to meet fire rating of structure penetrated.

3. Non-rated Surfaces:

a. Seal opening through non-fire-rated floor, wall, partition, ceiling and roof.
b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
c. Size sleeve to allow minimum of 1 inch void between sleeve and building element.
d. Install type of firestopping material recommended by manufacturer.
e. Occupied Spaces:

1) Install escutcheons, floor plates, or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
2) Occupied spaces include rooms with finished ceilings and rooms where penetration occurs below finished ceiling.

f. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
g. Interior Partitions:

1) Seal pipe penetrations at where indicated.
2) Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

E. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on Shop Drawings.

F. Expansion Joints:

1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Drawings.
2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.

G. Air Release and Vacuum Breakers: Provide vacuum breakers on all tanks and process equipment.

H. Backflow Preventers:

1. Install with nameplate and test cock accessible.
2. Install according to local code requirements.
3. Do not install in vertical position.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep equipment interior clean as installation progresses.

END OF SECTION 400506

SECTION 400507 - HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Structural attachments.
4. Pipe guides.
5. Formed steel channel.

1.2 SUBMITTALS

A. Product Data: Manufacturer's catalog data including load capacity.

B. Shop Drawings: Indicate system layout with location - including critical dimensions, sizes, and pipe hanger and support locations - and detail of trapeze hangers, anchors, and guides.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

D. Welders' Certificate: Compliance with ASME Section IX, AWS D1.1, verify qualification within previous 12 months.

E. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load carrying capacity of trapeze, multiple pipe, and riser support hangers.
2. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

F. Manufacturers' Instructions: Submit special procedures and assembly of components.

G. Qualifications Statements:

1. Qualifications for manufacturer, fabricator, installer, and licensed professional.
2. Manufacturer's approval of installer.

1.3 QUALITY ASSURANCE

A. Selection, fabrication and installation of pipe hangers and supports shall conform to the requirements of AWS D1.1, ANSI/ASME B31.1, MSS SP-58, SP-69 and SP-89, except as supplemented or modified by the requirements of these Specifications.

B. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years' documented experience.

C. Installer: Company specializing in performing Work of this Section with minimum three years' of experience for specified work.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.

B. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.5 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.6 WARRANTY

A. Furnish a minimum five year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Pipe hangers and supports shall be manufactured by Grinnell, B-Line Systems, Fee and Mason, Michigan Hanger Company, Aickenstrut, or Jove.
2. Substitutions: Per Section 012500 of these specifications.

B. Description:

1. Conform to ASME B31.1, ASME B31.9, MSS SP58.
2. Provide means of vertical adjustment after erection.
3. Pipe Sizes 1/2 to 1-1/2 in (13 to 38 mm): ASTM A47 (A47M), malleable iron, ASTM A36 (A36M), steel, adjustable swivel, split ring.
4. Pipe Sizes 2 in (50 mm) and Larger: ASTM A36 (A36M), steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Wall Support for Pipe Sizes 3 in (76 mm) and Smaller: Cast iron J-hook.
7. Wall Support for Pipe Sizes 4 in (100 mm) and Larger: Welded steel bracket.
8. Vertical Support: Riser clamp.
9. Floor Supports: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

C. Performance and Design Criteria:

1. Pipe Hangers:

a. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
b. Provide linkage to permit lateral or axial movement where anticipated.
c. Where horizontal pipe movement is greater than 1/2 in (12 mm), or where hanger rod deflection from vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.

2. Heat Transmission: Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.
3. Riser Supports: Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.
4. Point Loads:

a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides.
b. Avoid point loads on plastic piping by providing extra wide pipe saddles or galvanized steel shields.

5. Noise Reduction: Wrap copper tubes located within buildings with a 2-in (50-mm)-wide strip of rubber at each pipe support, bracket, clip, or hanger.

2.2 HANGER RODS

A. Hanger Rods:

1. ASTM A576, steel, ASTM A 320, stainless steel, Grade B8, ASTM A 307, Grade B.
2. Threaded both ends, Threaded one end, All-thread.
3. Diameter: ASME B31.1; as indicated on Drawings.
4. Nuts shall be heavy hex nuts conforming to ASTM A 194, Grade 8 or 8T, ASTM A 307.

2.3 STRUCTURAL ATTACHMENTS

A. Concrete Inserts:

1. Manufacturers:

a. Hilti, Red Head, Simpson, Tapcon
b. Substitutions: Permitted.

2. Description:

a. Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
b. Size inserts to suit threaded hanger rods.

c. Adhesive and wedge-type expansion anchor bolts shall be Type 316 stainless steel.

B. Mounting Brackets: ASTM A36, welded steel, 304 stainless steel, or as shown/called for otherwise.

C. Pipe Support Columns: All pipe support columns shall conform to ASTM A 53, Grade B and shall be minimum Schedule 40.

D. Beam Clamps:

1. Manufacturers:

a. Grinnell, B-Line Systems, Fee and Mason, Michigan Hanger Company, Aickenstrut, or Jove.
b. Substitutions: Permitted.

2. ASTM A36, steel, ASTM A181, forged steel; MSS SP-58.
3. Clamp Size: Based on load to be supported and load configuration.
4. Anchoring: Locknuts and cup-point set screws.
5. Reversible top or bottom flange.

E. Riser Clamps:

1. Manufacturers:

a. Grinnell or Fee and Mason.
b. Substitutions: Permitted.

2. ASTM A36, steel.
3. Support of Copper Tubing: Provide copper-plated clamps.

F. Offset Clamps:

1. Manufacturers:

a. Grinnell or Fee and Mason.
b. Substitutions: Permitted.

2. Double leg, two-piece.

2.4 PIPE GUIDES

A. Intermediate Guides:

1. Pipes 6 in (150 mm) and Smaller: Pipe clamp with oversize pipe sleeve.
2. Pipes 8 in (200 mm) and Larger: U-bolts with double nuts.

B. Alignment Guides:

1. Pipes 8 in (200 mm) and Smaller: Galvanized steel, Spider, Sleeve type.
2. Pipes 10 in (250 mm) and Larger: Galvanized steel, Roller type.

2.5 SUPPLEMENTAL STEEL

A. Standard Steel Shapes:

1. Utilize standard steel shapes fabricated in accordance with ASTM A 36.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field dimensions as indicated on Shop Drawings.

3.2 INSTALLATION

A. Obtain permission from Engineer before using powder-actuated anchors.

B. Do not drill or cut structural members.

C. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 in (100 mm) and larger.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above, flush with top of, or recessed into and grouted flush with concrete surface.

D. Pipe Hangers and Supports:

1. Install according to: ASME B31.1, ASME B31.5, ASME 31.9, MSS SP 58.
2. Support horizontal piping as scheduled/indicated on Drawings and indicated on Shop Drawings.
3. Install hangers with minimum 1/2 in (13 mm) space between finished covering and adjacent Work.
4. Place hangers within 12 in (300 mm) of each horizontal elbow.
5. Use hangers with 1-1/2 in (38 mm) minimum vertical adjustment.
6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft (1.5 m) maximum spacing between hangers.
7. Support vertical piping as shown piping schedule and/or the plan drawings.
8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
9. Support riser piping independently of connected horizontal piping.
10. Provide copper-plated hangers and supports for copper piping, sheet lead packing between hanger or support and piping.
11. Design hangers for pipe movement without disengagement of supported pipe.

12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
13. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
14. Use beam clamps where piping is to be suspended from building steel.
15. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
16. Use offset clamps where pipes are indicated as offset from wall surfaces.

E. Insulation:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.

F. Equipment Bases and Supports:

1. Provide housekeeping pads as detailed on Drawings.
2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.
3. Construct supports of steel members formed steel channel, steel pipe and fittings, or other structural steel shapes. Brace and fasten with flanges bolted to structure or as shown/called for on the Drawings.
4. Provide rigid anchors for pipes after vibration isolation components are installed. Comply with Section 400513 - Common Work Results for Process Piping.

G. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. Conform to Section 099113 – Exterior Painting.
3. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

END OF SECTION 400507

SECTION 400513 - COMMON REQUIREMENTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements common to pipe and tube of all material types used on the Project.
2. Accessories.

B. Related Requirements:

1. Section 099113 – Exterior Painting
2. Section 312000 – Earth Moving.
3. Division 40 – Process Interconnections

1.2 COORDINATION

A. Section 013000 – Project Management and Coordination.

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.

C. Shop Drawings: Indicate layout of piping systems, including equipment, fittings, critical dimensions, sizes, and material lists.

D. Submit manufacturer’s certification and certified test reports that the pipe and linings and coatings were manufactured and tested in accordance with the ASTM and ANSI/AWWA Standards specified. Submittal shall be at least 7 days prior to each shipment of pipe.

E. Material Certificates

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizing methods and calculations used.

G. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, invert and centerline elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work according to all applicable Federal, State and Local standards and these specifications.

B. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.

C. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

1.6 QUALIFICATIONS

A. Manufacturer: For each pipe material type, a company specializing in manufacturing products of the material shall be used. The manufacturer shall have successfully manufactured and delivered products of the diameters used in this project for a minimum of 15 projects over the past 5 years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging; include handling instructions.

C. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in a manner as to prevent damage to the exterior surface or internal coasting or lining of the pipe. If any part of the coasting or lining is damaged, the repair shall be made by the

D. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

E. Store piping and appurtenances according to manufacturer instructions.

F. Protect piping and appurtenances from oxidation by storing off ground.

G. Stored pipe shall be kept safe from damage and away from traveled ways. The interior of all pipe, fittings and other appurtenances shall be kept free from water, dirt, or foreign matter at all times.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 Pipe Schedule

A. Unless otherwise shown on drawings, the following is a general pipe schedule for the work:

Service	Location	Pipe Material	Fittings	Specification References	Comments
Raw Wastewater, Influent (WW) Wastewater, Effluent (WW1) Wastewater, Effluent Bypass (WW1B)	Buried	Ductile Iron (DI)	Mechanical Joint/Push-on Joint	400519	Pressurized pipe shall be restrained.
	Exposed	Ductile Iron (DI)	Flanged		
Sludge, Return (SLR) - Package Plant Scum, Return (SCR) - Package Plant Air Diffuser, Drop (AIR) - Package Plant	Buried	Ductile Iron (DI)	Mechanical Joint/Push-on Joint	400519, 460753	Pressurized pipe shall be restrained.
	Exposed	SCHD 40 steel, painted	Flanged		
Overflow Drain (OD) Process Backwash Drain (BWDR) Drain (DR)	Buried	Thermoplastic	Mech. Jt./Push-On Joint: Below Grade	400531	
Effluent to Spray Fields (ESF1)	Buried/ exposed	Ductile Iron (DI)	Welded/Flanged: Above grade; Push-On Joint: Below Grade	400519	Pressurized pipe shall be restrained
Effluent to Spray Fields (ESF2)	Buried	Thermoplastic	Push-On Joint & Solvent Weld Joint	400531	Pressurized pipe shall be restrained, use ductile iron fittings on 3" and larger.
Air (AIR)	Exposed	Stainless Steel (SS)	Welded/Flanged/Threaded: Above grade	400523	High temperature gaskets at flanged flanged
	Buried	Stainless Steel (SS)	Welded: Below Grade		
Water, Potable or Non-potable (PW or NPW)	Buried/ exposed	Ductile Iron (DI)	Welded/Flanged: Above grade; Push-On Joint: Below Grade	400519	Pressurized pipe shall be restrained
		Thermoplastic	Push-On Joint & Solvent Weld Joint	400531	Pressurized pipe shall be restrained

2.2 ACCESSORIES

1. Couplings, Adapters, Specials for Process Piping: As specified in Section 400506 - Couplings, Adapters, Specials for Process Piping
2. Hangers and Supports for Process Piping: As specified in Section 400507 - Hangers and Supports for Process Piping.
3. Process Piping Insulation: As specified in Section 404213 - Process Piping Insulation.

2.3 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. All pipe and fittings to be installed under this Contract shall be of new manufacture.

C. The manufacturer is responsible for the performance of all inspection requirements as specified.

D. Owner Inspection:

1. The manufacturer is responsible for performance of all inspection requirements as specified. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with these Specifications by the Owner, by an independent testing laboratory selected by the Owner, or by other representatives of the Owner.

E. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on the Drawings.

C. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Ream ends of threaded pipes and file smooth.

C. Cleaning: Thoroughly clean pipe and fittings before installation.

D. Surface Preparation:

1. Touch up shop-primed surfaces with primer as specified in Section 099113 – Exterior Painting.
2. Solvent-clean surfaces that are not shop primed.
3. Clean surfaces of metallic pipe to remove loose rust, mill scale, and other foreign substances by power wire brushing or commercial sand blasting; SSPC SP 6/NACE No. 3. Do not sand blast or power wire brush thermoplastic pipe.
4. Prime surface as specified in Section 099113 – Exterior Painting.

3.3 INSTALLATION

A. Buried Service: Install pipe as specified in the Section appropriate to the pipe material.

B. Exposed Service - Install according to ASME B31.3.

C. Provide required upstream and downstream clearances from devices as indicated.

D. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

E. Support piping as specified in Section 400507 - Hangers and Supports for Process Piping.

F. Provide expansion joints as specified in Section 400506 - Couplings, Adapters, and Specials for Process Piping and pipe guides as specified in Section 400507 - Hangers and Supports for Process Piping to compensate for pipe expansion due to temperature differences.

G. Dielectric Fittings: Provide between dissimilar metals.

H. Field Cuts: According to pipe manufacturer's recommendations.

I. Finish primed surfaces according to Section 099113 – Exterior Painting.

J. Run pipelines straight and true, parallel to building lines with a minimum use of offsets and couplings. Provide only such offsets as may be required to provide necessary headroom or clearance and to provide necessary flexibility in pipe lines.

K. Changes in direction of pipelines shall be made only with fittings or pipe bends. Changes in size shall be made only with fittings. Miter fittings, face or flush bushings, or street elbows shall not be used. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.

L. Provide flanges or unions at all final connections to equipment, traps and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

M. Use full and double lengths of pipe wherever possible.

N. Unless otherwise indicated, install all supply piping, including shut off valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at inlet to control valve or pump. Install supply piping from outlet of control valve at full size to connection of equipment served.

O. All pipe shall be cut to exact measurement and installed without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings. Particular care shall be taken to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment, or building elements with piping connections or piping supports.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Laying Tolerances: Unless otherwise specified, laying tolerances will be within 5/8”.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspection:

1. Inspect for damage to pipe lining or coating and for other defects that may be detrimental as determined by Engineer.
2. Repair damaged piping or provide new, undamaged pipe.
3. After installation, inspect for proper supports and interferences.

D. Damage:

1. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by Engineer.
2. Repair damaged piping or provide new undamaged pipe.

E. Pressure Testing:

1. Unless otherwise specified or indicated on the drawings, all pipe shall be pressure tested prior to acceptance.
2. Conduct pressure testing in according to AWWA C600 and following:

    a. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
    b. Conduct hydrostatic test for at least two hours.
    c. Slowly fill with water section to be tested; expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
    d. Observe joints, fittings, and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.

e. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate. Maintain pressure within plus or minus 5 psi of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.

f. Compute maximum allowable leakage by following formula:

1) L = SD x sqrt(P)/C.
2) L = testing allowance, in gph.
3) S = length of pipe tested, in feet.
4) D = nominal diameter of pipe, in inches.
5) P = average test pressure during hydrostatic test, in psig.
6) C = 148,000.
7) When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

g. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.

h. Correct visible leaks regardless of quantity of leakage.

F. After installation, inspect for proper supports and interferences.

3.6 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep pipe interior clean as installation progresses.

C. All piping shall be cleaned, flushed, and tested prior to use.

D. All water lines shall be flushed out under full treated water pressure; potable water piping shall be flushed with potable water; air piping shall be thoroughly blown out with air. All filters, control valves and gages shall be removed from lines or bypassed during the blowout period.

E. Following the blow through, all dirt legs and other low points in lines shall be disassembled and all residual material thoroughly removed. All stop valves shall be removed and cleaned.

F. The Contractor shall provide all water required for cleaning, and flushing at no additional cost to the Owner.

END OF SECTION 400513

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400519 - DUCTILE IRON PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ductile-iron pipe and fittings.
2. Accessories.

B. Conform to the requirements of Section 400513 – Common Requirements for Process Piping

C. Related Requirements:

1. Section 099113 – Exterior Painting
2. Section 331116 - Site Water Utility Distribution Piping
3. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe.
6. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
8. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B31.3 - Process Piping.

C. ASTM International:

1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.

D. SSPC - The Society for Protective Coatings:

1. SSPC SP 6/NACE No. 3 - Commercial Blast Cleaning.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Manufacturers:

1. US Pipe.
2. American.
3. Or Approved Equal.

B. Piping:

1. Comply with AWWA C151.
2. Diameter and Class: As indicated below:

Pipe Size (in)	Pressure Class
12” and Smaller	350
14” – 24”	250
30” and Larger	150

C. Joints:

1. Pressure Rating: Same as that of connected piping.
2. Mechanical:

    a. Comply with AWWA C110 and AWWA C111.
    b. Glands: Ductile iron with asphaltic coating.
    c. Use Tee-head or non-hex head bolts and head head nuts for joint makeup and gasket seating. Bolts & Nuts shall be carbon steel coated with corrosion inhibiting fluoropolymer composite material.
    d. Mechanical joint fittings hall be furnished with sufficient quantities of accessories as required for each joint.
    e. All mechanical joints shall be restrained.

3. Push On: Comply with AWWA C111.
4. Flanged: Comply with AWWA C115 with gaskets and bolts conforming to AWWA C115, Appendix A.
5. Gaskets for mechanical and push-on type joints shall conform to ANSI A21.11 and AWWA C111, Gaskets shall be SBR, neoprene, or EPDM.
6. Gaskets for flange joints shall conform to ANSI A21.15 and AWWA C115. Gaskets shall be neoprene or EPDM.
7. Gaskets for joints above 250 psi shall be Toruseal gaskets as manufactured by American specially designed for a working pressure of 350 psi.

D. Fittings:

1. Comply with AWWA C153, ductile iron.

2. Pressure Rating, Pipes 12 Inches and Smaller: 250 psig.

E. Specials:
1. Comply with AWWA C110, C111, C115, C153

2.2 FINISHES

A. Interior Coating
1. Cement-mortar lining, AWWA C104; standard thickness.
2. Glass-lined SR-14 or equal for grit and scum piping.
3. Ceramic epoxy for gravity and pumped raw wastewater.
4. Ductile Iron Pipe and Fittings used for air service shall be unlined pipe

B. Outside Coating:

1. Buried: Asphaltic; 1-mil thick, minimum, in accordance with AWWA C151 / ANSO A21.51.
2. Exposed: As specified in Section 099113 – Exterior Painting.

2.3 ACCESSORIES

A. Jackets:

1. AWWA C105, polyethylene jacket.
2. All buried ductile iron pipe shall receive polyethylene jacketing.

B. Dielectric Fittings: Provide between dissimilar metals.

C. Pipe Identification Labels

1. Identification for Process Piping: As specified in Section 400553 - Identification for Process Piping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 400513 – Common Requirements for Process Piping

3.2 INSTALLATION

A. Buried Service: Install pipe as specified in:

1. Section 331116 - Site Water Utility Distribution Piping.
2. Section 400513 – Common Requirements for Process Piping.
3. AWWA C600 – Installation of Ductile Iron Water Mains and their Appurtenances.

B. Exposed Service: Install pipe as specified in:

1. Section 400513 – Common Requirements for Process Piping.
2. Install according to ASME B31.3.
3. Fittings:

   a. Clean gasket seats thoroughly and wipe gaskets clean prior to installation.
   b. Install fittings according to manufacturer instructions.
   c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer recommendations.

4. Provide required upstream and downstream clearances from devices as indicated.

C. Tap ductile-iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.

D. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means acceptable to the Engineer.

E. The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe.

F. Where pipe is laid on a grade of ten (10) percent or greater, the laying shall start at the bottom and shall proceed upward with the bell ends of the pipe upgrade.

3.3 JOINING OF PIPE

A. Flanged Joints

1. Flanges conforming to AWWA C110 can be joined with Class 125 B16.1 flanges shown in ANSI B16.1 but not with Class 250 B16.1 flanges.
2. Flange joints should be fitted so that the contact faces bear uniformly on the gasket. The joint should be made with relatively uniform bolt stress.
3. Flanged joints shall be bolted together according AWWA C207 and related specifications.

B. Push-On Joint

1. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends upstream.
2. Pipe 8 inches in diameter and larger shall be socketed by fork tools or jacks.
3. Pipe cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. The spigot ends of field cut pipe shall be tapered back 1/8 inch at an angle of about 30 degrees to the barrel of the pipe with a coarse file or portable grinder. All sharp or rough edges that may injure the rubber gasket shall be removed in this operation.
4. Whenever it is desirable to deflect push-on joint pie, the amount of deflection shall not exceed the maximum limits according to Table 4 in AWWA C600.

C. Mechanical Joints:

1. Mechanical joints shall be in accordance with AWWA C600 and the manufacturer's instructions.
2. Bell ends shall be laid upstream for gravity flow pipe.
3. Bolts shall be tightened to the specified torque. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to obtain greater leverage.
4. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.
5. Bolts shall not be over-stressed to compensate for poor assembly.

D. Restrained Joints:

1. Mechanical restrained joint glands shall be EBAA Ironworks Megalug Series 1100, as manufactured by EBAA Iron, or Engineer approved alternate.
2. Integral bell restrained joint pipe shall be ACIPCO "FLEX-RING" or U.S. Pipe "TR-FLEX" for piping larger than 36-inches.
3. Integral bell restrained joint pipe shall be ACIPCO "Fast-Grip" or U.S. Pipe "Field-Lok Gasket".

3.4 PLACEMENT OF FITTINGS

1. Pipeline fittings, plugs, and caps shall be furnished and installed of the type indicated and at the location shown on the Drawings or as directed by the Engineer. It shall be the responsibility of the Contractor to furnish and install all proper size pipe bends for both horizontal and vertical deflections that are required to construct the pipeline to the line and grade as shown on the construction drawings or as set by the Engineer.

3.5 POLYETHYLENE ENCASEMENT

A. The Contractor shall use Method A of ANSI/AWWA A21.5/C105 to install polyethylene encasement.

3.6 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Test Pipe (other than air lines) per Section 400513 – Common Requirements for Process Piping.

C. Pressure Testing - Air

1. All pressure pipelines conveying process air, flume air or primary air shall be tested by the CONTRACTOR in a manner satisfactory to and witnessed by the ENGINEER.
2. The section under test shall be isolated by airtight plugs or valves from the air blowers and the diffuser headers which shall be tested separately.
3. The pressure and leakage test shall first consist of filling the test section with compressed air to a pressure of 12 psig. The air inlet point shall be sealed and with no further introduction of air, the pipeline shall maintain a pressure of 12 psig for one hour. A

pressure gage supplied by the CONTRACTOR and scaled to twice the test pressure shall be used to indicate the pressure.

4. If the pipeline fails the above test, the CONTRACTOR shall locate and correct all leaks and retest the pipe section until it satisfactorily passes the test.

3.7 DISINFECTION OF POTABLE WATERLINES

A. Following the testing procedure and after all corrections and adjustments have been made, all potable waterlines, both hot and cold water systems, shall be disinfected in strict accordance with the following procedure:

1. Water shall be introduced with a chlorine concentration of at least 50 mg/L. Chlorine shall be added with either a solution feed chlorinator or a hypochlorite feeder. Chlorine application shall continue until the system is filled with the chlorine solution.
2. The chlorinated water shall remain in the system for a minimum of 24 hr while all valves along the system are operated to insure their disinfection. Following the 24 hr period, a residual chlorine test shall be conducted on a fresh sample taken at a point farthest from the point the solution was introduced. If less than 25 mg/L of chlorine is indicated, the system shall be drained and the disinfection procedure repeated.
3. After a chlorine residual of at least 25 mg/L is obtained, the system shall be flushed until the chlorine concentration is equal to or less than 1 mg/L.
4. Disinfection shall conform to ANSI/AWWA C-651, latest revision. The ENGINEER and OWNER shall be notified 48 hours in advance of the disinfection procedure. Also, the flushed solution shall be disposed of as directed by the ENGINEER and OWNER.

END OF SECTION 400519

SECTION 40 05 23 - STAINLESS STEEL PROCESS PIPE AND TUBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stainless-steel pipe, tube, and fittings.
2. Stainless-steel cam and groove couplings.
3. Accessories.

B. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping.

C. Related Requirements:

1. Section 09 96 00 - High-Performance Coatings: Finishes as specified by this Section.
2. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

B. ASME International:

1. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
4. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed.
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
7. ASME B31.3 - Process Piping.
8. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding and Brazing Qualifications.

C. ASTM International:

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
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 A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
5. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
6. ASTM A632 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service.
7. ASTM A778 – Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
8. ASTM A789 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service.
9. ASTM D3308 - Standard Specification for PTFE Resin Skived Tape

D. AWWA

1. AWWA C220 – Stainless-Steel Pipe, ½ In. and Larger
2. AWWA C223 – Fabricated Steel and Stainless Steel Tapping Sleeves
3. AWWA C226 – Stainless-Steel Fittings for Waterworks Service, ½ In. Through 72 In.
4. AWWA C228 – Stainless-Steel Pipe Flanges for Water Service – Sizes 2 in. through 72 in.

E. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

F. The Society for Protective Coatings:

1. SSPC SP-6 - Commercial Blast Cleaning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Felker Brothers.
B. Brismet.
C. TW Metals.
D. Or Approved Equal.
E. All cam and groove couplings shall be as manufactured by PT Coupling, USA.

2.2 STAINLESS-STEEL PIPE, TUBE AND FITTINGS

A. All materials shall be new and unused.

B. Unless otherwise indicated on the drawings, stainless steel pipe shall be Type 304 stainless steel, schedule 10 conforming to AWWA C220.

C. Stainless steel tube shall be Seamless Type 304 stainless steel conforming to ASTM A269.

1. In the event plans/schedule indicate Type 304, the requirements for Type 316 shall be interchangeable with Type 304.

D. All welded pieces shall be shop fabricated.

E. Pipe shall be field assembled using flanges and gaskets where necessary. Field welding will not be allowed without written approval from the Engineer.

F. Fittings shall conform to AWWA C226. Shop-fabricated fittings made from flat-rolled stock, in accordance with ASTM A240 shall be in a solution-annealed condition. Shop fabricated fittings made from pipe shall be in accordance with AWWA C220, ASTM A312 and ASTM A778.

G. Flanges shall conform to AWWA C228.

1. Flanges shall be made from castings, seamless forgings, rolled and welded bar rings, segmented and welded plates, or cut from plate as a single piece.
2. Flanged joints shall be made with bolts, bolt studs with nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same Standard as the flanges.
3. Flanges shall be grade 316, Slip on type, minimum Class D. If service pressure is greater than 150 psi, class shall be rated for the same service pressure as the pipe.
4. Flange faces shall be raised except when bolted to flat face cast iron flanges.
5. Bolting:

a. Bolts and nuts shall be Type 316 stainless steel.
b. Bolts: Comply with ASTM A193, Grade B8M; square head.
c. Nuts: ASTM A194, Grade 8M; hex head.
d. Bolt studs and studs shall be of the same quality as machine bolts.
e. Washers on mating flanges or equipment connections: Same material as bolt

2.3 ACCESSORIES

A. Pipe-Thread Tape:

1. Material: PTFE.
2. Comply with ASTM D3308.

B. O-Ring Seals: EPDM.

C. Flange Gaskets:

1. Gaskets for flat face flanges shall be full face type. Gaskets for raised face flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Gaskets shall be 1/8 in. thick minimum and of following types:

a. Water, Sewage, Sludges (up to 175°F): Red rubber, heavy duty type, by John Crane Co., Morton Grove, IL, - Style 555.
b. Air: High temperature compressed gasketing consisting of organic fibers (Aramid) with SBR binder, Garlock “BLUE-GARD” Style 3200 or equal.

D. Connections with Dissimilar Pipes

1. For stainless steel to ductile iron connections, a weld neck flange can be used on the stainless steel and a megaflange may be used on the ductile iron side. Sufficient gaskets should be used between the nuts or bolts and stainless steel in order to protect the stainless steel.
2. End welding of longitudinal seams shall be performed by manual welding in accordance with AWWA C220-12 Section 4.4.3.4 and 4.4.3.4.1.

2.4 CAM AND GROOVE COUPLING

A. All cam and groove couplings shall be 316 stainless steel and designed for lightweight strength and long lasting durability.

B. Cam and groove couplings shall allow for hose connection without the need for threading tools, lugs, twisting, springs or snaps.

C. Locking arms shall be provided to prevent couplers from leaking or pulling apart during operation.

D. Gaskets and materials shall be selected based on the manufacturer's recommendation and the material being conveyed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with ASME B31.3.

B. Comply with Section 40 05 13 - Common Requirements for Process Piping.

C. Field Cuts: According to pipe manufacturer instructions.

D. Field welding of stainless steel is **not** permitted, without written permission from the Engineer.

3.2 TOLERANCES

A. Piping tolerances shall be per AWWA C220.

3.3 TESTING

A. Test installed components Per Section 40 05 13 – Common Requirements for Process Piping.

END OF SECTION 40 05 23

SECTION 400531 - THERMOPLASTIC PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe, tube, and fittings.
2. Chlorinated polyvinyl chloride (CPVC) pipe and fittings.
3. Acrylonitrile-butadiene-styrene (ABS) pipe and fittings.
4. High Density Polyethylene (HDPE) pipe, tube, and fittings.
5. Accessories for plastic piping and fittings.

B. Related Requirements:

1. Section 331116 - Site Water Utility Distribution Piping: Pipe laying requirements and tolerances, excavation, backfill, and thrust restraints.
2. Section 400513 - Common Work Results for Process Piping: Piping components, appurtenances, and identification requirements common to process piping systems.
3. Section 400523 - Common Work Results for Process Valves: Common product requirements for valves for placement by this Section.
4. Section 400507 - Hangers and Supports for Process Piping and Equipment: Hangers, anchors, sleeves, and sealing of piping to adjacent structures.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
4. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges.
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
7. ASME B31.3 - Process Piping Guide.

B. ASTM International:

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. ASTM D1527 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.

4. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
5. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
6. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
7. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
8. ASTM D2321 – Standard Practice for Underground installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
9. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
10. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
11. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
12. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
13. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
14. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
15. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
16. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
17. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
18. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
19. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
20. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
21. ASTM D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
22. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
23. ASTM D3892 - Standard Practice for Packaging/Packing of Plastics.
24. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
25. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
26. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
27. ASTM F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
28. ASTM F442 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
29. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

30. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
31. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
32. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
33. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
34. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing.
35. ASTM F1290 - Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.
36. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

C. American Water Works Association:

1. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
2. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
3. AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In.
4. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.

D. NSF

1. NSF / ANSI 14 – Plastic Piping and Components and Related Materials
2. NSF/ANSI 61 – Drinking Water System Components – Health Effects.

E. PVC Pipe Association

1. UNI-B-06-Recommended Low-Pressure Air Testing of Installed Sewer Pipe.

1.3 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Temperature: Do not install pipe when temperature is below 40 degrees F (4.4 degrees C) or above 90 degrees F (32.2 degrees C) if pipe is exposed to direct sunlight.

C. Ultraviolet (UV) Protection: Provide pipe installed above ground or outside with UV protection.

PART 2 - PRODUCTS

2.1 PVC PIPE, TUBE, AND FITTINGS

A. Manufacturers:

1. Eslon Thermoplastics; Charlotte, NC
2. R&G Sloane, Sun Valley, CA
3. Harvel Plastics, Easton, PA
4. LCP Chemicals & Plastics, Colfax, NC
5. Bristol Corp., Bristol, IN.
6. Or Approved Equal.

B. PVC Pipe and Fittings (for non-potable service):

1. PVC Pipe shall be ASTM D2241, SDR-21 for pressure service and SDR-26 for gravity service, calculated according to ASTM D2837.
2. Fittings: ASTM D2466, Schedule 40 for gravity service and ASTM D2467, Schedule 80 for pressure service.
3. Joints:
   a. Above ground service will be solvent-welded per ASTM D2855 or threaded or flanged if later removal is required.
   b. Below ground service will be gasketed joint per ASTM D-3139, and the gasket shall be per ASTM F477.
   c. Below ground service for 1.5 inch diameter and smaller shall be solvent-welded per ASTM D2855.
4. Materials: ASTM D1784, minimum cell classification 12545-C.

C. PVC Pipe and Fittings (for potable water service)

1. Pipe: AWWA C900 / AWWA C905, Class 235.
2. Fittings: AWWA C111, cast iron.
3. Joints: ASTM D3139, compression gasket ring.
4. Materials: ASTM D1784, minimum cell classification 12454-C per ASTM D1784.

D. PVC Tube and Fittings:

1. Tube:
   a. Clear.
   b. Size and Wall Thickness: As indicated on Drawings or piping schedule.
   c. Pressure Rating: As indicated on Drawings or piping schedule.

2. Fittings: Compression type; materials suitable for application.
3. Threads: Straight; ASME B1.1.

E. Pipe shall be colored based on applications as follows:

1. Purple – Reclaimed Water
2. Green – Sanitary Sewer Force Main and Gravity Lines
3. White – Non-potable Water

4. Blue – Potable Water

2.2 CPVC PIPE AND FITTINGS

A. Manufacturers:

1. Eslon Thermoplastics; Charlotte, NC
2. R&G Sloane, Sun Valley, CA
3. Harvel Plastics, Easton, PA
4. LCP Chemicals & Plastics, Colfax, NC
5. Bristol Corp., Bristol, IN.
6. Or Approved Equal.

B. CPVC Pipe and Fittings:

1. Pipe: ASTM F442, SDR 13.5 minimum.
2. Fittings:

   a. Flanged: ASME B16.1, ASME B16.5, Class 125.
   b. Socket Welded: ASTM F439, Schedule 80.
   c. Threaded: ASTM F437, Schedule 80; ASME B1.20.1.

3. Joints: Flanged for above ground service, Push-on for below ground service; threaded or flanged if later removal is required.
4. Materials: ASTM D1784, minimum cell classification 23447.

2.3 ABS PIPE AND FITTINGS

A. Manufacturers:

1. Mueller Industries
2. NIBCO Inc.
3. Or Approved Equal.

B. ABS Pipe and Fittings:

1. Pipe: ASTM D1527, Schedule 40 for up to 4” and Schedule 80 for diameters greater than 4”.
2. Fittings:

   a. ASTM D2661; molded; solvent cemented.
   b. Flanged Fittings: ASME B16.1, ASME B16.5, Class 125.
   c. Threaded Fittings: ASME B1.1.

3. Joints: Solvent welded; flanged if later removal is required.
4. Materials: ASTM D3965, minimum cell classification 42222.

2.4 PE PIPE, TUBE, AND FITTINGS

A. Manufacturers:

1. Performance Pipe
2. United States Plastic Corporation
3. Or Approved Equal.

B. Polyethylene Pipe and Fittings (for non-potable service):

1. Pipe: ASTM D2447, SDR 9, calculated according to ASTM D3035.

2. Fittings: Molded; ASTM D3261, butt welded or ASTM D2683, F1056, socket welded.
3. Joints: Socket heat fusion or Butt fusion; threaded or flanged if later removal is required.
4. Materials: ASTM D3350, manufactured from virgin resins with minimum cell classification 324433-C. No recycled compound shall be used except that generated in the manufacturer's own plant from resin of the same specification from the same raw material supplier.

C. Polyethylene Pipe and Fittings (for Potable Water Service):

1. Pipe: AWWA C901 /AWWA C906, DR 13.5 for 160 psig pressure rating.
2. Fittings: AWWA C901, AWWA C906, molded or fabricated.
3. Joints: Butt fusion; threaded or flanged if later removal is required.
4. Materials: ASTM D3350, minimum cell classification 324433-C.

D. Polyethylene Tube and Fittings:

1. Tube:

a. AWWA C901.
b. Size and Wall Thickness: ASTM D2737 or; as indicated on piping schedule.
c. Pressure Rating: As indicated on Drawings or piping schedule.

2. Fittings: Compression type; materials suitable for application.
3. Threads: Straight; ASME B1.1.

2.5 HDPE PIPE, AND FITTINGS

A. Manufacturers:

1. ISCO.
2. JM Eagle.
3. Or Approved Equal.

B. HDPE Pipe and Fittings:

1. Pipe: ASTM F714 or ASTM D3035. DR as shown on the Drawings.
2. Fittings: ASTM D3261, butt welded and fully pressure rated for the same service condition as the pipe.

3. Joints: Butt fusion per ASTM F2620; threaded or flanged if later removal is required.
4. Materials: ASTM D3350, manufactured from virgin resins PE4710 cell classification PC445474C.
5. All HDPE pipe and fittings for potable water service shall be of nominal DIPS (ductile iron pipe size) outside diameter per AWWA C900/C905. The nominal size and DR shall be as shown on the Drawings.

2.6 ACCESSORIES

A. Flange Bolting: Stainless steel, ASTM A193 Grade 8B hex head bolts and ASTM A194 Grade 8 hex head nuts.

B. Flange Gaskets: Full faced, ethylene propylene diene monomer (EPDM), according to ASME B16.21.

C. Push-On Joint Seals: Neoprene rubber gasket, according to ASTM D2241. Manufacturer shall certify that gasket material, solvent cement, and primer are resistant to the chemical being conveyed, where applicable.

D. Solvent Cement:

1. PVC Piping: ASTM D2564.
2. CPVC Piping: ASTM F493.
3. ABS Piping: ASTM D2235

E. Insert Fittings for PE Piping: ASTM D2609.

F. Couplings for PE Piping: ASTM F1055.

G. Tracer Wire: #12 AWG copper clad steel insulated wire, insulation color per pipe service.

H. Detectible Underground Marking Tape: underground marking tape shall be a minimum 3" width, detectable marking tape, with a minimum 5.0 mil overall thickness. Tape shall be manufactured using a 0.8 mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 mil solid aluminum foil core, and then laminated to a 3.75 mil clear virgin polyethylene film. Tape shall be printed using a diagonally striped design for maximum visibility, and meet the APWA Color-Code standard for identification of buried utilities. Detectable marking tape shall be Pro-Line Safety Products or approved equal and made in the USA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping and components according to the following:

1. Section 400513 – Common Requirements for Process Piping
2. ASME B31.3 for above ground service
3. AWWA C605 for potable water service

4. ASTM D2774 for non-potable underground pressure service
5. ASTM D2321 for non-potable underground gravity service

B. Joining:

1. HDPE pipe sections shall be joined on the jobsite above ground into continuous lengths by the Butt-Fusion Method in accordance with ASTM F2620, and in strict accordance with the Manufacturer's Recommendations. Maximum joined drag length is 600-ft.

2. HDPE pipe shall be joined to ductile iron valves and fittings with a DIPS size MJ Adapter Kit. Pipe Stiffeners shall be used to maintain roundness of the pipe. MJ adapter and stiffeners shall be installed in strict accordance with the manufacturer's instructions.

3. Perform heat joining according to ASTM D2657.
4. Perform electrofusion joining according to ASTM F 1290.
5. Primers and Cleaners: ASTM F402.
6. PVC Solvent-Cemented Joints: ASTM D2855.

C. Tracer Wire shall be installed on all non-metallic lines. The contractor shall perform a continuity test on all tracer wire in the presence of the engineer. Tracer wire shall be run along the top of the pipe and secured at intervals of 10' with wire or tape. The tracer wire shall be brought up into all valve and meter boxes so as to be readily accessible to system operators. All wire splices and connections shall be tied and tightly taped with insulated electrical tape.

3.2 A detectable marking tape shall be installed over all nonmetallic lines by the CONTRACTOR. Care will be taken to insure that the buried marking tape will bear the words "CAUTION-PIPE LINE BURIED BELOW." The detectable marking tape will be buried 4 to 6 in. below finish grade. The tape should be placed into backfill and allowed to settle into place in the backfill.

3.3 TESTING:

A. Clean lines by flushing or other means before testing begins.

B. Testing may be dangerous if a line is improperly prepared. The Contractor shall develop and put in place proper safety procedures when performing testing.

C. PE and HDPE pipe for pressure service will be tested in accordance with ASTM F2164-13.

D. PVC pipe for pressure service will be tested in accordance with AWWA C600.

E. Tests for Gravity Service shall include:

1. Infiltration Test:
   a. All lines below the water table shall be checked for infiltration
   b. If at any time prior to expiration of the correction period stipulated in the General Condition, infiltration exists, that is any inflow, and the pipe fails.
   c. The Contractor shall locate the leaks and make repairs as necessary to remove the infiltration.

2. Deflection Testing
   a. Conduct deflection test prior to low-pressure air test.
   b. Perform deflection testing after the final backfill and compaction has been in place at least thirty (30) calendar days and prior to placing lines into operation.
   c. Each reach of pipe shall be checked for excessive deflection by pulling a mandrel through the pipe. The mandrel shall be cylindrical in shape and constructed with 9 evenly spaced arms. The critical dimensions of the mandrel shall have a +/- 0.01 inch tolerance.
   d. Deflection shall not exceed 5% of initial diameter
   e. Pipe failing the deflection test shall be uncovered, and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested.
3. Low Pressure Air Testing
   a. Test each reach with maximum 5 psi
   b. The time elapsed for a 0.5 psi drop in air pressure shall be not less than 10 minutes or as specified in ASTM F1417 or UNI B-6-90 whichever is greater.
4. Joint Testing
   a. For pipes large enough to enter (27” in diameter or larger), individual joints may be pressure tested with a portable tester to 5 psi maximum, with air or water in lieu of low pressure air testing.
   b. Joint Testing shall be performed in accordance with ASTM C1103.

END OF SECTION 400531

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400551 - COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valves.
2. Valve actuators.

B. Conform to the requirements of Section 400551 - Common Requirements for Process Valves

C. Related Requirements:

1. Section 033000 - Cast-in-Place Concrete
2. Section 055000 - Metal Fabrications
3. Section 099113 – Exterior Painting
4. Division 40 – Process Inteconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
3. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International:

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturers Standardization Society:

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges, and Unions.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NFPA:

1. NFPA 70 - National Electrical Code (NEC).

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:

1. Equipment Directory.

1.3 COORDINATION

A. Section 013100 – Project Management and Coordination.

B. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer information for actuator with model number and size indicated.
2. Submit valve cavitation limits.

C. Shop Drawings: Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, and control system schematics.

D. Valve Schedule: Indicating the service, size, and connections, make, model number and any special features such as chain wheel operators, etc.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Certification of Valves Larger than 12 Inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.

H. Manufacturer Instructions: Submit installation instructions and special requirements.

I. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

K. Qualifications Statement:

1. Submit qualifications for manufacturer and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of valves and actuators.

1.6 QUALITY ASSURANCE

A. Maintain clearances as indicated on Drawings and Shop Drawings.

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

D. The manufacturer shall be required to furnish at the time of delivery an affidavit of compliance stating the valve and all materials used conform in every respect to the applicable performance of the appropriate AWWA Standard, and these supplementary specifications and that all tests have been performed with test requirements having been met. Test requirements shall be performed and test records furnished to the engineer prior to shipment.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum twenty years' documented experience

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Prepare valves and accessories for shipment according to latest edition of AWWA C500, Section 31 and:

1. Seal valve ends to prevent entry of foreign matter into valve body.
2. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign matter.

D. Store materials according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
3. Provide additional protection according to manufacturer instructions.

1.9 TOOLS AND SPARE PARTS

A. Provide to the OWNER, one operating wrench for every 10 valves of each type (but not less than 2 wrenches per type), not equipped with hand wheels or levers.

B. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.

B. General:

1. All packing, gaskets, discs, seats, diaphragms, lubricants, etc., shall conform to recommendations of the valve manufacturer for the intended service.
2. All valves shall be manufacturer's standard of the design which the manufacturer recommends for the service intended.
3. Each valve shall bear the maker's name or trademark or reference symbol to indicate the service conditions for which it is guaranteed.
4. All valves for use with copper tubing shall have solder type connections.
5. All screw end valves shall be threaded according to the American Standard for Pipe Threads No. B2.1.
6. Flange end valves shall have connecting end flanges in accordance with the B16.1, Class 125 Series of the American Standards Association for type valves covered in the Standard, and in accordance with the Manufacturer's Standardization Society Standard Practice for bronze valves corresponding to the maximum pressure and service for which the valve is to be used.

C. Valve Ends: Compatible with adjacent piping system.

D. Operation:

1. Open by turning counterclockwise; close by turning clockwise.
2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

E. Valve Marking and Labeling:

1. Marking: Comply with MSS SP-25.
2. Labeling: As specified in Section 400553 - Identification for Process Piping.
3. Provide buried valves with valve boxes, covers, and extensions as specified in Section 331116 - Site Water Utility Distribution Piping.

F. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
2. Bonnets:

   a. Flanged to body and of same material and pressure rating as body.
   b. Furnish glands, packing nuts, or yokes as specified in valve Sections.

3. Stems and Stem Guides:

   a. Materials and Seals: As specified in valve Sections.
   b. Bronze Valve Stems: According to ASTM B584.
   c. Space stem guides 10 feet o.c.
   d. Submerged Stem Guides: Type 304 stainless steel.

4. Nuts and Bolts: As specified in Section 055000 - Metal Fabrications.

G. Valve Type:

1. Plug Valves: As specified in Section 400562 – Plug Valves.
2. Ball Valves: As specified in Section 400563 – Ball Valves.
3. Butterfly Valves: As specified in Section 400564 – Butterfly Valves.
4. Swing and Disc Check Valves: As specified in Section 400565.23 – Swing and Disc Check Valves.
5. Pressure-Regulating Valves: As specified in Section 400567.36 – Pressure-Regulating Valves.
6. Pressure-Relief Valves: As specified in Section 400567.39 – Pressure-Relief Valves.
7. Combination Air Valves for Wastewater Service: As specified in Section 400578.29 – Combination Air Valves for Wastewater Service.

2.2 VALVE ACTUATORS

A. Description: Manual, pneumatic and electric motor actuators.

B. Provide actuators per specification Section 400557 – Actuators for Process Valves and Gates

2.3 INSULATION

A. As specified in Section 404213 - Process Piping Insulation or as indicated on Drawings.

2.4 FINISHES

A. Valve lining and coating: Comply with AWWA C550.

B. Exposed Valves: As specified in Section 099600 - Painting and Coating.

C. Do not coat flange faces of valves unless otherwise specified.

2.5 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013100 – Project Management and Coordination: Requirements for installation examination

B. Verify that piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Valves shall be installed with the stems positioned in the horizontal or above the centerline of the pipe unless otherwise shown on the Drawings.

D. Operators shall be positioned so that they do not interfere with pedestrian traffic.

E. Valve operators which are 7 ft 0 in. or more above the operating floor or platform shall be chain wheel operated.

F. Where necessary for operations as described above, valves shall be bevel or spur gear operated. Plug valve 6 in. and larger shall be gear operated.

G. Coat studs, bolts and nuts with anti-seizing lubricant.

H. Clean field welds of slag and splatter to provide a smooth surface.

I. Install valves with stems upright or horizontal, not inverted.

J. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.

K. All buried valves shall have a 2” operating nut and handwheels for all exposed valves.

L. Install 3/4-inch ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.

M. Install valves with clearance for installation of insulation and to allow access.

N. Provide access where valves and fittings are not accessible.

O. Pipe Hangers and Supports: As specified in Section 400507 - Hangers and Supports for Process Piping.

P. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.

Q. Install insulation as specified in Section 404213 - Process Piping Insulation and as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Valve Field Testing:

1. Test for proper alignment.
2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
3. Architect/Engineer will witness field testing.

END OF SECTION 400551

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400553 - IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Requirements:

1. Section 099600 – High-Performance Coatings
2. Division 40 – Process Integration
3. Division 43- Process Gas and Liquid Handling, Purification and Storage Equipment
4. Division 46 – Water and Wastewater Equipment

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color-coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Samples: Submit one tag, label, and pipe markers for each size used on Project.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirement.

G. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials: Furnish one container of spray-on adhesive.

C. Tools: Furnish special tools and other devices required for Owner to reinstall tags.

1.6 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:

1. Craftmark Pipe Markers
2. Kolbi Pipe Marker Co.
3. Seton Identification Products
4. Approved Equal

A. Description: Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with oval head stainless steel screws or drive pins. Nameplates shall at a minimum contain manufacturers name and address, year of manufacture, serial number, speed (if applicable) and other applicable information.

2.2 TAGS

A. Plastic Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Approved Equal

2. Description:

a. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square.

B. Metal Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Approved Equal

2. Description:

a. Aluminum or Stainless-steel construction; stamped letters.
b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square with finished edges.

C. Information Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Approved Equal

2. Description:

a. Clear plastic with printed DANGER, CAUTION, WARNING, and message.
b. Minimum Tag Size: 3-1/4 by 5-5/8 inch.
c. Furnish grommet and self-locking nylon ties.

3. Tag Chart: Typewritten, letter-size list of applied tags and location, [in anodized aluminum frame.

2.3 STENCILS

A. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Seton Identification Products
c. Approved Equal

B. Description:

1. Clean-cut symbols.
2. Letters:

a. Up to 2-inch Outside Diameter of Insulation or Pipe: 1/2-inch-high letters.
b. 2-1/2- to 6-inch Outside Diameter of Insulation or Pipe: 1-inch-high letters.
c. Over 6-inch Outside Diameter of Insulation or Pipe: 1-3/4-inch-high letters

C. Stencil Paint: As specified in 099113 – Exterior Painting; semigloss enamel.

D. Color-Coding and Lettering Size: Conform to ASME A13.1.

2.4 PIPE MARKERS

A. Color-Coding and Lettering Size: Conform to ASME A13.1.

B. Plastic Pipe Markers:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Seton Identification Products
d. Approved Equal

2. Description:

a. Factory-fabricated, flexible, semirigid plastic.
b. Preformed to fit around pipe or pipe covering.
c. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.

d. Seton Identification Products
e. Approved Equal

2. Description: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:

1. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Seton Identification Products
c. Approved Equal

2. Description:

a. Brightly colored, continuously printed plastic ribbon tape.
b. Minimum 6 inches wide by 4 mil thick.
c. Manufactured for direct burial service.

2.5 LABELS

A. Manufacturers:

a. Brady ID
b. Seton Identification Products
c. Approved Equal

B. Description:

1. Aluminum or Laminated Mylar construction.
2. Minimum Size: 1.9 by 0.75 inches.
3. Adhesive backed, with printed identification and bar code.

2.6 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

a. Brady ID
b. Master Lock Company, LLC
c. Approved Equal

2. Description:

a. Anodized aluminum or Reinforced nylon construction.
b. Furnish hasp with erasable label surface.
c. Minimum Size: 7-1/4 by 3 inches.

B. Valve Lockout Devices:

1. Manufacturers:

a. Brady ID
b. Master Lock Company, LLC
c. Approved Equal

2. Description:

a. Nylon or Steel construction.
b. Furnish device preventing access to valve operator and accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Prepare surfaces as specified in Section 099113 – Exterior Painting for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting as specified in Section 099113 – Exterior Painting.

B. Install identifying devices after completion of coverings and painting.

C. Identify equipment with nameplates.

D. Identify inline pumps and other small devices with tags.

E. Identify control panels and major control components outside panels with plastic nameplates.

F. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

G. Labels:

1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
2. For unfinished covering, apply paint primer before applying labels.

H. Tags:

1. Install tags using corrosion-resistant chain.
2. Number tags consecutively by location.

I. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

J. Identify valves in main and branch piping with tags.

K. Piping:

1. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers and/or stenciled painting.
2. Use tags on piping 3/4-inch diameter and smaller.
3. Identify service, flow direction, and pressure.
4. Install in clear view and align with axis of piping.
5. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

L. Ceiling Tacks:

1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
2. Locate in corner of ceiling panel closest to equipment.

END OF SECTION 400553

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400557 - ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual actuators.
2. Pneumatic actuators.
3. Electric motor actuators.

B. Related Requirements:

1. Section 055000 - Metal Fabrications
2. Section 099600 - High-Performance Coatings
3. Division 40 - Process Integration

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Water Works Association:

1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
2. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
3. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.

C. NFPA:

1. NFPA 70 - National Electrical Code.

1.3 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with installation of valves and accessories.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for actuator with model number and size indicated.

C. Shop Drawings:

1. Indicate parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams, control system, and control system schematics on assembly drawings.
2. Submit actuator Shop Drawings with valve and gate submittal.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit special procedures and placement requirements.

F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and types of actuators.

1.6 QUALITY ASSURANCE

A. Valve Actuators in NEC Class I, Group D, Division 1 for areas where flammable gases, vapors or liquids can exist all of the time or some of the time under normal operating conditions.

B. Valve Actuators in NEC Class I, Group D, Division 2 for areas where flammable gases, vapors or liquids are not likely to exist under normal operating conditions.

C. Locations: Comply with NFPA 70.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers:

1. Dezurik
2. Valmatic
3. Trumbull
4. Clow
5. EIM Limitorque
6. Approved Equivalent

2.2 DESCRIPTION

A. Furnish gear and power actuators with position indicators.

2.3 MANUAL ACTUATORS

A. Gate Valves: Gave valves shall be fitted with cast iron hand wheels of suitable size or gear and hand wheel operators in accordance with AWWA C500.

B. Butterfly Valves: Butterfly valves 3 inches and smaller shall be lever and locking ratchet operated. Butterfly valves 4 inches and larger shall be equipped with gear and hand wheel operators. The operators shall be furnished by the manufacturer of the valve, in accordance with AWWA C504, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operator shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be used.

C. Plug and Ball Valves: Plug and ball valves 3 inches and smaller shall be lever and locking ratchet operated. Plug and ball valves 4 inches and larger shall be provided with gear and hand wheel operators.

D. Provide gear and power actuators with position indicators.

E. Gear-Assisted Manual Actuators:

1. Drive Type: Worm gear except where otherwise shown or specified
2. Provide totally enclosed gears.
3. Gearing: Designed for 100 percent overload.
4. Bearings:

    a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
    b. Permanently lubricated bronze.
    c. Minimum L10 Life: 100,000 hours.
5. Maximum Operating Force: 60 lbf.
6. Handwheel: Minimum 12-inch diameter.
7. Packing: Accessible for adjustment without requiring removal of actuator from valve.

F. Chain Actuators:

1. Description:

    a. Chain actuators for shutoff valves mounted 7 feet and greater above operating floor level.
    b. Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above operating floor level.

2. Chain Wheels: Sprocket rim type.
3. Furnish chain storage if chains may interfere with pedestrian traffic.

G. Buried Valves:

1. Comply with AWWA C500.
2. Floors:

    a. Furnish extension stems to grade, and square nuts or floor stands with position indicators.
    b. Cast-iron/Steel pipe extensions with valve boxes, covers, and operating keys.
    c. Floor Boxes: Hot-dip galvanized cast iron or steel, with bronze cover.
    d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

3. Valve Boxes:

    a. Material: Cast iron.
    b. 12 Inch Diameter Valves and Smaller: Two-piece, screw type.
    c. Valves Larger than 12 Inch Diameter: Three-piece, screw type.
    d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

2.4 ELECTRIC MOTOR ACTUATORS

A. Manufacturers:
1. Auma Actuators, Inc.; Canonsburg, PA
2. EIM Limitorque
3. Beck Actuators; Newtown, PA
4. Approved Equivalent

B. Description:

1. Motor, reduction gearing, torque switches, limit switches, auxiliary hand wheel, starter, mechanical position indicator, and accessories.
2. Comply with AWWA C542.
3. Open-close operation or modulation, as specified, or as shown on the Drawings.
4. Valve closing time will be 60 seconds, unless otherwise noted.
5. Actuators will be capable of operating in an ambient temperature range of -20 to +175 degrees F.
6. All actuators in open/close service will be furnished with integral, motor controls consisting of reversing starters, control transformer, phase discriminator, monitor relay, positioner, “open-stop-close” pushbuttons, “local-off-remote” selector switch in addition to red and green indicating lights. The positioner shall be capable of accepting a 4~20 mADC signal from the controller and positioning the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer mounted inside the actuator. The positioner shall be field adjustable to fail in the “open”, “closed” or “last” position on loss of 4~20 mADC command signal.

C. Enclosure:

1. Minimum NEMA 250 Type 4. When specified, motor and all electrical enclosure shall be available to meet NEMA 6 submersible, or NEMA 7 hazardous requirements.
2. Mounting: Attached actuator housing using flanged motor adapter.

D. Motors:

1. As specified in Section 400593 - Common Motor Requirements for Process Equipment.
2. Type:

    a. Reversing or modulating, as specified, or as shown on the Drawings.
    b. Totally enclosed, non-ventilated, high starting torque, low starting current.
    c. Full-voltage starting.

3. Electrical Characteristics:

    a. Connections: As specified in Division 26 – Electrical.
    b. Torque: A running torque per valve manufacturer's recommendation.
    c. Sufficient horsepower to open or close a valve against the maximum specified differential pressure when voltage to the motor is ±10% of nominal voltage with a factor of safety of 1.5.
    d. Voltage: 480 V, three phase, 60 Hz.
    e. Lubrication: Pre-lubricated.
    f. Bearings Type: Anti-friction
    g. Motor Rating: 30 minute duty.

E. Reduction Gearing:

1. Description: Single- or double-reduction unit of spur or helical gears and worm-gearing.
2. Lubrication: Grease or oil.
3. Bearings:

    a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
    b. Minimum L10 Life: 100,000 hours.

F. Limit Switches:

1. Type: Heavy duty, open contact.
2. Actuation: Rotor cam.
3. Compartment: Totally enclosed and equipped with a heater and thermostat to prevent build-up of moisture and contamination.
4. Switches shall be SPDT and rated 10A at 120 VAC or as specified.
5. Actuating Point: Adjustable at any point of valve between fully open and fully closed.
6. Adjustment: Capable of quick adjustment requiring no more than five (5) turns of the adjustment spindle.
7. Contacts: One set of normally open and one set of normally closed contacts will be furnished and available for use by the plant control system at each end of travel where indicated. Contact shall be of silver and capable of reliably switching a low voltage DC source from the control system furnished by other.

G. Torque Limiting Switches:

1. Torque limiting switches shall be provided.
2. Torque limiting switches shall be responsive to the mechanical torque developed in seating, backseating, or by obstruction.
3. Accuracy: Within ±5%

4. Calibration: The use of torque wrenches for calibration shall not be required. Calibrated by use of a dynamometer in order to accurately predict the output of the actuator.
5. A calibration tag stating the maximum torque output of each torque switch at 100% setting shall be permanently affixed to the torque switch dial.

H. Hand Wheel Operation:

1. A permanently attached hand wheel shall be provided for emergency manual operation.
2. A seized or inoperable motor shall not prevent manual operation.
3. The hand wheel shall not rotate during electrical operation.
4. Maximum Torque Required: 60 lb-ft.
5. Maximum Force Required: 60 lbs.
6. Inscription: An arrow and either the work OPEN or CLOSE shall be cast in the hand wheel to indicate the direction to turn hand wheel.
7. Minimum Diameter: 8 inches.

2.5 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assemblies.

C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Shop Drawings.

3.2 INSTALLATION

A. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.

B. Extend chain actuators to 5-1/2 feet above operating floor level.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating as specified in Section 099600 - High-Performance Coatings.

END OF SECTION 400557

SECTION 40 05 59 - ALUMINUM SLIDE GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Aluminum slide gates.

B. Related Requirements:

1. Section 03 30 00 – Cast-In-Place Concrete
2. Section 05 50 00 – Metal Fabrications
3. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
2. AWWA C542 - Electric Motor Operators for Valves and Slide Gates.
3. AWWA C562 - Fabricated Aluminum Slide Gates.

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination

B. Coordinate Work of this Section with Work of other Sections.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's product information for system materials and component equipment.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation and anchoring requirements, fasteners, and other details.
3. Indicate gate identification number, location, service, type, size, design pressure, operator details, stem details, and loads.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Certify that installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports:

1. Certify that equipment has been installed according to manufacturer's instructions.
2. Indicate activities on Site, adverse findings, and recommendations.

I. Qualifications Statements:

1. Submit qualifications for manufacturer and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed slide gates and components.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

C. Tools: Furnish special tools, wrenches, etc. and other devices required for Owner to maintain equipment.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging, and inspect for damage.

C. Store materials according to manufacturer's instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from areas involved in construction operations.
2. Provide additional protection according to manufacturer's instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

C. Furnish five year manufacturer's warranty that clear plastic stem covers will not crack, discolor, or become opaque.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Seating/Unseating Pressure:

1. Measurement: From maximum water surface to centerline of gate.

B. Minimum Vertical Loading: 50 percent of force on the gate from operating head acting on horizontal centerline of gate, multiplied by effective gate area, plus weight of slide and stem.

C. Gate Reinforcement: As required for deflection not greater than 1/360 of span.

D. Operating Head:

1. Safety Factor: Design gate to operate under specified operating head with safety factory of three.

2.2 ALUMINUM SLIDE GATES

A. Manufacturers:

1. Whipps, Inc.
2. Waterman Industries
3. Hydro Gate
4. Golden Harvest, Inc.
5. Or Approved Equal

B. Description:

1. Comply with AWWAC562.
2. Self-contained aluminum slide gate, with extended frame, stiffeners, yoke, lifting stem attached to yoke, lift and lift support, stem, stem guide, and stem block.
3. Non-self-contained aluminum slide gate, with limited frame, lifting stem, lift and lift support, stem, stem guide, and stem block.
4. Size, Operating Head, Closure and Opening are as indicated on Gate Schedule in Drawings.

C. Gates:

1. Location: See P&ID drawings and P&ID valve schedule drawing.

2. Configuration:

   a. One piece.
   b. Removable.

3. Material:

   a. Type 6061-T6 aluminum.
   b. Comply with AWWA C562.

4. Minimum Thickness: 1/4 inch.
5. Size: As indicated on Drawings.

D. Yokes:

1. Material: Structural steel.
2. Mounting: Bolted to gate frame.

E. Seats:

1. Impacted into dovetail slots and held in position without use of screws or other fasteners.
2. Maximum Clearance between Seating Faces: 0.004 inch when gate is fully closed.

F. Wedges:

1. Description: Machined brass blocks with angled faces and secured with a stud bolt to prevent slippage during operation.
2. Provide side, top, and bottom wedges.

G. Frames:

1. Configuration: One piece.
2. Material:

   a. Type 6061-T6 extruded aluminum.
   b. Comply with AWWA C562.
   c. Bearing Bars: Ultra-high-molecular-weight polymer.

3. Mounting: As indicated on Drawings.
4. Minimum Thickness: 1/4 inch.
5. Liner: One-piece, extruded polymer channel or Neoprene rubber seal.
6. Bottom Flush Closure: Resilient seal securely attached to frame along invert.
7. Seal: UHMW seat / seal.

H. Lifting Devices:

1. Description: Stem, lifting nut, supports, bushings, stem cover, position indicator, gear-assisted handwheel, handwheel, gear-assisted crank, crank, pneumatic actuator, hydraulic actuator and electric-motor actuator.
2. Mounting: Fabricated 304 stainless steel pedestal.
3. Powered Lift Devices:

   a. As specified in Section 40 05 57 – Actuators for Process Valves and Gates.
   b. Comply with AWWA C541 and AWWA C542.

4. Hand-Lifted Gates: Provide PVC grip for hand hole or stainless-steel lifting handle.

I. Handwheel:

1. Material: Cast aluminum.
2. Diameter: 18 inches, minimum.
3. Fully lubricated.
4. Configuration: Removable.
5. Mounting: Locate center of handwheel 36 inches above operating floor.

J. Lifting Nut:

1. Material: Brass.
2. Furnish grease fitting.
3. Furnish polymer bearing pads above and below lifting nut.

K. Lifting Stem:

1. General:

   a. Stems shall be designed to transmit in compression a minimum of two times the rated output of the hoist at 40 lbs. effort on the crank or handwheel. The L/r ratio of the unsupported stem shall not exceed 200.
   b. Stem guides, where required to limit the unsupported stem length, shall have a polymer or bronze bushings.

2. Material: Type 304 stainless steel.
3. Configuration:

    a. Rising or Nonrising.
    b. Removable.

4. Thread:

    a. Acme, double lead.
    b. Cut threads are not acceptable.

5. Fully lubricated.
6. Diameter: 1-1/8 inch
7. Maximum Number of Turns: 16 per foot of travel.
8. Stem Covers: Provide rising stem gates with clear polycarbonate or methacrylate plastic covers, capped, vented, and of a length to allow full travel of gate.

2.3 FINISHES

A. Stainless-Steel Surfaces: Mill finish.

2.4 ACCESSORIES

A. Hardware: Type 316 stainless steel.

B. Nameplates: As specified in Section 40 05 53 - Identification for Process Piping.

2.5 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assemblies.

C. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that facilities are ready to receive slide gates.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Clean surfaces according to manufacturer's instructions.

3.3 INSTALLATION

A. Install slide gates according to manufacturer's instructions.

B. Ensure that products are installed plumb, true, and free of warp or twist.

C. Locate operators to avoid interference with handrails and other work.

D. Guides:

1. Surface and Flange Mounted:

a. Install guides with expansion anchors.
b. Position guides at elevation as indicated on Drawings.

2. Recessed:

a. Cut slot in concrete to receive guides.
b. Position guides at elevation as indicated on Drawings.
c. Aluminum frames in contact with concrete or grout shall be coated with bitumestic.
d. Grout guides in place according to manufacturer's instructions.

E. Sealant:

1. Apply 1/8-inch-thick layer of elastomeric sealant to back of frame.
2. Tighten nuts snug until sealant begins to flow beyond frame.
3. Remove excess sealant.
4. Cure sealant for minimum seven days.
5. Tighten nuts to their final positions.

F. Lubricants: Provide oil and grease as required for initial operation.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspection:

1. Verify alignment of gate and components.
2. Verify that gate operates smoothly and does not bind or scrape.

D. Testing:

1. Comply with AWWA C501.
2. Leakage: Not exceeding 0.1 gpm/ft. of seating perimeter under 20 feet of seating head and not exceeding 0.21 gpm/ft. under 20 feet of unseating head.

E. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two (2) days on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

F. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and re-inspect.
2. Make final adjustments to equipment under direction of manufacturer's representative.

G. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Adjust slide gates to provide smooth operation.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment operation, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 05 59

SECTION 400562 - PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Eccentric plug valves.

B. Conform to the requirements of Section 400551 - Common Requirements for Process Valves

C. Related Requirements:
1. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
4. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.

C. ASTM International:

1. ASTM A536 - Standard Specification for Ductile Iron Castings.
2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

PART 2 - PRODUCTS

2.1 ECCENTRIC PLUG VALVES

A. Manufacturers:

1. M and H: Anniston, AL
2. Henry Pratt Company; Aurora, IL
3. DeZurick; Sartell, MN
4. Val-Matic; Elmhurst, IL
5. Or approved equal

B. Description:

1. Type:

    a. Non-lubricated.
    b. Eccentric.
    c. 90 Degree Turn
    d. Resilient faced Plug

2. Working Pressure: 175 psig for valves through 12” and 150 psig for valves for 14” through 72”.

3. Ports:

    a. Configuration: Rectangular.
    b. Minimum Port Area: 100 percent of nominal pipe area for valves.

4. Stem Bearings: Self-lubricating.
5. Stem Seals:

    a. Type: V-ring.
    b. Material: Neoprene.

6. Packing and Gland: Accessible and externally adjustable.
7. End Connections:

    a. Flanged: Comply with ANSI 125/150 lb. Standard
    b. Mechanical Joint

C. Operation:

1. As specified in Section 400557 Actuators for Process Valves and Gates.

D. Materials:

1. Body:

    a. Cast iron, ASTM A126 Class B.
    b. Lining: As recommended by valve manufacturer for service conditions.

2. Plug:

    a. Ductile iron, ASTM A126 Class B.
    b. Lining: Synthetic viton compound of a minimum of 70 durometer hardness.

3. Seats: 1/8”, welded, 90% pure Nickel.
4. Stem: Type 316 stainless steel.
5. Stem Bearings: Type 316L stainless steel.
6. Seals: Buna-N.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 400551 - Common Requirements for Process Valves.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 400551 - Common Requirements for Process Valves.

C. Testing: Test gate valves according to AWWA C509.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 400551 - Common Requirements for Process Valves

B. According to AWWA C517.

C. Horizontal Piping: Stem horizontal.

D. Vertical Piping: Plug at top when closed.

E. Plugs: On top when open and on pressure side when closed.

END OF SECTION 400562

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400563 - BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rubber-seated ball valves.
2. PTFE-seated ball valves
3. Plastic ball valves.

B. Conform to requirements of Section 400551 – Common Requirements for Process Valves

C. Related Requirements:
1. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C507 - Ball Valves, 6 In. Through 60 In.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3.
4. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
2. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

PART 2 - PRODUCTS

2.1 RUBBER-SEATED BALL VALVES

A. Manufacturers:

1. Henry Pratt Company - Aurora, IL.
2. Valtorc – Kennesaw, Ga.
3. Apollo – Matthews, NC
4. Approved Equal.

B. Smaller Than 4 Inches:

1. Comply with MSS SP 110.
2. Working Pressure: 150 psig at 90 deg. F.
3. Maximum Process Fluid Temperature: 90 deg. F.
4. Body:

    a. Type: Two piece.
    b. Material: Bronze.

5. Ball: Stainless steel.
6. Port: Regular.
7. Seats: Buna-N.
8. Stem: Blowout proof.
9. End Connections: Threaded, with union.
10. Operator: Hand lever.
11. Finishes: As specified in Section 400551 - Common Requirements for Process Valves.

2.2 PTFE-SEATED BALL VALVES

A. Manufacturers:

1. Apollo
2. Assured Automation
3. NIBCO
4. Approved Equal

B. 2 Inches and smaller:

1. MSS SP110 Compliant
2. Stainless steel or Bronze ball as called for on Drawings or specified otherwise.
3. Full-Port Design
4. Polytetrafluoroethylene PTFE Seat
5. 600 psig CWP, Non-Shock
6. Blowout-Proof Stem Design
7. Threaded or solder end connections
8. Hand lever operator

2.3 PLASTIC BALL VALVES

A. Manufacturers:

1. Hayward
2. NIBCO
3. Asahi/American
4. Approved Equal

B. Description:

1. Working Pressure: 232 psig at 68 deg. F.
2. Ports: Full size.
3. End Connections:

a. Socket Union
b. Threaded Pipe Union.

C. Operator: Manual unless otherwise specified or shown.

D. Materials:
1. Body and Ball: PVC, CPVC, PP as specified, shown on drawings, or recommended by the manufacturer for the service conditions specified.
2. Seats: PTFE.

2.4 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 400551 - Common Requirements for Process Valves.

C. Testing: Test ball valves according to AWWA C507.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 400551 - Common Requirements for Process Valves

B. According to AWWA C507

END OF SECTION 400563

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 05 64 - BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber-seated butterfly valves.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C504 - Rubber-Seated Butterfly Valves.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM A536 - Standard Specification for Ductile Iron Castings.
2. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3. ASTM D3222 - Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
4. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

PART 2 - PRODUCTS

2.1 RUBBER-SEATED BUTTERFLY VALVES

A. Manufacturers:

1. Milliken; Henry Pratt Company, Aurora, IL
2. DeZurik, Sartell, MN

3. GA Industries
4. Or approved equal

B. Description:

1. Comply with AWWA C504, Class 150.
2. Minimum Working Pressure: 150 psig.
3. Shaft: Bearings shall be non-metallic and permanently lubricated.
4. Seats:

   a. Mounting: On body for valves 24 inches and smaller.
   b. Type: Field replaceable for valves larger than 30 inches.

5. Packing: V-type packing with a minimum of 4 sealing rings or multiple U-cups.
6. End Connections: Flanged end valves of short body design with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

C. Operator:

1. As specified in Section 40 05 57 – Actuators for Process Valves and Gates
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

D. Materials:

1. Body: Cast iron, ASTM A126 or ductile iron, ASTM A536 Grade 65-45-12.
2. Stem: Stainless steel.
3. Disc: Cast iron, ASTM A48, Class 4C or ductile iron, ASTM A536 Grade 65-45-12
4. Seats:

   a. Type: Resilient..
   b. Material: Buna N or EPDM for water, or as required for other services

5. Seating Surfaces: Type 316 stainless steel.
6. Bearings: Non-metallic and permanently lubricated.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 09 96 00 – High-Performance Coatings.

2.2 BUTTERFLY VALVES FOR AIR SERVICE

A. Manufacturers:

1. M and H: Anniston, AL
2. Henry Pratt Company; Aurora, IL
3. DeZurik; Sartell, MN
4. GA Industries
5. Or approved equal

B. Description:

1. Comply with AWWA C504, Class 150.
2. Minimum Working Pressure: 175 psig.
3. Shaft: Bearings shall be non-metallic and permanently lubricated.
4. Seats:

    a. Mounting: On body for valves 24 inches and smaller.
    b. Type: Field replaceable for valves larger than 30 inches.

5. Packing: V-type packing with a minimum of 4 sealing rings or multiple U-cups.
6. End Connections: Flanged end valves of short body design with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

C. Operator:

1. As specified in Section 40 05 57 – Actuators for Process Valves and Gates
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

D. Materials:

1. Body: Cast iron, ASTM A126 or ductile iron, ASTM A536 Grade 65-45-12.
2. Stem: Stainless steel.
3. Disc: Cast iron, ASTM A48, Class 4C with welded nickel edge or ductile iron, ASTM A536 Grade 65-45-12 with 316 stainless steel edge.
4. Seats:

    a. Type: Resilient.
    b. Material: EPDM for up to 250F air service.

5. Seating Surfaces: Type 316 stainless steel.
6. Bearings: Non-metallic and permanently lubricated.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 40 05 51 - Common Requirements for Process Valves.

C. Testing: Test butterfly valves according to AWWA C504.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves

B. According to AWWA C504.

END OF SECTION 40 05 64

SECTION 400565.23 - SWING AND DISC CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Swing check valves 3 inches and larger.

B. Conform to the requirements of Section 400551 – Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm through 600-mm) NPS.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.

PART 2 - PRODUCTS

2.1 STANDARD SWING CHECK VALVES

A. Manufacturers:

1. DeZurik
2. GA Industries, Inc.
3. Henry Pratt Company

4. Kennedy Valve Company
5. Crispin Valves; Berwick, PA
6. Or Approved Equal

B. Description:

1. Comply with AWWA C508
2. Minimum Working Pressure: 200 psig for 2” - 12” and 150 psig for 14” - 30”
3. Type: Swing, resilient seated with outside lever and adjustable weight.
4. Mounting: Horizontal or vertical.
5. End Connections: Integral flange ends shall be ANSI B16.1 Class 125, suitable for horizontal or vertical installation

C. Materials:

1. Body and Cover: Ductile iron, ASTM A536.
2. Disc, Disc Arm: Ductile iron, ASTM A536
3. Body Seat: Replaceable, Type 316 ASTM A276 with Buna-N renewable seat ring
4. Shaft: Type 303 Stainless Steel ASTM A582
5. Disc Seat: Buna-N
6. Lever and Counterweight: Ductile Iron, ASTM A536
7. Hinge Pin and Key: Type 316 Stainless Steel
8. Rubber Components: Buna-N
9. Connecting Hardware: Type 304 stainless steel.

D. Finishes: As specified in Section 400551 - Common Requirements for Process Valves.

2.2 SYNTHETIC DISC CHECK VALVE

A. Manufacturers:

1. Valmatic
2. Or Approved Equal

B. Description:

1. Comply with AWWA C508
2. Minimum Working Pressure: 200 psig for 2” - 12” and 150 psig for 14” - 30”
3. Type: Swing, flexible disc check valve, full body flow type.
4. Mounting: Horizontal or vertical.
5. End Connections: Integral flange ends shall be ANSI B16.1 Class 125, suitable for horizontal or vertical installation

C. Materials:

1. Body and Cover: Ductile iron, ASTM A536.
2. Disc: Precision molded Buna-N ASTM D2000
3. Epoxy Coated Interior
4. Screw-Type Stainless Steel backflow actuator

5. Mechanical Position indicator
6. Open-Close position indicator limit switch

D. Finishes: As specified in Section 400551 - Common Requirements for Process Valves.

2.3 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:

1. Hydrostatically test check valves at twice rated pressure according to AWWA C508.
2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 400551 - Common Requirements for Process Valves

B. According to AWWA C508.

END OF SECTION 400565.23

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400578.21 - AIR RELEASE VALVES FOR WASTEWATER SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Air release valves for wastewater treatment facilities.

1.2 SUBMITTALS

A. Product Data: Manufacturer catalog information.

B. Shop Drawings: Assembly drawings indicating materials, dimensions, weights, and end connections.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

D. Manufacturer Instructions: Special procedures and setting dimensions.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Qualifications for manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this Section with five (5) years' experience. Valve shall be manufactured per ANSI/ AWWA C512.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials according to manufacturer instructions.

B. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.5 WARRANTY

A. Furnish five (5) year manufacturer's warranty for air release valves.

PART 2 - PRODUCTS

2.1 AIR RELEASE VALVES FOR WASTEWATER SERVICE

A. Manufacturers:

1. GA Industries, APCO Valve Corporation, Crispin, Henry Pratt, or Val-Matic.
2. Substitutions: Permitted.

B. Description:

1. Stems and Bodies: Long-float type.
2. Furnish blowoff valve, inlet shutoff valve, water inlet valve, quick-disconnect couplings, and minimum 5 feet of hose.

C. Materials:

1. Body and Cover: ASTM A126 Class B cast iron, or ASTM A536 Grade 65-45-12 ductile iron.
2. Float, Seat, and Trim: Type 316 stainless steel.

D. Working Pressure: 150 psig.

E. Size: 2 – 4 Inch.

F. End Connections: NPT inlets and outlets.

2.2 INSULATION

A. As specified in Section 404213 - Process Piping Insulation or indicated.

2.3 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Section 099113 – Exterior Painting.

2.4 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field dimensions are as indicated.

B. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flanges mate properly.

3.2 PREPARATION

A. Thoroughly clean end connections before installation.

B. Close pipe and equipment openings with caps or plugs during installation.

C. Cleaning: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to manufacturer instructions.

B. Provide access for operation, removal, and maintenance, and to avoid discharge to occupied areas or other equipment.

3.4 FIELD QUALITY CONTROL

A. Inspection: After installation, inspect for interferences and proper supports.

B. Testing:

1. Demonstrate operation without undue noise or vibration.

C. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.5 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 400578.21

SECTION 40 70 00

INSTRUMENTATION DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Primary elements.

B. Transmitters.

C. Receivers.

D. Analytical instruments.

E. Devices.

F. Cables.

1.2 SYSTEM DESCRIPTION

A. System consists of all field and panel mounted instrumentation devices as noted, complete with all necessary signal converters, isolators, amplifiers, power supplies, cables and other appurtenances necessary for interfacing with other components.

B. Except as noted, scale all indicators in engineering units.

1.3 SUBMITTALS

A. Submit product data.

1.4 MAINTENANCE AND TEST EQUIPMENT

A. In addition to the tools and test equipment, provide the following complete with carrying cases, patch cords, etc.

1. One portable admittance tester with rechargeable batteries as manufactured by Drexelbrook or equal, to calibrate the admittance instruments provided.

2. One pneumatic calibrator as manufactured by Wallace & Tiernan, Meriam Instrument, or equal.

3. One (1) hand held smart transmitter calibrators shall be provided by the transmitter manufacturer to calibrate all smart field transmitters provided.

B. Spare Parts

1. Miscellaneous Spare Parts

a. One year supply of items recommended by the Manufacturer of the equipment for each component.

2. The spares shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperature.

3. Provide other spare parts as indicated on the individual device specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTS AND DEVICES

A. Level Transmitters (Flow Measurements) – Ultrasonic

1. Type: Microprocessor based ultrasonic level transmitter. Unit shall have input or output filter capability.
2. Sensor: Sensors shall have minimum 26 foot range and shall be supplied with sufficient cable length for arrangement indicated. Sensor shall have a NEMA 4X (minimum) enclosure. Unit shall be supplied with automatic temperature compensation as required below. Sensor face material shall be Kynar or Teflon as required.

3. Accuracy: ± 1.0 percent of calibrated range or better for ranges greater than 25-inches (with temperature compensation).

4. Output: Isolated 4-20 mADC into loop loads of 0 to 500 ohms (minimum), two (2) Form "C" Relay Contacts rated at 5A, 250 VAC, non-inductive.

5. Enclosure: NEMA 4X, polycarbonate or fiberglass.

6. Power Supply: 120 VAC

7. Mounting: The System Manufacturer shall coordinate mounting to ensure that the sensor is mounted away from vessel walls and other obstructions in accordance with the manufacturer's recommendations. All chemical storage tank sensors shall have Teflon face suitable for 4" flange mounting. The System Manufacturer shall provide appropriate standoff distance for sensor face from the highest liquid level to accommodate blanking distance.

8. Acceptable Manufacturers: Equal to Milltronics (Hydro-Ranger 200), Endress & Hauser (Prosonic), Systematic Controls, or STI.

B. Level Transmitter (Submersible Head-Type)

1. Type: Pressure sensor
2. Transmitter: Control box with Local LED display of level in Feet and built-in power supply to convert 110/1/60 to 24 VDC for pressure sensor loop power. Control box to have one or two displays as required.
   a. Outputs: one or two 4-20 mA outputs
   b. Accuracy: 0.3% of full range
   c. Enclosure: NEMA 4X, polycarbonate housing
   d. Power Supply: 120VAC, 1 PH, 60 HZ
3. Sensor: 316SS sensor housing and pressure sensor diaphragm with 33' of viton cable. Polarity independent leads for 24 VDC powered loop from transmitter. Atmospheric compensation tube built into cable. Range as specified on instrument chart.
4. Cleaning: Not required
5. Transmitter (Control Box) Mounting: mounted to 1/8" aluminum mounting plate with drip lid and SS hinged opaque sun shield.
6. Sensor Mountings:

a. PVC hanger with minimum of 4" of cable contact and SS cable for hanging to eye bolt on side of tank or as specified on instrument chart.

b. Slide Rail Mounting: Sensor supplied with two SS clips and 19" long SS Slide rail for wall mounting

7. Start-Up: provide minimum of 2 hours/meter of service by factory-authorized representative for system start-up plus ½ day of training.

8. Acceptable Manufacturer: Endress & Hauser Waterpilot FMX 21 model of approved equal.

C. Level Switch (Float Type)

1. Type: Submersible coated 316 stainless steel, polypropylene, or polyethylene body; non-mercury switch contact rated 4 amps at 120 VAC; normally open, normally closed, or Form C (N.O. and N.C.) contact configuration as indicated. Mercury float switches are unacceptable.

2. Cable: Minimum 18 gauge, 300 volt (minimum) rated; heavy-duty type SOW or equivalent. Provide sufficient length for mounting at the elevations indicated.

3. Junction Box: Provide NEMA 4X stainless steel junction box, mounted near the switch, for terminating vendor supplied cable and discrete control wiring to control panel.

4. Switch Mounting: The System Manufacturer shall provide 3/4 or 1 inch Schedule 40 PVC, 316 stainless steel pipe, or 1.25 inch cable for mounting the floats for a particular tank or well. The pipe shall extend from two feet above the highest switch setting (up to the top of the vessel) to two feet below the lowest level setting (down to the vessel bottom) for the vessel or well and allow for adjustment of the switch or switches anywhere along the length of the pipe. The method for fixing the float to the pipe shall be easily adjustable and shall provide for protection and strain relief for the float switch cable. Provide a minimum of two mounting brackets for fixing the pipe to the vessel wall while maintaining appropriate standoff distance. The System Manufacturer shall ensure mounting is in accordance with the manufacturer's recommendations.

5. Spare Parts: Provide 2 spare float switches.

6. Acceptable Manufacturers: Equal to Warrick Series M, Anchor Scientific.

D. Pressure and Vacuum Gauges

1. General: Pressure and vacuum gauges shall, unless otherwise specified, conform to the following. Gauges shall be of the stem-mounting type unless panel-mounted type is shown on the Schedule. Refer to Section 15100 – Valves, for additional requirements.

2. Construction: Gauges shall be of the bourdon tube or bellows type with 270 degrees clockwise pointer travel. Dials shall be white with black numerals. Dial size shall be 4 1/2-inch. Panel-mounted gauges shall have round bezels for flush mounting and rear connection, others shall have a stem-mounting bottom connection. Connections for all gauges shall be male 1/2-inch NPT with square wrench flats. Wetted parts shall be corrosion-resistant to the process fluid shown in the Table A and unless specified in the Table A shall be the manufacturer's best quality standard. All dials shall be glycerin filled, hermetically sealed. Cases shall be black phenolic. Accuracy shall be ±0.5% of span.

3. Chemical Seal: Where used for sewage or sludge service, the gauge shall be furnished with a diaphragm seal unless specified elsewhere. Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing. The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its

measuring element from the process fluid. The space between the diaphragm and the instruments pressure element shall be completely filled with a suitable fill liquid – defaulting to silicone oil. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch or any other pressure instrument. The diaphragm seal shall have a removable bottom housing to permit the servicing of the need to refill. All exposed surfaces, top and bottom housings, and diaphragm shall be constructed of Type 316 stainless steel as a minimum and shall be compatible with the process fluid. The process connection shall be a 3/4-inch threaded connection with a flushing connection.

4. Manufacturers: The gauges shall be as manufactured by Ashcroft Duraguage, U.S. Gauge, or user approved equal. The diaphragm seals shall be as manufactured by Ashcroft 200 series, Mansfield and Green SG Series, or approved equal.

E. In-Line Pressure Seal

1. Where specified provide a pressure isolating ring that uses a elastomer membrane to isolate a pressure measurement from the process fluid in the pipeline. The membrane/diaphragm shall be provide direct contact with the process fluid but shall isolate the pressure measurement from the effects of solids, abrasives and slurries in the pipe line that would clog standard pressure sensing lines.
2. The pressure sensed by the membrane shall be transmitted to the associated pressure sensor, gauges, and/or transmitter via use of a suitable fill fluid – defaulting to silicone oil. Any air between the membrane and the associated pressure devices shall be fully evacuated during the filling process.
3. Inside diameter of the measuring membrane shall match the inside diameter of the associated pipeline.
4. Manufacturers: The in-line pressure seal shall be manufactured by Onxy Valve, Red Valve, or approved equal.

2.2 CABLES

A. Fiber Optic Cable

1. Fiber optic cable shall be optic multimode, loose tube, all-dielectric cable, Siemens, Nordx/CDT, Belden, or approved equal, and meet the following specifications:

Cladding Diameter	125.0 Microns
Core Diameter	62.5 Microns
Attenuation Range	≤0.8 dB/KM at 1300 NM ≤3.1 dB/KM at 850 NM
Bandwidth Range	≥600 Mhz-KM at 1300 NM ≥200 Mhz at 850 NM
Cable Construction	Splitable outdoor cable
Core Type	Hollow core, filled
Materials	
– basic element	PVC, gray
– strain relief	Kevlar fibers and impregnated glass

- outer sheath/cable color PVC black

Mechanical Characteristics

- dimensions of basic element (3.5 ± 0.2) mm dia
- cable dimensions (6.3 X 9.8) ± 0.4 mm
- cable weight approx. 65 kg/km
- permissible tensile load ≤ 500 N (short time)
- bending radii ≥ 100 mm Over flat side only

Permissible Ambient Conditions

- laying and installation temp. -5°C to +50°C
- operating temperature -25°C to +60°C
- storage temperature -25°C to +70°C

Cable shall be compliant with EIA, ANSI Standards, graded index. All fibers must be color coded for easy identification with all-dielectric construction. All cables shall be of an insulation type rated for the purpose of installation. Where shown on Contract Drawings all fiber optic conduit run shall contain redundant 24 strand fiber optic cables as specified in this section.

2. Connector Type BFOC
3. Coordinate the exact fiber cable requirement with the SCADA system integrator.

B. Industrial Twisted Pair (ITP) 100 Mb Fast Ethernet Cables

1. ITP cable shall have two cores stranded with two dummy elements to form a pair.
2. Each pair shall be sheathed in plastic film and shielded with two plastic-clad aluminum foils.
3. The outer shield braid shall be made of tinned copper wires around all pairs.
4. The plastic sheath shall be PVC.
5. The ITP cable shall be a standard 9 pin cable with RJ45 type connectors.
6. ITP Cables shall be Siemens Industrial Twisted Pair standard cable or equal by AT&T or Belden.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Instrument Tagging

1. Provide stainless steel identification tags attached with stainless steel wire or screws for all field instruments.

3.2 FIELD QUALITY CONTROL

A. Tests And Calibration

1. Perform continuity and insulation resistance tests on instrumentation conductors.

2. Calibrate each instrument to its published accuracy. Submit calibration sheets including the instrument tag number or name, the date, name of individual performing calibration, procedures and equipment used, and results obtained.

END OF SECTION

SECTION 40 71 13 - MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Magnetic flow meters.
2. Transmitters.
3. Indicators.
4. Recorders.
5. Integrators.

B. Related Requirements:

1. Division 26 - Electrical: Wiring requirements.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
2. AWWA M33 - Flowmeters in Water Supply.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with Div. 33.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store equipment according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish manufacturer's warranty for magnetic flow meters and appurtenant devices.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Furnish sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, interconnecting cables, and unit conversions and algorithms as required for application.

2.2 MAGNETIC FLOW METERS

A. Manufacturers:

1. Rosemount
2. Siemens
3. Endress-Hauser – Promag

B. Description: Low-frequency, electromagnetic induction-type flow meter, producing a linear signal directly proportional to flow rate, consisting of flow tube, signal cable, and transmitter.

C. Performance and Design Criteria:

1. Conform to AWWA M33 (AWWA C751).

2. Designed for IP68 indefinite submergence with factory potting construction.

D. Flow Rate Range: As indicated in schedule in Section 3.5.

E. Size: As indicated in schedule in Section 3.5.

F. Flow Tubes:

1. Material: Type 304 stainless steel with polyurethane liner.
2. Length: As indicated on Drawings
3. End Connections: Flanged, ASME B16.1, carbon steel.

G. Electrodes:

1. Type 316L stainless steel.
2. Self-cleaning.

H. Accuracy: Plus or minus 1 percent of actual flow rate over a 10:1 range.

I. Provide adjustment for zero and span.

J. Accessories:

1. Provide automatic, non-mechanical electrode cleaning system without taking meter out of service.
2. Furnish cable between transmitter and receiver.

2.3 TRANSMITTERS

A. Transmitter Output:

1. 4- to 20-mA dc analog signal.
2. Accuracy: Plus or minus 0.25 percent of full scale.

B. Housing Material: Cast aluminum.

C. HMI:

1. Touch-screen programming, functioning through enclosure window without opening enclosure.
2. Display:

a. Size: Four lines by 16 characters.
b. Type: Backlit digital display.
c. User-selectable engineering units.
d. Readout of diagnostic error messages.

D. Mounting:

1. Integral or remote mounting up to 30 feet from flow meter.
2. Mounting Locations Less Than 4 Feet above Grade: Provide stainless-steel mounting posts.

E. Transmitter Communication Interface: PROFIBUS, 4-20mA HART, Modbus RS485 or EtherNet/IP.

F. Accessories:

1. Current signal output simulation.
2. Empty pipe detection.
3. Self-diagnostics.
4. Automatic zero adjustment.
5. Stainless-steel sunshield.
6. Signal Cable: Provided by flow meter manufacturer.

2.4 INDICATORS

A. Manufacturers:

1. Rosemount
2. Siemens
3. Endress-Hauser

B. Description:

1. Integrally mounted in transmitter housing.
2. Scale: Graduated.
3. Units: 2 gpm
4. Mounting: Panel.

2.5 INTEGRATORS

A. Manufacturers:

1. Rosemount
2. Siemens
3. Endress-Hauser

B. Description:

1. Totalize flow in specified units.
2. Interface with specified flow meter assembly.
3. Accuracy: Plus or minus 0.25 percent of full scale.

2.6 OPERATION

A. Control Power:

1. Wiring: As specified in Division 26 - Electrical.
2. 120-V ac, single phase, 60 Hz.
3. Furnish local transformers as required.

B. Enclosures: NEMA 250 Type 4X.

2.7 REQUIRED INSTRUMENTS

A. FE/FIT 1050
B. FE/FIT 2050

2.8 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of meters according to AWWA M6.

C. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

D. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

2.9 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be certified for use in hazardous areas, independent of the output protocol selected.

C. At a minimum, the device shall allow installation in a Class I, Division 2, Group A to D as a non-incendive design.

D. All devices shall be suitable for use as non-incendive devices when used with appropriate non-incendive associated equipment.

E. Electrical equipment housing shall conform to NEMA 4X classification.

F. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as cCSAus, FM, or UL for the specified electrical area classification.

G. Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of flow meter with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Testing:

1. Test and calibrate flow meter to demonstrate that it meets specified accuracy requirements.
2. Comply with AWWA M6.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 1 day on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

3.5 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.
1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 71 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 71 69 – PARSHALL FLUME

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered by this section shall include materials and installation for the fiberglass reinforced plastic (FRP) parshall flume to measure the incoming wastewater flow, as shown on the drawings and described in the specifications.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related work specified elsewhere includes:

1. Division 3 – Concrete
2. Division 5 – Metals
3. Division 26 – Electrical
4. Division 27 – Communications

1.3 REFERENCES

A. ASTM D256 - Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.

B. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

C. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

D. ASTM D2583 - Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.4 COORDINATION

A. Coordinate installation of anchorages for weirs, baffles, frames and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: For glass-fiber-reinforced-plastic parshall flume. Test results of fiberglass reinforced plastic.

C. Shop Drawings:

1. Include plans, sections, details, and attachments to other work.
2. Critical dimensions, jointing and connections, fasteners and anchors
3. Materials of construction.
4. Sizes, spacing, and locations of structural members, connections, attachments, openings, fasteners, and loads.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging, including application instructions.

C. Inspection: Accept Parshall flume and accessories on-site in original packaging. Inspect for damage.

D. Store equipment and accessories according to manufacturer's instructions.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with parshall flume by field measurements before fabrication.

1.8 QUALIFICATIONS

A. Manufacturer of baffle wall system shall have full responsibility for products and design. Split responsibility of materials or design is not acceptable.

B. Manufacturer of baffle wall system shall have completed within the last five (5) years a minimum of five (5) projects of similar type as those required in this scope.

C. Manufacturer must be ISO9001 certified, and manufacturer all of the FRP components in its own facility.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment, parshall flume, shall be manufactured by:

1. Warminster Fiberglass Company; Southampton, PA
2. Tracom Fiberglass Products; Alpharetta, GA
3. Enduro Composities, Inc.
4. Strongwell; Bristol, VA
5. Virtual Polymer Compounds; Getzville, NY
6. Or Approved Equal.

2.2 PRODUCTS

A. All components of the weir, baffle, frame and support system shall be design and fabricated by a single manufacturer to insure uniform and finished appearance as a well as component compatibility.

B. Baffle planks shall be installed without the need of drilling or fastening, and the panels shall be removable without the need of loosening fasteners or any other mechanical device.

C. The baffle planks shall be supports in a channel-shaped frame on each end. Such frame shall fold the baffle blanks for a maximum strength and load bearing capability. The channel frames shall be manufacturer of T-304 stainless steel.

D. The baffle panels, when mounted in their structural support system, shall be square and accurately size to minimize gaps between the frame members and panels.

2.3 PARSHALL FLUME

A. Material: Fiberglass reinforced plastic:

1. Tensile strength (ASTM D 638): 14,000 psi.
2. Flexural strength (ASTM D 790): 27,000 psi.
3. Flexural modulus (ASTM D 790): 1,000,000 psi.
4. Impact, notched, Izod (ASTM D 256): 10 ft-lb/in.
5. Barcol hardness (resin-rich surface) (ASTM D 2583): 50, minimum, average.
6. Temperature limit: 150 °F.
7. Chemical resistance: Comply with ANSI/AWWA F101, Type II classification.
8. Wall thickness: Minimum 3/16 inch

B. Construction: One-piece, fiberglass reinforced plastic, with integral stiffening ribs to make unit self-supporting and eliminate external bracing.

1. For flumes to be embedded in concrete, provide temporary internal bracing.
2. Parshall flume shall have 12” throat, and shall be able to accurately measure flow up to 10.4 MGD.

C. Level Transducer

1. Level transducers shall comply with Section 40 72 13 – Ultrasonic Level Meters.

D. Accessories:

1. Ultrasonic Transponder mounting bracket.
2. Staff gauge graduated in MGD.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fiberglass reinforced plastic (FRP) parshall flume per the manufacturer's recommendations.

3.2 MATERIAL HANDLING

A. The Contractor shall protect FRP materials from cuts, scratches, gouges, abrasions, and impacts. When lifting crated FRP materials, spreader bars shall be used (not wire slings unless materials are fully protected). FRP components shall not be dragged across one another unless separated by a non-scratching spacer.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the contract documents.

C. Set flume at proper elevation in accordance with drawings.

D. Set floor of flume at inlet end level with flow and across flow. Set side walls plumb. Set top flanges level, each side.

E. Fasten flume securely to prevent flotation or twisting during placement of concrete.

F. Place concrete along sides and bottom of flume to ensure complete filling without voids and displacement of flume. Stage placement in alternating lifts, 1/3 height on each side of flume.

3.4 ADJUST AND CLEAN

A. Clean surfaces in accordance with manufacturer's instructions.

B. Remove trash and debris, and leave the site in a clean condition.

END OF SECTION 40 71 69

THIS PAGE INTENTIONALLY LEFT BLANK.

SECTION 407243 - PRESSURE AND DIFFERENTIAL PRESSURE TYPE LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydrostatic-level measurement devices.
2. Transmitters.

1.2 SUBMITTALS

A. Product Data: Manufacturer information for system materials and component equipment, including connection requirements.

B. Shop Drawings:

1. System materials and component equipment.
2. Installation requirements and other details.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

D. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

E. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

F. Qualifications Statement:

1. Qualifications for manufacturer.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.4 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

C. Perform Work in accordance with Federal, State and Local codes, regulations and laws.

D. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials according to manufacturer instructions.

B. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.6 WARRANTY

A. Furnish five-year manufacturer's warranty for hydrostatic level measurement devices.

PART 2 - PRODUCTS

2.1 HYDROSTATIC-LEVEL MEASUREMENT DEVICES

A. Manufacturers:

1. Cerlic Model NV52d (0-16.5’) or NV152d (0-35’) or Endress-Hauser.
2. Substitutions: Permitted.

B. Sensor:

1. Description: Pressure sensor, condensate proofed and long-term stable, and incorporating continuous temperature and pressure compensation.
2. Turndown: 100:1.
3. Certified according to IEC 61508 and IEC 61511.
4. Measuring Cell:

a. Hermetically sealed.
b. Material: Ceramic.
c. Accuracy: Plus or minus 0.2 percent.
d. Furnish pressure range 0 – 16ft.

C. Communications Protocol: HART, PROFIBUS PA, FOUNDATION Fieldbus.

D. Operation: Menu guided.

2.2 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Install as shown on the Drawings or as directed by Engineer.

3.3 FIELD QUALITY CONTROL

A. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.4 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 407243

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 407276 - LEVEL SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Float-type level switches.

1.2 SUBMITTALS

A. Product Data: Manufacturer information for system materials and component equipment, including connection requirements.

B. Shop Drawings:

1. System materials and component equipment.
2. Installation requirements and other details.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

D. Qualifications Statement:

1. Qualifications for manufacturer.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.4 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Comply with NSF 61 and NSF 372.

C. Perform Work in accordance with Federal, State, and Local codes, regulations, and laws.

D. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials according to manufacturer instructions.

B. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.6 WARRANTY

A. Furnish five-year manufacturer's warranty for level switches.

PART 2 - PRODUCTS

2.1 LEVEL SWITCHES

A. Float Type:

1. Manufacturers:

a. Warrick Series M or Anchor Scientific.
b. Substitutions: Permitted.

2. Description: Two float switches, independently activated.
3. Material: Submersible coated 316 stainless steel, polypropylene, or polyethylene body.
4. Actuation: Non-mercury switch contact rated 4 amps at 120 VAC; normally open, normally closed, or Form C (N.O. and N.C.) contact configuration as indicated.
5. Relays: Intrinsically safe.
6. Mounting: Provide 3/4 or 1 inch Schedule 40 PVC pipe for attaching/securing to tank/wetwell wall with 316SS anchors/bolts.
7. Cable: Oil-resistant thermoplastic.
8. Rated voltage: 600 V.

B. Operation:

1. Control Power Wiring: As specified in Section 260503 - Equipment Wiring Connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Install as shown on the Drawings or as directed by Engineer.

3.3 FIELD QUALITY CONTROL

A. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.4 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 407276

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 75 00 – REFRIGERATED AUTO SAMPLER

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements for a refrigerated sampler for the representative collection and storage of liquid water samples. Samplers may take inputs from other process liquid analytical or flow devices and may be used to collect samples and/or monitor influent and effluent waters from municipal and industrial NPDES facilities. These requirements define samplers suitable for indoor and/or outdoor use:

1. Field, laboratory, and portable pH/ORP analyzers.
2. Testers.

B. Related Sections:

1. Control and Information Systems Scope and General Requirements Connections: Wiring connections to equipment.
2. Power Instruments, General.

1.2 SUBMITTALS

A. Furnish complete product data, shop drawings, test reports, operating manuals, record drawings, manufacturer's certifications, manufacturer's Field Reports.

B. Product Data:

1. Dimensional drawings.
2. Materials of construction.
3. Measurement Accuracy.
4. Range and Range Ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.3 QUALITY ASSURANCE

A. Manufacturing facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.

B. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 CALIBRATION AND WARRANTY

A. The sampler shall have standard one year warranty from date of shipment.

1.7 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

B. Scheduled maintenance:

1. On a monthly basis the sampler shall require no more than a visual inspection and, if necessary, cleaning.

C. Unscheduled maintenance:

1. Pump tube replacement (peristaltic pump only).
2. Dosing chamber cleaning (vacuum only).
3. Rotor removal and cleaning.
4. Clean distributor arm.
5. Desiccant replacement.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 SYSTEMS/ASSEMBLIES

A. Manufacturers:

1. Hach Sigma Model AS950 Indoor Refrigerated Sampler with options as outlined below.

B. Performance criteria:

1. Sample cooling: maintain sample liquid at 4°C (39°F) in ambient temperature to 50°C (122°F) maximum; accurate to ±0.8°C (±1.5°F).
2. Sample volume: programmable in 10 mL increments from 10 to 10,000 mL.
3. Sample volume repeatability: ± 5% of 200 mL sample volume with: 4.6 m (15 ft.) vertical lift, 4.9 m (16 ft.) of 3/8-in vinyl intake tube, single bottle, full bottle shut off at room temperature and 1524 m (5000 ft.) elevation.
4. Pacing intervals: selectable in single increments from 1 to 9,999 flow pulses or 1 to 999 hours in 1 minute increments. Accepts 4-20mA input from an external device to pace the sampler.
5. Vertical lift: minimum 8.5 m (28 ft.) using 8.8 m (29 ft.) of 3/8-in. vinyl intake tube at sea level at 20 to 25°C (68 to 77°F).
6. Sample transport velocity: 0.9 m/s (2.9 ft./s) with: 4.6 m (15 ft.) vertical lift (16 ft.) of 3/8-in. vinyl intake tubing, 21°C (70°F) and 1524 m (5000 ft.) elevation.
7. Pump flow rate: 4.8 L/min (1.25 gpm) at 1 m (3 ft.) vertical lift with 3/8-in. intake tube typical.

C. Certifications:

1. Controller: CE
2. AC power supply: UL/CSA/CE
3. Cabinet: UL/CSA/CE

D. Environment:

1. Operating temperature: 0 to 50°C (32 to 122°F)
2. Storage temperature: -40 to 60°C (-14 to 140°F)

2.2 MANUFACTURED UNITS

A. The Sigma AS950 Indoor Refrigerated Sampler consists of a controller and refrigerator.

B. Tubing:

1. Pump tube: 0.95 ID x 0.16 OD cm (3/8 ID x 5/8 in. OD)
2. Intake tube: 9.5 mm (3/8 in.) ID vinyl Teflon® lined polyethylene in 10- , 25- , or 100-ft. lengths

C. Weighted strainer constructed of 316 stainless steel and Teflon

2.3 EQUIPMENT

A. The controller housing of the AS950 sampler is submersible, watertight, dust-tight, corrosion and ice-resistant to NEMA 4X, 6, IP68 standards.

B. The desiccant cartridge, which prevents moisture from accumulating inside the controller electronics area, shall be visual and accessible externally from the side of the controller; the replacement of the desiccant shall not require tools or disassembly of controller from base.

C. The pump shall use spring loaded rollers and be accessible by a clear hinged cover with single thumbscrew.

D. The refrigeration components and copper plumbing are corrosion protected with conformal coating.

E. Sample cooling is made with a 1/10 HP, 75 Watt, 400 BTU/hr compressor, 120 CFM condenser fan, and three-sided wrap-around plate type evaporator. Rigid foam insulation is used throughout.

F. An air sensing thermostat is capable of maintaining sample liquid within specified limits.

G. The power requirement is 115 Vac, 60 Hz (230 Vac optional). The compressor current is 1.5 to 2.0 A, running. The locked rotor current is 12 A. Overload protection is made by a 5 A dc line fuse to the pump and a 1 A dc line fuse (ac power converter). The compressor: thermal overload relay opens at 110°C (230°F).

H. The internal battery is a lithium ion battery (maintains real time clock for five years minimum).

I. The Graphics Display is 1/4 VGA, Color; self-prompting/ menu-driven program.

J. Communication choices include:

1. USB and optional RS485 (Modbus)
2. Permits embedded software upgrades in the field
3. FSData data management software used to download, analyze, and report data, save templates, download sample history and event logs, create graphs for reports and presentations. Link directly to PC A to A USB cable.

K. The membrane switch keypad user interface is self-prompting/menu driven program with 2 multiple function soft keys.

L. Sampling pacing modes shall include Time Weighted, Flow Weighted, Time Table, Flow Table, and Event.

M. Datalogging:

1. Sample History: Stores up to 4000 entries for sample time stamp, bottle number and sample status (success, bottle full, rinse error, user abort, distributor error, pump fault, purge fail, sample timeout, power fail and low main battery).
2. Measurements: Stores up to 325,000 entries for selected measurement channels in accordance with the selected logging interval.

3. Event Log: Stores up to 2000 entries. Records Power On, Power Fail, Firmware Updated, Pump Fault, Distributor Arm Error, Low Memory Battery, Low Main Battery, User On, User Off, Program Started, Program Resumed, Program Halted, Program Completed, Grab Sample, Tube Change Required, sensor communication errors, cooling failed, heating failed, thermal error corrected.

N. Internal software is protected by a 7 amp fuse.

O. Diagnostics: View event and alarm logs as well as maintenance diagnostics A program lock is provided for access code protection to prevent tampering of program and system settings.

P. The sampler is convertible to composite operation by installing a composite container and full bottle shut off.

Q. Sample containers include choice of:

1. Glass: (1) 2-1/2 gal., (2) 2-1/2 gal., (4) 2-1/2 gal., (8) 0.5 gal., (24) 350 mL
2. Polyethylene: (1) 5-1/2 gal., (2) 2-1/2 gal., (4) 2-1/2 gal., (8) 0.6 gal., (12) 0.5 gal., (24) 1 L

R. Sampling features include:

1. Dual programming: Up to 2 sample programs can be run sequentially, in parallel, or according to day of week scheduling; enabling a single sampler to function like multiple samplers.
2. Cascade sampling: for two samplers in combination—the first sampler, at the completion of the program, initiates the second.
3. Status Screen: Communicates what program is running, if there are any missed samples, when the next sample will be taken, how many samples remain, number of logged channels, time of last measurement, memory available, number of active channels, if alarms were triggered, when alarms were triggered, active sensors and cabinet temperature.

S. Automatic shutdown modes:

1. Multiple bottle mode: after complete revolution of distributor arm (unless continuous mode is selected).
2. Composite mode: after preset number of samples have been delivered to composite container, from one to 999 samples, or upon full container.

T. Sample distribution modes include continuous/non-continuous, bottles per sample, or samples per bottle.

U. Manual grab sample can be made with the AS950 sampler to deliver a grab sample to a specific bottle location.

V. The high-speed peristaltic sample pump uses four rollers with spring tension to accommodate larger particles.

W. The intake air purge is made automatically before and after each sample. The duration automatically compensates for varying intake line lengths.

X. The intake line is optionally rinsed with source liquid prior to each sample from one to three times.

Y. The sample collection cycle is optionally repeated from one to three times if a sample is not obtained on the initial attempt.

2.4 FACTORY INSTALLED OPTIONS

A. Two Sensor Ports: Sampler accepts Hach digital Differential pH, Hach digital AV9000 analyzer with submerged area velocity flow and/or Hach digital US9000 ultrasonic level sensors.

B. Rain/RS485 Port: Sampler accepts Hach Rain Gauge (not included) or can be used as RS485 communications.

2.5 COMPONENTS

A. Standard equipment:

1. Controller: high impact injection-molded ABS/PC plastic
2. Base: 22 gauge steel with vinyl laminate overcoat; 201 stainless steel finish optional. Hinged, lockable lid is available as an option.
3. Pump enclosure: corrosion-resistant polycarbonate door, high impact-resistant plastic, polyphenylene sulfide track
4. Intake strainers in standard size, high velocity, or low profile for shallow depth applications. Choice of:

    a. Teflon and 316 stainless steel construction
    b. All 316 stainless steel

B. Dimensions: 61 x 61 x 112 cm (24 x 24 x 44 in.)

C. Weight: 63 kg (140 lbs.)

2.6 ACCESSORIES

A. Bottle kits

B. Tubing and strainers

C. Cables and interfaces

D. FSData Desktop software

E. AC battery back up

F. Controller cover

G. IO9000 Input/Output Module

2.7 SOURCE QUALITY CONTROL AND CALIBRATION

A. Any standards and cleaning solutions will be supplied with MSDS data sheets.

2.8 SAFETY

A. All devices shall be suitable for operation in a non-hazardous area.

B. Device failure modes, self-monitoring characteristics and diagnosis shall follow NAMUR standard NE 43.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and ensure instruments are compatible with installed process and environmental conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. Contractor will install the sampler in strict accordance with the manufacturer's instructions and recommendation.

B. The sampler must be installed in a suitable manner so that the sampler is not directly installed over the sampling area.

C. The standard one-year warranty against manufacturing defects shall be extendable to three-years on covered equipment if paid start-up service is accomplished on that covered equipment by an authorized service provider.

D. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

1. General contractor.
2. Electrical or Instrumentation contractor.
3. Factory trained authorized service provider or representative.
4. Site (owner/operator) personnel.
5. Engineer.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.

B. The ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.

1. Manufacturer field service representative shall verify installation of all installed samplers.
2. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall generate a configuration report for each sampler installation following commissioning.

3.4 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.
   a. The ENGINEER shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 75 00

SECTION 40 75 13 – PH/ORP SENSORS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:

1. Control and Information Systems Scope and General Requirements.
2. Power Instruments, General.

B. Related Requirements:

1. Section 05 50 00 - Metal Fabrications: Fasteners, brackets, and other miscellaneous metal fabrications as required by this Section.
2. Section 26 05 03 - Equipment Wiring Connections: Wiring connections to equipment.
3. Section 40 05 13 - Common Work Results for Process Piping: Execution requirements for piping specified by this Section.
4. Section 46 05 53 - Identification for Water and Wastewater Equipment: Nameplates.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Furnish complete product data, shop drawings, test reports, operating manuals, record drawings, Manufacturer’s certifications, Manufacturer’s Field Reports.

C. Product Data:

1. Dimensional drawings.
2. Materials of construction.
3. Measurement accuracy.
4. Measurement Range.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.4 QUALITY ASSURANCE

A. Manufacture facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.

B. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced.

1.6 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.7 CALIBRATION AND WARRANTY

A. Sensors shall arrive pre-calibrated and ready for installation. Calibration information is to be stored in the sensor for automatic download to the transmitter, once connected.

B. The sensor and transmitter system shall have one-year warranty from date of shipment and three year extended warranty with the meter is commissioned by a factory certified technician.

1.8 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 - PRODUCTS

2.1 pH/ORP SENSOR

A. Manufacturer:

1. Endress+Hauser, Digital pH/ORP Sensors.
2. ABB, TBX5 pH/ORP Sensors.
3. Rosemount, 3900 General Purpose pH/ORP Sensors
4. Or Approved Equal

B. Measurement Range:

1. pH: 0-14 pH.
2. ORP -1500 mV to 1500 mV.

3. Temperature range: Sensor dependent; 5 to 275 °F.
4. Maximum Pressure: 100 psig at 212 °F (100 °C)
5. Body Material: Ryton

C. Sensor:

1. Type: Inline, immersion.
2. Wetted Materials: Type 316 stainless steel.
3. pH Sensor: Glass.
4. ORP Sensor: Platinum.

D. Supported Calibration Methods:

1. Single point standardization.
2. Single point temperature adjustment.
3. pH Only:

   a. Two-point, with low and high buffer.
   b. Two-point, with automatic buffer recognition.

4. Automatic temperature compensation.

2.2 TRANSMITTER

A. Current outputs

1. Active; 0-20 mA, linear

B. Current inputs

1. Passive; 0-20 mA.

C. Relay outputs

1. NO/NC, 24 VDC to 230 VDC, 0.1 to 2 amp.
2. Four electromechanical, UL rated, user-definable, fully programmable SPDT relay outputs rated 100 to 230 VAC, 5 amp at 30 VDC resistive maximum.

D. Discrete Inputs/Outputs

1. Input: Passive, pulse width 500 µs at 1 kHz. Input high= 1-30 VDC, low = 0-5 VDC.
2. Output: Open collector, 30 V max., 15 mA.

E. Power requirements

1. Standard: Universial AC powered: 100 to 230 VAC ±15%, 50/60 Hz.
2. Optional: 24 V powered: 24 V AC/DC ±20%, 50/60 Hz

F. Communication Protocols

1. MODBUS RTU

2. MODBUS TCP
3. Ethernet IP
4. HART4-20mA

G. The transmitter shall use a menu-driven operation system.

H. The transmitter shall display is graphic dot matrix LCD with LED backlighting.

I. The transmitter shall be equipped with a real-time clock.

J. The transmitter shall be equipped with two security levels.

K. The transmitter shall be equipped with a system check for:

1. Power up test (monitoring and shutdown)
2. Total power draw
3. Memory devices
4. Temperature mother board

L. The controller has the option of graphical measurement that tracks measurement values over time.

M. Materials

1. Housing: polycarbonate, aluminum (powder coated), and stainless steel
2. Rating: NEMA 250 Type 4X enclosure, rated IP66
3. Conduit openings: 0.75 in. NPT

2.3 ACCESSORIES

A. Calibration solutions shall be available for both pH sensors (buffer solutions, pH 4 and pH 7 recommended) and ORP sensors.

B. Weather protection shield

2.4 SOURCE QUALITY CONTROL AND CALIBRATION

A. Any standards and cleaning solutions will be supplied with MSDS data sheets.

2.5 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be suitable for operation in a non-hazardous area.

C. Device failure modes, self-monitoring characteristics and diagnosis shall follow NAMUR standard NE 43.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. Contractor will install the transmitter and sensor in strict accordance with the manufacturer's instructions and recommendation.

B. The sensor must be mounted using a suitable mounting assembly so that the sensor is always submersed in the solution to be measured.

C. Mount sensor vertically with electrode pointing down. The sensing tip of the sensor must be pointing slightly down with a minimum angle of 15 degrees.

D. The standard one-year warranty against manufacturing defects shall be extendable to three-years on covered equipment if paid start-up service is accomplished on that covered equipment by an authorized service provider.

E. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

1. General contractor.
2. Electrical or Instrumentation contractor.
3. Factory trained authorized service provider or representative.
4. Site (owner/operator) personnel.
5. Engineer.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the Engineer shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC.
2. Each instrument shall be supported with a device profile permitting direct integration in the PLC.

B. The Engineer shall witness all instrument verifications in the field.

C. Manufacturers Field Services Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.

1. Manufacturer field service representative shall verify installation of all installed sensors, cables and transmitters.
2. Manufacturer representative shall notify the Engineer in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall generate a configuration report for each senor installation following commissioning.

3.4 ADJUSTING

A. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

1. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 75 13

SECTION 40 75 33 – CHLORINE/FLUORIDE ANALYZERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Free Chlorine Reagentless Amperometric Electrodes
2. Fluoride Ion Selective Electrodes
3. Dual Input Transmitters

B. Related Requirements:

1. Section 26 05 23 – Control Voltage Electric Power Cables: Wiring connections to equipment.
2. Section 26 05 53 - Identification for Electrical Systems: Nameplates.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including electrical characteristics and connection requirements.

C. Shop Drawings:

1. Indicate size and configuration of assembly, mountings, weights, and accessory connections.
2. Indicate system materials, component equipment, wiring diagrams, and schematics.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.6 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for Electrodes and Transmitters.

1.7 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.8 CALIBRATION

A. Analyzers and sensors shall arrive pre-calibrated and ready for installation. Calibration information is to be stored in the sensor for automatic download to the transmitter, once connected.

1.9 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Emerson-Rosemount – St. Louis, MO.

1. Fluoride Sensor – S10258
2. Chlorine Sensor – 499ACL
3. Dual Channel transmitter –SPQ10103-LQD
4. Single Channel transmitter - SPQ10102-LQD

B. Prominent –

1. Fluoride Sensor – FLEP 010
2. Chlorine Sensor – CGE 3 - mA
3. Three Channel transmitter –DULCOMETER DACb

C. Approved Equal

2.2 CHLORINE SENSOR

A. Performance criteria (Sensor):

1. Free Chlorine measuring range: 0 to 5 or 10 ppm.
2. Response time: Less than or equal to 30 seconds.
3. Maximum measured error: ±2% of the measured value ±0.2 mg/l.
4. Repeatability: ± 2% of the displayed value.
5. Sensor type: Reagentless Amperometric electrode.
6. PFC is CE marked.

B. Environment:

1. Ambient temperature range: 0 to 45°C.
2. Process temperature range: 0 to 45°C.
3. pH range for Chlorine - Independent of pH between 7 and 9.5.
4. Process Connection: 1/2 in MNPT
5. Sample Flow Required: 10-20 gal/hr.

2.3 FLUORIDE SENSOR

A. Performance criteria (Sensor):

1. Free Fluoride measuring range: 0.01 to 10 ppm.
2. Response time: Less than or equal to 80 seconds.
3. Maximum measured error: ±2% of the measured value.
4. Repeatability: ± 2% of the displayed value.
5. Sensor type: Combination Ion Selective Electrode.

B. Environment:

1. Ambient temperature range: 5 to 35°C.
2. Process temperature range: 5 to 35°C.
3. pH range for Fluoride - Independent of pH between 5.5 and 9.5.
4. Process Connection: 1 in MNPT
5. Sample Flow Required: 1-4 gal/hr.

2.4 TRANSMITTER

A. Three Input as required.

1. Analyzer

a. The analyzer shall be microprocessor-based, with illuminated LCD display of measured value, status, and error annunciation. Unit shall feature non-volatile memory to retain settings in the event of power failure: menu-driven calibration, limit and control settings; sensor monitoring to alarm upon sensor failure or loss of sensitivity; programmable access code allowing calibration but not unauthorized adjustment of limits and outputs.
b. The device shall have the provision to be configured with a second independent channel for control of a second application parameter.
c. The unit shall have the ability to control via proportional or PID loop control functions.
d. In Free Chlorine applications the analyzer shall allow for pH compensation of the Free Chlorine reading via a pH probe installed in the sample stream and wired to the analyzer.
e. The controller shall have the provision of saving data (datalogging) to an SD card.
f. If required by the application the unit shall be able to accept a process flow rate disturbance variable and shall adjust its corresponding chemical feed output based on this variable.
g. In addition to the above requirements the analyzer shall have the following capabilities and specifications:

1) Resolution – 0.01 ppm (Chlorine) / 0.01 (pH) / 1 mV (ORP)
2) Accuracy – 0.3% based on the full-scale reading
3) pH Compensation Range for Chlorine – 6.5 to 8.5
4) Disturbance Signal – Flow via mA or Frequency
5) Current Outputs – Three (3) 0/4-20mA electrically isolated (measured value, correction value and/or control variable selectable)
6) Control Outputs

a) Two (2) Pulse Frequency Outputs for metering pump control
b) Two (2) Relays (limit value, 3-point step or pulse length control)

h. Alarm Relay – 250 Volt, 3 Amp, 700 VA (maximum)
i. Enclosure – IP67
j. Tests and Approvals – CE, MET (Corresponding to UL according to IEC 61010)

B. Case: Polycarbonate.

C. Display: Four Line Backlit.

D. Outputs:

1. Four 4-20 mA isolated outputs (Fully scalable and independently assigned to Fluoride, Chlorine, temperature and pH).
2. Four alarm relay outputs (programmable and assignable for high-low operation, dead band, setpoint, internal fault or timer).

E. Mounting:

1. All components shall be mounted on a backplate
2. System shall include a constant head flow controller for the sample flow.
3. Sensors shall be prewired to the transmitter
4. Inlet shall include a check valve to insure that sensors remain submerged in the event of sample flow loss.

F. Sensor Holder

1. The sensor holder (DGMA) shall be transparent PVC material with integral flow control valve and rotameter for setting the sample flow rate between 8 and 15 gph. The flow shall be directed at the sensor membrane to provide continuous cleaning action. Mounting brackets for wall mounting shall be included.
2. A flow switch shall be provided as part of the rotameter. This switch shall be wired to the controller which shall be able to initiate a pause to chemical feed if a loss of sample flow is detected. The switch shall be capable of actuating a fault annunciation signal from the analyzer.
3. The free chlorine sensor, pH sensor, and flow switch shall be mounted in the DGMA sensor holder.
4. The fluoride sensor, reference electrode, and temperature sensor shall be mounted in a DLG IV sensor holder, The DLG sensor holder shall be mounted above a magnetic stir plate, allowing for two-point calibration if necessary.
5. DGMA and DLG IV sensor holders shall be mounted in line with one another, allowing for a single common sample water stream.

G. Analyzer Package

1. The analyzer(s), sensor(s), and sensor holder(s) specified herein shall be installed on a single back panel and shall be fully wired and ready for installation with sample tubing or piping connections as specified by the customer.
2. The water sample piping shall include a pressure reducing valve and pressure gauge, to allow for adjusting sample water pressure to 14psig max or lower. The sample line shall also include a needle valve, to provide sufficient back pressure to prevent release of entrained air that could otherwise interfere with accurate sensor measurement.
3. The analyzer back panel shall be made of Polyethylene/Polypropylene sheet material of at least 3/8” thickness and shall be UV resistant.

2.5 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be suitable for operation in a non-hazardous area.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. Contractor will install the transmitter and sensor in strict accordance with the manufacturer's instructions and recommendation.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

1. General contractor.
2. Electrical or Instrumentation contractor.
3. Factory trained authorized service provider or representative.
4. Site (owner/operator) personnel.
5. Engineer.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC.
2. Each instrument shall be supported with a device profile permitting direct integration in the PLC.

B. The ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.

1. Manufacturer field service representative shall verify installation of all installed sensors, cables and transmitters.

2. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall generate a configuration report for each senor installation following commissioning.

3.4 ADJUSTING

A. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

    a. The ENGINEER shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 75 33

SECTION 40 75 43 – FLUORESCENT DISSOLVED OXYGEN MEASURING

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements for a high-performance, digital fluorescence sensor for measurement of dissolved oxygen in liquid. The sensor will offer fast, accurate and drift-free measurement. The sensor will support low maintenance, with high availability and easy handling. The sensor's long-term stable fluorescence layer will be exclusively oxygen-selective (interference-free), ensuring consistently reliable measurement. The sensor will use Memosens® digital technology to provide maximum process and data integrity, and facilitate simple lab calibration.

B. Related Sections:

1. Control and Information Systems Scope and General Requirements.
2. Power Instruments, General.

1.2 SUBMITTALS

A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer’s certifications, Manufacturer’s Field Reports.

B. Product Data:

1. Dimensional drawings.
2. Materials of construction.
3. Measurement accuracy.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.3 QUALITY ASSURANCE

A. Manufacturing facilities shall be certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

B. Any instruments that are not stored in strict conformance with the Manufacturer's recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 CALIBRATION AND WARRANTY

A. The sensor shall have standard one year warranty from date of shipment and if the measuring system is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

B. The manufacturer's warranty does not cover normal wear and tear, damage to the sensor due to improper storage or handling, or any other mode of failure or reduced sensor life that is not a direct consequence of a manufacturing defect.

1.7 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 SYSTEMS/ASSEMBLIES

A. Manufacturer:

1. Endress+Hauser Oxymax COS61D digital oxygen sensor with Liquiline CM44x or CM44xR transmitter.

B. Performance Criteria:

1. Measurement Range: 0-20 mg/l, 0-200 %SAT, 0-400 hPa

2. Repeatability: ±0.5% of measuring range end

3. Max Measured Error: 0.01 mg/l or ±1 % of measured value (< 12 mg/l) ±2 % of measured value (from 12 to 20 mg/l)

4. Response time (t_{90}): 60 sec.

5. Sensor cap lifetime: >2 years (under reference operating conditions, protected against direct sunlight)

6. Temperature Sensor: NTC temperature sensor, 0-50°C (32-122°F)

C. Certifications:

1. CE marked.
2. Interference emission and interference immunity with EN 61326; 2005, Namur NE 21:2007.

D. Environment:

1. Process temperature: -5 to 55 °C (23 to 131°F).
2. Process pressure: max 10 bar (145 psi).
3. Ambient Temperature: -20 to 60°C (0 to 140°C)
4. Ingress Protection: IP68

2.2 MANUFACTURED UNITS

A. Transmitter:

1. Shall be a multi-parameter controller as specified in Section 40 75 05 and on the plans.

B. Sensor:

1. Optical fluorescence technology with minimum maintenance and maximum availability.
2. Shall incorporate digital Memosens technology with calibration saved in sensor and a high degree of EMC protection.
3. Simple single-point calibration in air, air-saturated water or in medium shall be possible.
4. Extended maintenance intervals and a high degree of long-term stability; intelligent self-monitoring shall guarantee reliable measure values.
5. Fixed, waterproof cable connection at the sensor with up to 330 feet (100 meters) length between the sensor and transmitter.

2.3 ACCESSORIES

A. Assemblies

1. Sensor mounting hardware shall be available in a modular assembly system to secure sensors in open basins, channels and tanks. Versions in stainless steel shall be available for immersion in open basins. The mounting hardware shall be applicable for nearly any type of fixing - fixing on the floor, wall or directly on a rail.

2. A retractable assemby shall be available, constructed in stainless steel and ball valve, to allow for retraction of the sensor from the process without shutting down the process.

B. Interconnecting Cable

1. The sensor cable shall be available in length up to 330 feet (100 m) with a choice of direct wire to the transmitter or connection using M12 quick connections.

2.4 REQUIRED INSTRUMENTS

A. AIT-7101

B. AIT-7102

2.5 SOURCE QUALITY CONTROL AND CALIBRATION

A. Reagents, standards and cleaning solutions for the analyzer will be supplied with MSDS data sheets.

2.6 SAFETY

A. All devices shall be suitable for operation in a non-hazardous area.

B. Device failure modes, self-monitoring characteristics and diagnosis shall follow NAMUR standard NE 43.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. As shown on installation details and mechanical Drawings.

B. Installation will occur in strict accordance with the manufacturer’s instructions and recommendation.

C. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

1. General contractor.
2. Electrical or Instrumentation contractor.
3. Endress+Hauser factory trained authorized service provider or representative.
4. Site (owner/operator) personnel.
5. Engineer.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC.
2. Each instrument shall be supported with a device profile permitting direct integration in the PLC.

B. The ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.

1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.
2. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.
4. Manufacturer representative shall generate a configuration report for each meter.

3.4 ADJUSTING

A. Verify factory setup of all instruments in accordance with the Manufacturer’s instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

    a. The ENGINEER shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 75 43

SECTION 40 90 00 - INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements

Requirements specified in Division 01 of these Specifications form a part of Division 26. This Section covers the general requirements for furnishing and installation of the instrumentation, control and monitoring (ICM) system complete in every detail for the purposes specified and shall form a part of the other Sections of Division 26 unless otherwise specified. The other Sections of this Division shall supplement this Section as necessary.

1. Work Included
   a. The intent of Division 40 is to require that the complete Instrumentation, Control and Monitoring System, including other Sections of Division 40 shall be furnished by a single Control Systems Integrator (CSI) to assure system uniformity, subsystem compatibility and coordination of system interfaces.
   b. The new SCADA system shall deliver a complete and functional system as described herein, as per the Contract Documents, and as shown on the Contract Drawings. The SCADA system shall be capable of monitoring and performing controls (as indicated on the drawings) of Homesteads Pollution Control Facility equipment. And shall be capable of communication with the existing Piedmont Water master SCADA workstation to depict the new facility I/O points and new HMI graphics. All equipment, materials, incidentals, software, supervision, and labor shall be provided under this Contract.
   c. Furnish the tools, equipment, materials, and supplies and perform the labor required to complete the furnishing and installation of, including instrumentation signal and power conduit and wiring not specifically shown on the electrical drawings, validation, start-up and operational testing of a complete and operable ICM system as indicated on the Contract Drawings and as specified herein.
   d. Provide the equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to ensure that the Owner receives an integrated and operational ICM system as herein specified.
   e. Coordinate with the requirements of Division 26 – Electrical, and provide for operator restart of all equipment on restoration of loss-of-power condition. Sequence automatically equipment restart and provide for time delays as necessary to prevent breaker trips on inrush from multiple equipment concurrent starting.
2. As a minimum, the CSI shall perform the following work:
   a. Implementation of the ICM system:
      i. Prepare shop drawing submittals.
      ii. Design, develop, and electronically draft loop drawings and control panel designs.

iii. Prepare the test plan, the training plan, and the spare parts submittals.
iv. Procure hardware.
v. Fabricate panels.
vi. Program the ICM system as shown on the Contract Drawings.
vii. Perform factory tests on panels.
viii. Perform bench calibration and verify calibration after installation.
ix. Oversee and certify installation.
x. Oversee, document, and certify loop testing.
xi. Oversee, document, and certify system commissioning.
xii. Conduct the performance test.
xiii. Prepare operations and maintenance manuals.
xiv. Conduct training classes.
xv. Prepare record drawings.
xvi. Prepare calibration sheets.
xvii. Certify the installation of the ICM system.

b. Integration of the ICM system with instrumentation and control devices being provided under other Sections:
   i. Develop all requisite loop drawings and record loop drawings associated with equipment provided under other Divisions and Owner equipment.
   ii. Resolve signal, power, or functional incompatibilities between the ICM system and interfacing devices.

3. Work Not Included
   a. Process piping, installation of in-line instrumentation, i.e., final control elements in process pipelines, air compressors, main air supply headers, and mechanical work as specified in other Divisions.
   b. Electrical power distribution specifically included under Division 26, circuit protection devices, power conduit and wiring indicated, local equipment control stations, and miscellaneous electrical requirements as specified in Division 26.

B. System Responsibility
1. The ICM system as specified in Division 40 is an integrated system and therefore shall be provided by a competent, qualified CSI who shall have total responsibility for the Work of Division 40. Entire system installation including calibration, validation, start-up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had experience performing similar installations. The System shall be integrated using the CSI's latest, most modern proven design and shall, as far as practical, be by one manufacturer.
2. The Contractor shall perform the Work under this Division 40, through the use of a qualified CSI who shall perform said Work but it shall be understood that this shall not relieve the Contractor from any responsibility under the Contract.
3. The Contractor shall be responsible for the correct installation of all hardware and systems specified in Division 40.

4. The Contractor shall be responsible to see that all instrumentation components of other Divisions, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, alarming devices and appurtenances are compatible and shall function as outlined, and he shall furnish and install such additional equipment, accessories and appurtenances as are necessary to meet these objectives at no additional cost to the Owner.
5. The Contractor shall use the instrument tag and equipment numbering scheme as shown in Contract Documents, for identifying components which are part of this system.
6. Due to the complexities associated with the interfacing of numerous control system devices, the CSI or vendor shall be responsible to the Contractor for the integration of the ICM system with existing devices and devices provided under other Divisions and provide a completely–integrated control system free of signal incompatibilities; this includes providing review and comment to other vendor equipment submittals and overall coordination of the system.

C. Certification of Intent:
   1. Fifteen days after notice to proceed, the Contractor shall submit a certification from the selected CSI. The certification shall be typed on letterhead paper of the CSI. The certification shall be signed by an authorized representative of the CSI. The certification shall include the following statements:
      a. (Company name) "hereby certifies intent to assume and execute full responsibility to the Contractor to perform all tasks defined under Paragraph 1.01 Scope, in full compliance with the requirements of the Contract Documents."
      b. “It is certified that the quotation to the Contractor includes full and complete compliance with the requirements of the Contract Documents without exception."

D. Documentation of Instrumentation Subcontractor Qualifications:
   1. General
      a. The entire control system installation including panel building, calibration, validation, start-up, operational testing, and training shall be performed by a control systems integrator (CSI) staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.
      b. The system shall be integrated using the latest, most modern proven design and shall, as far as practical, be of one manufacturer.
      c. The equipment, level of detail, and overall quality of the control system shall be consistent a typical industrial type control system.
      d. Overall system performance shall be guaranteed.
      e. Software packages shall be latest versions available.
   2. System Integrator qualifications:
      a. The following system integrator is pre-qualified to perform the control system work described in Division 40:
         i. **Southern Flow Inc., Alpharetta, GA**
   3. Training and Certification:

a. Completion of the following training courses (or appropriate portions thereof) or possession of the following certifications may be substituted for portions of the System Integrator's personnel experience requirements described above.
b. Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
c. Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
d. Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Technical Skills Training program.
e. Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.
f. Training program curriculums as offered by ISA.
g. Training or certification does not satisfy the related project experience requirements described above.
h. Submit training and registration evidence with the above experience evidence.

E. Contract Drawings
1. Information on the Drawings
a. The following information relative to the Work of Division 40 is indicated on the Division 26 Contract Drawings.
i. Location of primary elements, control panels, and final control elements.
ii. Instrumentation signal and power conduit runs between control panels and field instruments and devices.
iii. Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Contractor.
iv. Location of all equipment having alarm and equipment status contacts.
v. Major instrument conduit runs.
2. Information Not on the Drawings
a. The following information relative to the Work of Division 40 may not be shown on the Drawings, but shall be the responsibility of the Contractor to determine, furnish, coordinate with other Trades, and submit for acceptance, based upon the systems specified.
i. Tubing for pneumatic signals, and/or power between main headers and control panels, field mounted primary elements, field instruments and final control elements.
ii. Number or sizes of tubing required for pneumatic and hydraulic signals.
iii. Point of connection to any hydraulic or pneumatic supply lines.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. Instrument Society of American (ISA).
      a. ISA S5.4 – Instrument Loop Diagrams.
   2. National Electrical Manufacturers Associations (NEMA).
      a. NEMA – Electrical Code.
   3. American Standard Code for Information Interchange (ASCII).
   4. Institute of Electrical and Electronic Engineers (IEEE).
      a. IEEE C62.41 – Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits.

1.03 SUBMITTALS

A. General.

Refer to the General Conditions of the Contract Documents for required method of preparation and transmittal and conform to requirements herein.
   1. Pre-submittal Conference
      a. Arrange a conference with CSI, the Engineer, and the Owner within thirty (30) days after award of the Contract for the purpose of informally discussing in detail and verifying the correctness of the CSI's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by CSI, and duly authorized representatives of the Contractor, Engineer, and Owner.
      b. Submit 4 copies of the following items for discussion at the Pre-submittal Conference:
         i. A list of equipment and materials required for the ICM system and the manufacturer’s name and model number for each proposed item. Identify items by tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether item is "as specified" or "equivalent." Items identified as "equivalent" shall be accompanied by a comparative listing of the published specifications for the item specified and for the item proposed. Equivalent items shall only be accepted by the Engineer if the specified item is no longer manufactured.
         ii. A list of proposed clarifications to the Contract Documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the Engineer.
         iii. A sample of each type of submittal specified herein.
         iv. A flow chart showing the steps to be taken in preparing and coordinating each submittal.
         v. A bar-chart type schedule for all system related activities from the Pre-submittal Conference through start-up and training. Dates of submittals, design fabrication, programming, factory testing, deliveries, installation, field testing, and training shall be shown. The schedule shall be subdivided

to show activities relative to each major item or group of items when everything in a given group is on the same schedule.

vi. An overview of the proposed training plan. The Engineer will review the overview and may request changes. All changes to the proposed training shall be resolved at the Pre-submittal Conference. The overview shall include the following for each proposed course:

a) Course title and objectives.

b) Prerequisite training and experience of attendees.

c) Course content – a topical outline.

d) Course duration.

e) Course format – lecture, laboratory demonstration, etc.

vii. A preliminary copy of the ICSI Qualification submittal.

c. Take minutes of the Pre-submittal Conference, including all events, questions, and resolutions. Before adjournment, all parties must concur with the accuracy of the minutes and sign accordingly.

B. Shop Drawings

Before proceeding with any manufacturing, submit Shop Drawings for acceptance in complete bound sets indexed by specification number. Describe the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Schematics shall be complete with tag and terminal numbers. Submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing equipment and tag numbers on panels. Submit panel graphic drawings where applicable. Include material specifications lists where applicable. Include a draft of the theory of operation for relay logic circuits including those implemented via programmable controllers. Submit detailed field instrument installation drawings for each instrument.

C. Design Related Submittals

1. In accordance with the requirements of Section 01 - Submittals, provide the following submittals:

a. Catalog Cuts

i. Catalog information, descriptive literature, wiring diagrams, and shop drawings shall be provided for all devices, whether electrical or mechanical, furnished under Division 40. This includes, but is not limited to, primary elements, transmitters, analytical equipment, gauges, valves, controllers, indicators, power supplies, switches, lights, relays, timers, etc.

2. Component Data Sheets

a. Data sheets, specification sheets, and an instrument list shall be provided for components provided under this Section. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., part numbers, scales, ranges, service, materials of

construction, component location, options, and the individual tag number as noted in the Contract Drawings and in Contract Documents.

b. Include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. More than one tag numbered item may be included on a sheet.

3. Sizing Calculations
   a. Complete sizing calculations shall be provided for all flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all computing modules and function generating modules and shall include the actual scaling factors and units used.
4. Panel Construction Drawings
   a. Shop Drawings and Catalog Cuts
      i. Provide detailed shop drawings and catalog cuts for panels, instrument racks, and enclosures. Drawings shall show the location of front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show major dimensions as well as elevations, in inches from the base up, of the rows of components.
      ii. Shop drawings shall indicate location and size of available spare mounting space for rear-of-panel devices.
      iii. The panel legend shall list and identify front of panel devices by their assigned tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
      iv. The bill of materials shall include devices mounted within the panel that are not listed in the panel legend, and shall include the device tag number, description, manufacturer, and complete model number.
   b. Color Schedule
      i. Provide a color schedule with color samples for control panels for the Owner's selection/approval.
5. Power Requirement and Heat Dissipation
   a. Provide a summary of the power requirements and heat dissipation for control panels. Power requirements shall state required voltages, currents, and phase(s) Heat dissipations shall be maximums and shall be given in BTU/Hr. Summary shall be supplemented with calculations.
6. Panel Wiring Diagrams
   a. Wiring diagrams shall be similar to those diagrams shown in the Contract Drawings, but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, hand switches and interlocks.
   b. Provide complete terminal identification of external primary elements, panels, and junction boxes that interface directly to the panel wiring being shown. Polarity of analog signals shall be shown at each terminal.
   c. External wiring that the electrical contractor must provide and wire shall be shown as a dotted line. Special cables that are provided with the instrument shall be clearly identified.

d. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show each circuit individually. Common or typical diagrams shall not be allowed.

e. Provide panel power wiring diagrams for panels. The diagrams shall include grounding requirements.

7. Interconnecting Wiring Diagrams

a. Diagrams shall show component and terminal board identification numbers, external wire and cable numbers. The drawings shall show intermediate terminations between field elements and panels (e.g., terminal junction boxes) This diagram shall be coordinated with the Contractor and shall bear his mark showing that this has been done.

8. Loop Diagrams

a. Provide an individual wiring diagram for each analog loop showing terminal numbers, the location of the DC power supply, the location of any dropping resistors, the location and connection of the surge protection devices. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:

b. Each loop diagram shall be divided into three areas for identification of device locations: panel face, back-of-panel, and field respectively. Each loop diagram shall list (1) Transmitter Drive Capability, (2) Loop Impedance, (3) Transmitter Reserve Drive Capability. Loop diagrams shall be on 11-inch by 17-inch Drawings.

9. Instrument Installation Details

a. The CSI shall review the Contract Documents and develop and submit for review, complete installation details for each field mounted device and panel prior to shipment and installation. Common details, not requiring any modification, may be referenced by an index showing the complete instrument tag number, service, location, and device description. Installation details shall be provided as required to adequately define the installation of the ICM system components.

10. Operator Interface Submittal

a. This submittal shall cover the specific plant control schemes as well as the details of the plant reports and process graphic displays.

b. The submittal shall contain the semi-final details of all logs, reports, and process graphic displays. The specifics of what shall appear on each display and what calculations are required to support them shall be developed and submitted.

c. Submitted process graphic displays shall be no smaller than 8.5-inches by 11-inches and in full color.

d. A complete listing of all signals to be collected for long term historical information shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

e. A complete listing of all signals to be collected for trend display shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

11. Process Control Strategy Submittal:

a. The process control schemes shall be developed in a ladder logic diagram or functional block (logic) diagram presentation based on information from the Contract Documents. Included with each diagram shall be:
   i. Brief Scope of the Control Function.
   ii. Listing of all scanned inputs to the control function.
   iii. A short narrative of the control strategy.
   iv. Any assumptions made in developing the program.
   v. Listing of all inputs and outputs (i.e., AI, DI, AO. DO) from the control function.
   vi. Cross reference list of all I/O showing to which I/O modules or software modules they are linked.
   vii. Listing of all operator inputs/outputs to and from the control function. Any special CRT displays related to the function shall be illustrated. A description of the operation of any panels shall be described as it relates to the control function.
   viii. Failure contingencies shall be described in detail.
   ix. A flowchart representing the control strategy.
b. This submittal shall cover all of the associated logic developed under the CSI required to implement the control functions specified.
c. The System Integrator shall submit annotated logic on 8-1/2-inch x 11-inch format and as an ASCII file on compact diskettes for all logic developed. Annotation shall be 3 lines of 6 characters each for every logic contact. In addition, each network or rung shall be annotated so that a non-technical person can read and easily comprehend what control function the rung or network is performing.
d. This submittal shall also include copies of the PLC I/O configuration tables, I/O reference usage table, complete cross reference to specific rung used of all inputs, outputs, internal coils, data registers, and special purpose coils. In addition, any special switch settings or hardware configuration requirements such as com port configurations shall be described in detail and submitted.

D. Test Related Submittals

Provide five (5) copies of the following:

1. Operational Field Acceptance Test (OAT) Documentation.

   The CSI shall submit an example of each type of Instrument Calibration Sheet and Loop Status Report that will be used for the OAT.

   After acceptance of the examples, the CSI shall prepare Loop Status Report Sheet(s) for each loop and an Instrument Calibration Sheet for each active ICM system element (except simple hand switches, lights, etc.) These sheets shall be submitted after the tests are completed.

   a. Instrument Calibration Sheets.
      i. Provide a written report to the Engineer on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include all applicable data as listed below plus any defects noted, correction

action required, and correction made. Data shall be recorded on prepared forms and shall include not less than the following items:

a) Facility identification (Name, location, etc.)
b) Loop identification (Name or function)
c) Equipment tag and serial numbers.
d) Scale Ranges and units.
e) Test mode or type of test.
f) Input values or settings.
g) Expected outputs and tolerances
h) Actual readings at 10%, 50%, and 90% of span.
i) Explanations or special notes as applicable.
j) Date, time, and weather.
k) Tester's certification with name and signature.

2. Functional Acceptance Test Documentation.

The CSI shall prepare two types of test procedures and forms as follows.

a. Loop Test Documentation

For functions that can be demonstrated on a loop-by-loop basis, the form shall include:

i. Project Name.
ii. Loop number.
iii. Loop description.
iv. Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.
v. For each component: tag number, description, manufacturer, and data sheet number.
vi. Space for sign off and date by the CSI, the Contractor, and the Engineer.

b. Functional Test Documentation

For those functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:

i. Specification page and paragraph of function demonstrated.
ii. Description of Function.
iii. Test procedure description.
iv. Space after each specific test to facilitate signoff on completion of each test.

E. Testing

1. Factory Testing, field Testing, and Final Acceptance Testing shall be provided.
2. System Commissioning Assistance.
   a. Provide the services of a factory trained and field experienced instrumentation engineer to assist Owner's personnel during each startup of the various systems. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

F. Operation & Maintenance Manuals.

Furnish Instruction Manuals and Parts Lists for instrumentation equipment in accordance with the requirements of Division 1 and as noted herein.

1. Schedule.
   a. Deliver manuals not later than the equipment shipment date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver balance of manuals to Engineer.
2. Material Content. Include in the manuals not less than the following applicable information for each instrument, equipment, subsystem and/or control loop. The O&M Manuals shall consist of, at least, the following material:
   a. Bill of Materials.
      i. A listing of all the panels, racks, instruments, components, and devices supplied. Components shall be grouped by component type, with the component types identified in a similar manner to the component identification code used in these specifications. The list shall contain, as a minimum:
         a) Instrument, panel, rack or device tag number.
         b) Description.
         c) Quantity supplied.
         d) Reference to component data sheet and/or catalog cut.
         e) Component type.
   b. Component Data Sheets.
      i. See Paragraph 1.03 C.2 specified herein before.
   c. Catalog Cuts.
      i. See Paragraph 1.03 C specified herein before.
   d. Component O&M Manuals.
      i. An O&M manual shall be submitted for instruments and devices supplied. The O&M manuals shall contain, as a minimum:
         a) Operating procedures.
         b) Installation procedures.
         c) Maintenance procedures.
         d) Troubleshooting procedures.
         e) Calibration procedures.
         f) Internal device schematics and wiring diagrams.
         g) Shut-down procedures.
         h) Component parts list.
         i) Detailed circuit operational description including annotated programmable controller ladder diagrams.
   e. Spare Parts and Expendables List

i. The spare parts and expendables list shall include not only those items supplied, but also the additional items recommended for successful long term operation.

f. "As-Shipped" Drawings

i. Drawings shall be a record of work "As-Shipped" from the factory and shall be labeled as "As-Shipped". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following "As-Shipped" drawings as a minimum:

a) Panel Fabrication Drawings.

b) Panel Wiring and Interconnection Drawings.

G. Final Record Documentation's

1. Reproducible Drawings. Contractor shall submit reproducible's of finished schematics, wiring diagrams and installation drawings to include installed field and panel instruments, mounting details, point to point diagrams with a cable, wire, and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as "RECORD DOCUMENTS", in accordance with the requirements of Section 01 – Contract Closeout. One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.

a. Loop Diagrams.

1) See Paragraph 1.03 C.8 specified herein before.

b. Panel Fabrication and Wiring diagrams.

1) See Paragraph 1.03 C.4 and 1.03 C.6 specified herein before.

c. Interconnecting Wiring Diagrams.

1) See Paragraph 1.03 C.7 specified herein before.

d. Instrument Installation Details.

1) See Paragraph 1.03 C.9 herein before.

2. Process and Instrumentation Diagrams (P&ID's).

a. The Engineer will supply the Contractor with P&ID's on magnetic media for revisions to reflect the final installed system.

b. The P&ID's shall be updated by the Contractor who may use these drawings for producing the final documentation.

3. Software Documentation. In addition to the reproducible hard copy of drawings and literature generated specifically for the project, Contractor shall submit electronic copy to the Engineer with all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc. Drawing format shall be compatible with AutoCad ver. 2018 or newer.

H. Training Requirements.

1. General:

a. Contractor shall provide the services of a CSI factory trained and field experienced instrumentation engineer to conduct group training of Owner's designated personnel in the operation of each instrument system. Obtain Owner's written consent that the training has been adequate. Include instruction covering basic system theory, operating principles and adjustments, routine

maintenance and repair, and "hands on" operation. The text for this training shall be the P & ID's, graphic operation interface, PLC and SCADA software, panel wiring diagrams and layouts, and the operation and maintenance manuals furnished under these Specifications.

2. Duration:
   a. Training specific to the system control panel hardware and software. This training shall be for a minimum time period of 30-8-hour days and 6 trips. This training shall be separate from start-up and testing.
3. Operator Training:
   a. Operator training shall include instruction in the use of Control Panels and Field Panels furnished.
4. Maintenance Training:
   a. Maintenance training shall include instruction in the calibration, maintenance, and repair required for all instruments.

I. Post-Contract System Support.
1. Maintenance Contract:
   a. Duration.
      i. Provide a 1 year maintenance contract for components furnished starting from the date of acceptance.
   b. Schedule.
      i. Develop a program of preventive maintenance visits that includes verification of instrument performance on a monthly basis and complete calibration of instruments on a semi-annual basis. After every visit, submit to the Owner records of instrument verification and calibration on appropriate forms.

J. Guarantee and Warranties
1. The equipment manufacturers shall warrant and guarantee against defective equipment, workmanship, and materials under normal use, operation and services, unless otherwise noted in other Division 40 Sections shall be for a period of 2 years after acceptance from the final date or final resolution of the Owner acceptance of Work as substantially complete. For equipment bearing a manufacturer's warranty in excess of two years, furnish a copy of the warranty to Engineer with Owner named as beneficiary.

PART 2 - PRODUCTS

2.01 HARDWARE REQUIREMENTS

A. Job Conditions.
1. Contract Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Contract Drawings as closely as possible and exercise care (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to accommodate structural features. Verify dimensions and

conditions at the project site, and install materials and equipment in the available spaces.

B. Materials and Standard Specifications.
   1. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities, instruments supplied by the Contractor, of the same type shall be by the same manufacturer. All panel mounted instruments shall have matching style and general appearance. All meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise required to match existing equipment. This allows the stocking of the minimum number of spare parts.

C. Product Delivery, Storage, and Handling.
   1. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element which could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

D. Mountings.
   1. Mount and install equipment as indicated. Where not shown, mount field instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with suppliers recommendation. Unless specified otherwise all mounting hardware shall be stainless steel. Where mounted in control panels, mount according to manufacturer recommendations.
   2. Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting. Non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than three (3) feet nor higher than five (5) feet above walkways, platforms, and catwalks. Such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in Type 316 stainless steel NEMA 4X cases unless otherwise noted.

E. Instrument Identification.
   1. Components provided under this Section, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.
   2. Nameplates for panels and panel mounted equipment shall be as specified on the design documents.
   3. Field mounted tags shall be 16-gauge, Type 304 stainless steel with 3/16-inch high characters.
   4. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with

standard stainless steel hose clamps and meeting the same description. In some cases where this would be impractical, use 20 gage stainless steel wire.

5. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In each case, the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

F. Electronic Equipment.

1. If the equipment is electronic in nature, provide solid state equipment to the greatest extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Where conduit connection is provided for mounting a surge/lightning suppresser directly to the instrument, the arrestor shall be so mounted. Field equipment shall have a Joslyn (or accepted equal) surge suppresser mounted on the instrument housing, if such mounting is provided on the instrument, otherwise a threaded surge suppresser connection shall be provided on the conduit as close as practical to the instrument. See Section 16473 – Low Voltage Surge Suppression Devices.

G. Equipment Operating Conditions.

1. Equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:
2. Power:
   a. Electrical. 115 VAC +/- 10%, 60 Hz +/-1 Hz except where specifically stated otherwise on the drawings or in the specifications.
3. Field Instruments:
   a. Atmospheric contaminants (All Areas):
      i. Hydrogen Sulfide: 0.1 mg/l.
      ii. Chlorine: 0.01 mg/l.
      iii. Ammonia: 0.5 mg/l.
      iv. Dust: 50.0 µg/m3.
   b. Outdoor Areas:
      i. Ambient Temperature: -20ºF to +120ºF.
      ii. Ambient Relative Humidity: 10% to 100%.
      iii. Weather: Rain, wind, sun and blowing sand.
4. Indoor Environmentally Uncontrolled Areas:
   a. Ambient Temperature: 40ºF to +105ºF.
   b. Ambient Relative Humidity: 20% to 80%.
5. Indoor Environmentally Controlled Areas:
   a. Ambient Temperature: 55ºF to +85ºF.
   b. Ambient Relative Humidity: 20% to 80%.

c. Short term excursions to temperature limits for non-environmental controlled areas.

6. Provide, as necessary, enclosures, heat tracing, heaters and sunshields, etc. to assure normal operations under these conditions.
7. Corrosive Areas: Provide instrument enclosures and hardware suitable for the corrosive location.
8. Hazardous Areas: All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Contract Drawings for the locations. All Work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all Owner costs arising there from.

H. Power Supplies.
1. Provide electrical instruments and control devices for operation on 120 VAC, 60 Hz current. Protect each device power supply with properly sized fuses.
2. Unless otherwise indicated provide battery backed up Uninterruptable Power Supply (UPS) with AC inversion for each control panel and PLC. UPS shall be sized to run the peak tributary load for a period of not less than 30 minutes. UPS shall be mounted in the respective panel. Minimum UPS size shall be 990 watt-hour. Provide bypass switch for panels to run directly from power source or through UPS with front of panel mounted indicator light showing current models.
3. Output overvoltage and overcurrent protective devices shall be provided for DC power supplies to protect instruments from damage due to power supply failure and to power supply from damage due to external failure. Power supplies shall be provided with NEMA 1 enclosures. Power supplies shall be mounted such that dissipated heat does not adversely affect other components. Source of operating power shall be 120 VAC, 60 Hz commercial power. Units shall be mounted within the control panels. Power supply fusing shall be provided with blown fuse indicators.

I. Signal Isolators, Converters and Conditioners.
1. Insure that input-output signals of all instruments and control devices (new and existing) are compatible. Analog signals between field and panels shall be 4-20 mA unless specifically accepted otherwise. Granting such acceptance does not relieve the Contractor from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application, as required for accurate signal acquisition.

J. Auxiliary Contacts by Others.
1. Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

K. Painting.
1. Provide factory paint for instruments and equipment except where in pipelines.

L. Electrical.

1. Work shall include the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required and not specifically included under Division 26.
2. Wiring installations shall include cables, conductors, terminals, connectors, wire markers, conduits, conduit fittings, supports, hardware and all other required materials not specifically included in the Work of other Divisions.
3. Provide the materials and complete the required installations for equipment grounding as specified in Division 26 of these Specifications and indicated on the Contract Drawings.
4. Incidental items not specifically included in the Contract Documents that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided and installed by the Contractor at no additional cost to the Owner.
5. Field Wiring. For wiring materials, refer to Division 26 and Details on the Contract Drawings. Test signal wiring for continuity prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type heat shrink label or equal for each termination.

M. Process Connections.

1. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance, etc. All instrument pneumatic tubing shall be Type 316 stainless steel. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shut down of the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under other Divisions of these Specifications but coordinated by Division 40.

N. Electrical Transient Protection.

1. Instrument and control equipment mounted outside of protective structures (field mounted equipment) shall be equipped with surge-arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Both power and signal circuits shall be protected with surge and transient protectors installed at the source and destination ends of the circuits. Protective devices used on 120 VAC inputs to field mounted equipment shall be secondary surge protectors conforming to the requirements of IEEE C62.41 8/20μs wave form.
2. Surge and transient protectors shall be normally connected to the electrical system ground. When an electrical system ground is not available near the device, the protectors shall be connected to a ground rod located within 10 feet of the device. The ground rod shall meet all the requirements of Section 26 05 26 - Grounding and Bonding, in Division 26, Electrical.

3. Protectors for analog signal circuits on or near field instrument housings shall be Innovative Technology Model OEM D22TX, Phoenix Contact Surge Trab Series, or accepted equal.
4. Protectors shall be provided for conductors penetrating panel enclosures for power circuits protectors shall be Innovative Technology Model HS-P-5P secondary arrestor, Phoenix Contact PT Series, or accepted equal. For analog and data circuits protectors shall be rail mounted Innovative Technology Model HS, or accepted equal. Protectors for data utilizing coaxial connections shall be Innovative Technology, or accepted equal. Provide multi-stage gas tube and solid state Innovative Technology, or accepted equal, protectors for digital circuits.

O. Spares and Maintenance Materials.
1. Furnish the following items as specified herein. Deliver to Engineer, as directed, with itemized list in a letter of transmittal accompanying each shipment.
2. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.
3. One Fuse of each size and type for every five used but no less than five of each type.
4. One Relay of each type for every five used but no less than two of each type.
5. One Panel Indicating Light Bulb for every five used but no less than four of each type.
6. One Transient Protector for every five used but no less than four of each type.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING

A. Shipping Precautions: After completion of shop assembly, factory test, and acceptance, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. Special Instructions: Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment before packaging and shipment.

C. Tagging: Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the ICM system. Identification shall be prominently displayed on the outside of the package.

D. Storage: Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected

against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor at no additional cost to the Owner. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. Such tests shall be at no additional cost to the Owner, and if the equipment fails the tests, it shall be replaced at no additional cost to the Owner.

E. Protection during Construction: Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters.

F. Paint Finish: Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer.

3.02 MANUFACTURER'S SERVICES

A. Furnish the following Manufacturer's services for all instrumentation provided:
   1. Perform bench calibration.
   2. Oversee installation.
   3. Verify installation of installed instrument.
   4. Certify installation and reconfirm Manufacturer's accuracy statement.
   5. Oversee loop testing, prepare loop validation sheets, and certify loop testing.
   6. Oversee pre-commissioning, prepare pre-commissioning validation sheets, and certify pre-commissioning.
   7. Train the Owner's personnel.

3.03 INSTALLATION

A. General:
   1. All instrumentation, including instrumentation furnished under other Divisions, shall be installed per the manufacturers' instructions and Division 40.
   2. Equipment Locations: The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment that do not impact material quantities or cause material rework, make such changes without additional cost to the Owner.

B. Conduit, Cables, and Field Wiring
   1. All conduit shall be provided, in accordance with Section 26 05 33.

2. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, remote I/O, PLC I/O, and other non-specialty field wiring and cables shall be provided and installed, in accordance with Section 26 05 05.
3. All ICM system specialty cables, data highway fiber optic cable and specialty cable termination devices shall be provided under Division 40 and installed, in accordance with Section 26 05 05..
4. All field cables and wiring terminations and wire identification at ICM system equipment furnished under this or any other Division shall be provided in accordance with the requirements of Section 26 05 05. All terminations shall be checked by the equipment supplier and the electrical contractor.

C. Instrumentation Tie-Downs: All instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements that apply to the site.

D. Existing Instrumentation: Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned and recalibrated by an authorized service facility of the instrument Manufacturer. Provide certification of this Work before reinstallation of each instrument. Provide replacement for interim period as required.

E. Ancillary Devices: The Contract Documents show all necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements at no additional cost to the Owner. All such additions and all such changes, including the proposed method of installation, shall be submitted to the Engineer for acceptance before commencing the Work. Such changes shall not be a basis of claims for extra work or delay.

F. Installation Criteria and Validation: All field-mounted components and assemblies shall be installed and connected according to the requirements below:
1. Installation personnel have been instructed on installation requirements of the Contract Documents.
2. Technical assistance is available to installation personnel at least by telephone.
3. Installation personnel have at least one copy of the accepted and approved shop drawings and data.
4. Instrument process sensing lines shall be installed similar to conduit. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3-feet of rigid tubing.
5. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.
6. All differential pressure elements shall have three valve manifolds.
7. All flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
8. All power and signal wires shall be terminated with crimped type lugs.
9. All connectors shall be, as a minimum, water tight.

10. All wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
11. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically accepted by the Engineer. All wiring shall be protected from sharp edges and corners.
12. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.
13. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. Certify in writing that for each loop or system checked out, all discrepancies have been corrected.
14. The Owner will not be responsible for any additional cost of rework attributable to actions of the Contractor or the CSI.

3.04 CALIBRATION

A. General: All devices provided under the instrumentation Sections shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Calibration Points: Each instrument shall be calibrated at 20, 40, 60, 80 and 100% of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Testing Standards.

C. Bench Calibration: Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Field Calibration: Instruments that were not bench-calibrated shall be calibrated in the field to insure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. All samples and sample gases shall be furnished by the manufacturers.

F. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. Have the Instrumentation Supplier sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.05 LOOP TESTING

A. General: Individual instrument loop diagrams per ISA Standard S5.4 - Instrument Loop Diagrams, expanded format, shall be submitted to the Engineer for review before the loop tests. The Contractor shall notify the Engineer of scheduled tests a minimum of 30 days before the estimated completion date of installation and wiring of the ICM. After the

Engineer's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the Engineer.

B. Control Valve Tests: All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to ensure that no changes have occurred since the bench calibration.

C. Interlocks: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.

D. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance its Manufacturer's specifications and instructions. Any instrument that fails to meet any Contract requirement, or, in the absence of a Contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the direction of the Engineer at no additional cost to the Owner.

E. Loop Validation: Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA and PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Specified accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks that incorporate analog elements, simulated sensor inputs corresponding to 20, 40, 60, 80 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated root-mean-square-summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. All analog loop test data shall be recorded on test that include calculated root-mean-square-summation system accuracy tolerance requirements for each output.

F. Loop Validation Sheets: Prepare loop confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop provided by the CSI:

1. Project name.
2. Loop number.
3. Tag number, description, manufacturer and model number for each element.
4. Installation bulletin number.
5. Specification sheet number.
6. Loop description number
7. Adjustment check.
8. Space for comments.
9. Space for loop sign-off by Instrumentation Supplier and date.
10. Space for Engineer witness signature and date.

G. Loop Certifications: When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the Engineer as a witness, with test data entered, shall be submitted to the Engineer together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

3.06 PRE-COMMISSIONING

A. General: Pre-commissioning shall start after acceptance of all wire test, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contract requirements. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

B. Pre-commissioning Procedures and Documentation: All pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer as submitted by the CSI. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, that include calculated tolerance limits for each step. Completion of all system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.

C. Operational Validation: Where feasible, system pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic

analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

D. Loop Tuning: All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 20, 40, 60, 80 and 100% of span and the results checked against indicated accuracy tolerances.

E. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on one of two types of test forms as follows:
   1. For functions that can be demonstrated on a loop-by-loop basis, the form shall include:
      a. Project name.
      b. Loop number.
      c. Loop description.
      d. Tag number, description, manufacturer and data sheet number for each component.
      e. Space for sign-off and date by both the CSI and the Engineer.
   2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description, the following information shall be included:
      a. Specification page and paragraph of function demonstrated.
      b. Description of function.
      c. Space for sign-off and date by both the CSI and the Engineer.

F. Pre-commissioning Certification: Submit an ICM system pre-commissioning completion report that shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

3.07 ONSITE SUPERVISION

A. Furnish the services of an on-site service engineer to supervise and coordinate installation, adjustment, testing, and start-up of the ICM system. The Engineer will be present during the total period required to affect a complete operating system. A qualified team of the Instrumentation Subcontractor personnel shall be on site as required to check all equipment, perform the tests indicated in this Section, and furnish startup services.

3.08 PERFORMANCE TEST

A. The entire ICM system shall operate for 30 days without failure.

B. Furnish all necessary support staff as required to maintain the system and to satisfy the repair or replacement requirements.

C. If any component fails during the performance test, it shall be repaired or replaced within 4 hours and the ICM system shall be restarted. If the system is not repaired and running within four (4) hours or more than six component failures within the four (4) hour repair period, the system shall be restarted and operate for an additional 30 days without failure.

3.09 TRAINING

A. Test entire ECM system.

B. General: Train the Owner's personnel on the maintenance, calibration and repair of all instruments provided under this Contract.

C. Instructions: The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

D. Duration: Each training class shall be a minimum of 8 hours in duration and shall cover, as a minimum, operational theory, maintenance, troubleshooting/repair, and calibration of instruments. Include a minimum of 4 hours training per instrument or control device; for PLC, and software include 8 hours for each type supplied.

E. Schedule: Training shall be performed during the pre-commissioning phase of the project and 30 days after acceptance. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The Owner and Engineer will review the course outline and the training manual as submitted by the CSI for suitability and provide comments that shall be incorporated.

F. Agenda: The training shall include operation and maintenance procedures, trouble shooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment.

G. Documentation: Within 10 days after the completion of each session the Contractor shall submit the following:
   1. List of all Owner personnel who attended the session.
   2. Evaluation of Owner personnel via written testing or equivalent evaluation.
   3. Copy of the training materials used including all notes, diagrams, and comments.

3.10 ACCEPTANCE

A. For the purpose of this Section, the following conditions shall be fulfilled before the Work is considered substantially complete:
   1. All submittals have been completed and accepted.
   2. The ICM system has been calibrated, loop tested and pre-commissioned.

3. The Owner training has been performed.
4. All required spare parts and expendable supplies and test equipment have been delivered to the Owner.
5. The performance test has been successfully completed.
6. All punch-list items have been corrected.
7. All record drawings in both hard copy and electronic format have been submitted.
8. Revisions to the operations and maintenance manuals information that may have resulted from the field tests have been made and reviewed.
9. All debris associated with installation of instrumentation has been removed.
10. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

3.11 WARRANTY

A. Supplier shall warrant design, materials, and workmanship for customary period applicable for the equipment involved, but in no case for less than 24 months from date of acceptance, in accordance with the requirements of Paragraph 1.03, J, 1.

B. During warranty period, if mechanical defects occur, or equipment fails to perform in accordance with specified performance requirements under conditions of normal use within the design limitations of the equipment, supplier shall, upon request of the company, repair or replace equipment or parts as required and shall place equipment in proper working condition, assuming all expenses involved.

C. A written prepaid maintenance contract executed by the CSI shall be provided to the Owner for on-site warranty and travel maintenance services, in accordance with the requirements of Paragraph 1.03, H, and Paragraph I, 1. This maintenance contract shall include all travel and living expenses, labor, parts, and emergency calls providing on-site response within 4 hours, to provide complete system maintenance for a period of one year after the date of final acceptance of the system.

D. The maintenance contract shall include a minimum of 4 (quarterly) preventive maintenance visits by a qualified serviceman of the Supplier who is familiar with the type of equipment and software provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of system equipment and written verification of calibration and correct software operation.

E. An annual fee shall be quoted 90 days before completion of the first year maintenance contract for annual maintenance subsequent to the first year of operation. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from day of issue.

END OF SECTION

SECTION 40 94 03 - PROGRAMMABLE LOGIC CONTROLLER SUBSYSTEM (PLCS)

PART 1 - GENERAL

1.01 SCOPE

A. General - This section describes the Programmable Logic Controller (PLC), Input/Output (I/O) equipment, Operator Interface Terminal (OIT), fiber optic industrial Gigabit Ethernet and associated network communication equipment, and associated hardware and equipment, PLC programming software, Human Machine Interface (HMI) SCADA application software including all engineering and programming and development required for monitoring and control. All devices, accessories, programming, and appurtenances required for proper operation of a complete and functional Instrumentation Control and Monitoring (ICM) system shall be provided.

1. The SCADA system shall be designed, coordinated, and supplied by a Control System Integrator (CSI) consisting of PLC based data acquisition and operator interface graphic display systems, who shall guarantee satisfactory operation of the installed ICM system.
2. Develop and provide the PLC and SCADA HMI and OIT graphic display applications programs and hardware configuration needed to monitor and control the process equipment to perform the functional requirements as specified in Division 40 Sections or as required by the process equipment manufacturers and as required by and described in these Contract Documents.
3. SCADA PLC’s shall be configured and provided with hardware necessary to communicate with Ethernet enabled process instrumentation and equipment as required in these specifications.
4. In general, communication network from structure to structure shall be via industrial redundant, self-healing Ethernet optical fiber network. Each PLC and Operator Workstation shall be provided with a UPS with a 30-minutes full load minimum. In the event of local power failure, the PLC shall automatically stop fault sequencing, PID windup, and continue accumulation of data and process calculations while notifying the operator via the HMI screens. Communication shall continue with PLC and workstations.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. National Electrical Manufacturers Association (NEMA).
2. Instrument Society of America (ISA).

1.03 SUBMITTALS

A. The Contractor shall make submittals in accordance with Divisions 01 and 40.

B. The following information shall be provided:

1. Electronic copy of each of the following shall be submitted:
   a. Manufacturers complete data.
   b. Shop drawings, which include the following:

i. Outline drawings of all components and a composite drawing.
ii. Schematic drawings of auxiliary piping and wiring.

2. Electronic copy of each of the following shall be submitted:
   a. Operation and maintenance manual.
   b. Training documentation.

1.04 TESTING

A. Factory testing, field testing, and final acceptance testing of computers and programmable logic controllers shall conform to the requirements of Section 40 90 00.

1.05 WARRANTY

A. Conform to warranty requirements of Division 40.

B. The equipment manufacturers shall warrant and guarantee against defective equipment, workmanship, and materials under normal use, operation and service, for a period of 2 years after acceptance from the final date or resolution of the Owner accepting Work as substantially complete.

1.06 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as required. In addition, the following specific spare parts items shall be provided:
   1. One of each type of CPU and co-processor module for PLC equipment furnished under this Contract.
   2. One of each type of input/output module for PLC equipment furnished under this Contract.
   3. One of each type and size of PLC and equipment power supply furnished under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Provide Programmable Logic Controller including necessary equipment and appurtenances as manufactured by the following acceptable manufacturer:
   1. Allen Bradley – CompactLogix.

2.02 PROGRAMMABLE LOGIC CONTROLLER AND I/O HARDWARE

A. General
   1. Provide PLC hardware including processors, power supplies, rack assemblies, interconnecting cables, grounding system, communication modules, hot standby modules, and accessories required to perform the control and monitoring functions.

B. Programmable Logic Controller (PLC)
   1. The PLC shall be provided with the following minimum features:

a. The processor shall be the slot mount type, include at least 2MB available user memory. Minimum CPU shall be CompactLogix series.

b. The PLC system shall be able to accommodate the quantity and type of I/O points shown and described including future I/O points. In addition, provide 20% spare I/O points for each type, where a certain type of I/O is not required such as analog output, provide at least one such I/O module.

c. The PLC system shall include one Ethernet communication module. Ethernet communication module shall be used for permanent system-type communications from PLC to PLC and to HMI operator workstations throughout the plant. Data transfer rate shall be up to 100Mbit/s.

d. The PLC system shall operate over 0 to 60 degree Celsius temperature range, and a 0 to 95% (non-condensing) humidity range.

e. The processor shall include diagnostic indicators for power, mode, low battery, communications ports, and memory and I/O errors.

f. The PLC system shall allow on-line and off-line programming.

g. The CPU's shall have executive firmware which may be upgraded in the field using an upgrade/download procedure which does not require the removal and/or insertion of IC chip.

h. The PLC system shall be capable of communicating with third party devices such as Motor Control Centers, including Variable Frequency Drives (VFD), and packaged vendor equipment systems via Ethernet IP.

2. The PLC system in each control panel shall include a single or redundant processor (when shown on the drawings), power supply, and hot standby module. If the primary PLC system fails the standby PLC system shall assume primary control functions within 48 milliseconds of the failure. A failed component shall be able to be removed, replaced, and reloaded (with software) without shutting the on-line PLC system down. No special application programming shall be required to implement the hot standby PLC systems.

3. A power supply (quantity and size as required) shall be provided to supply power to the processor and I/O modules. The supply voltage to the power supply shall originate within the control panel and shall be 120 VAC. A separate 24 VDC power supply shall be provided to power the analog loops.

4. I/O modules shall be provided as required to accommodate the types and quantities of I/O points identified. Sample I/O point types include; dry contact outputs, 4-20 mAdc analog inputs, 4-20 mAdc analog outputs, and 120 VAC discrete inputs. Discrete inputs shall use 120 VAC as the voltage signal, and analog loop signals that leave the control panel shall use a 4-20 mAdc current signal. I/O module point density shall not exceed 16 points per module. Each I/O module shall include front panel mounted diagnostic indicators for point status, fault conditions, and active conditions. The I/O modules shall be able to be replaced while under power and shall be keyed to prevent the wrong type of module from being inserted in the wrong slot. All I/O modules shall have removable terminal blocks for termination of field wiring. All terminal blocks shall be 'keyed' to prevent application of terminal block to wrong I/O module. All I/O modules shall report to the CPU should a terminal block fail or be removed.

5. The PLC and I/O modules rack assemblies shall be housed in the control panels as specified.

6. The control panels shall be provided with sufficient I/O modules to allow 20% spare installed and wired I/O points. Spares shall be provided for each different type of I/O.

7. The PLC and I/O equipment shall be a standard industrial grade product mechanically and electrically suitable for use in an industrial environment with a satisfactory product history of at least five years.

2.03 PROGRAMMABLE CONTROLLER APPLICATION & DEVELOPMENT SOFTWARE

A. The PLC programming and configuration software shall be the manufacturer's latest version, and compatible with the Windows 10 operating system. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. Programming shall be accomplished through the use of ladder logic and other IEC 1131.3 languages. PLC programming software shall include electronic documentation.

B. Third-party programming software shall be acceptable if recommended by the manufacturer and if that software exceeds the capabilities of the PLC manufacturer's standard software package.

C. All configuration and programming software necessary shall be provided on each operator workstation computer specified, including the Portable Laptop Programming Terminal, for connection to any PLC processor on the Ethernet network or via direct connection to the processor communications port. All necessary hardware drivers required to perform PLC configuration and programming shall be provided.

D. If available, the configuration and programming software shall support communication over the network to implement its functions remotely from an operator workstation. All configuration and programming software necessary to implement this functionality shall be provided on the SCADA System Operator Workstations. All necessary hardware and software drivers required to allow the operator workstation to perform PLC configuration and programming shall be provided.

E. The ladder logic instruction set for the PLC shall include the following, as a minimum:
   1. Relay type instructions.
   2. Counter and timer instructions.
   3. Comparison instructions (equal, greater than, limit tests, etc.).
   4. Integer and floating point mathematical instructions.
   5. Advanced math and trigonometric functions.
   6. Statistical instructions.
   7. Matrix and array instructions.
   8. Logical instructions (and, not, or, etc.).
   9. BCD conversion instructions.
   10. Bit modification, moving, and shift instructions.
   11. File instructions (search, copy, fill, etc.).
   12. Diagnostic instructions.
   13. Sequencer instructions.
   14. Program control instructions (jump, goto, subroutine, etc.).
   15. PID control loops.
   16. Block read and write capability.

17. Send/receive messages.
18. Immediate I/O and communications update instructions.

F. The PLC programming & configuration software shall be the latest version of RSLogix as required.

2.04 SCADA HMI APPLICATION SOFTWARE

A. Provide an operator interface software package that, when combined with the operator station computer hardware, will gather, display, and store real-time operating information. The operator interface software package shall be sized according to the appropriate I/O point count and shall be able to accommodate 20% additional I/O in the future, but as a minimum shall accommodate 10,000 I/O.

B. HMI Application Software

1. The operator interface software package shall provide the following minimum functions:
   a. Compatible with Windows 10 Pro operating system.
   b. The software package shall be provided with the appropriate Ethernet driver software, Ethernet hardware interfaces, and required Ethernet communication/configuration interface software as required.
   c. The SCADA software shall utilize existing HMI software package.
   d. Database management shall be performed using Microsoft SQL Server Database. The ability to store historical data (analog or digital) to daily, weekly, or monthly files and the ability to archive historical data to tape.
   e. Report writing software shall be the latest version of XLReporter by SyTech, Inc., or accepted equal. The system integrator shall coordinate directly with the owner on types of required report as well as the reports format, etc.
   f. Analog data shall be configured to be stored as average, minimum, maximum, or instantaneous values, in the proper engineering units.
   g. A complete alarm handling package shall be provided that shall annunciate alarms in an alarm queue and allow them to be displayed on the process graphic displays with messages or by changing colors or otherwise massaging graphic display symbols. An alarm summary screen shall be provided. Alarms shall be able to be acknowledged by an operator at the operator station CRT on an individual or screen basis and nuisance alarms shall be able to be disabled. Alarms shall be logged to the alarm printer.
   h. Password protection for the various levels of access (day-to-day functions versus configuration changes), Log in and Log out at all times and Auto log off with set time.
   i. The data base points shall be identifiable by tag numbers.
   j. The entire system configuration, including database, shall be able to be backed up on Cloud Storage (cloud services shall be prepaid by the system integrator for at least 3 years) as well as a local External Drive.
2. Real Variables Processing.
   a. Real Variables shall represent process data for which there are analog signal inputs to the system. The system shall sample each of these input signals at their selected scan frequency, and perform the proper conversions and scaling to obtain the instantaneous

engineering values. These values then shall be used to update real-time data on CRT displays, check for alarm conditions, and store for use in the historical files.

3. Calculated Variables Processing:
   a. Calculated variables shall represent process parameters for which there are no direct analog inputs to the system. These variables shall utilize Real Variables, and manually entered constants or laboratory data to compute their value.
   b. There shall be two types of calculated variables defined:
      i. Calculated Variables that utilize one or more Real Variables and/or manually entered constants. These variables shall be treated in the same manner as Real Variables and shall have the same attributes as Real Variables (including alarming and control), with the exception that the calculation shall be performed automatically every 5 seconds.
      ii. Calculated Variables which are used only for the Daily, Monthly, and Annual Operation Summary reports, and which utilize laboratory input data shall be computed once a day for inclusion in the Daily report and stored for use in the Monthly and Annual reports. The capability to display these variables shall be provided.
   c. The System shall provide for a minimum of 4096 calculated variables.
4. Manual Input Data Handling.
   a. The application software shall provide the capability to enter data manually from any operator's keyboard. This data shall consist of additional values for the current data file (e.g., laboratory analyses), inserting alarm limits, set point changes, adjustments to process constants, control system set point changes and system tuning parameter adjustments.
   b. All manually entered data shall be entered and stored in the appropriate engineering units. All data entered shall be displayed for confirmation on the data entry device prior to incorporation to the data base.

2.05 MANAGED ETHERNET SWITCHES

A. The managed Ethernet switch will be IEEE 802.3 compliant.

B. The switch shall be powered by a nominal 24VDC supply.

C. The switch will have a permissible voltage range of 18.5 VDC to 30.2 VDC

D. Switch will support redundant power inputs that allow immediate switchover without switch operation interruption.

E. The switch shall have an operating temperature range of 0°C to +55°C.

F. The permissible storage temperature range for the switch will be -20°C to +70°C.

G. The switch will withstand a maximum continuous operating humidity of 95% without condensation.

H. Units should be of fan-less design to increase reliability

I. Switching Capabilities:
   1. Auto-negotiation.
      a. All Copper TX ports will support auto negotiation.
      b. Each TX port will be able to interface to 10/100/1000 Mbps or full/half duplex devices.
      c. Fiber optic ports will support continuous 10/100/1000 Mbps full duplex communications.
   2. Auto Cross.
      a. All TX ports will support MDIX providing cable autocross capability.
   3. Auto Polarity.
      a. The switch will support automatic port polarity change in the event a pair of twisted pair receive cables (RD+/RD-) are connected incorrectly.
   4. Serial Interface.
      a. The device will have a V.24 RS232 communications interface.
   5. Accuracy & Capacity of switching table.
      a. The switch will only forward valid Ethernet frames using the store and forward, or equivalent method.
      b. The MAC address table will have a storage capacity of 8000 addresses.
   6. Configurations.
      a. The switch will support a removable memory device for the storing of switch settings, and the ability to share settings among like switches.

J. Diagnostics:
   1. Port Status LED's.
      a. Link: Each port will have an LED indication that there is a proper electrical connection to the attached device as well as providing indication that there is port activity.
      b. Communication: Each port will have an LED indication for detection of packet collisions, and showing communication duplex mode.
      c. To simplify the process of troubleshooting, the status indication of heavy communications traffic vs. the status of an active link with no communications traffic will be unambiguous.
   2. LED Display.
      a. The switch will employ a multi-position diagnostic display for reporting various startup and operational states, or error conditions that may occur.
   3. Alarm Contact.
      a. Switch to be equipped with an alarm contact to enable automatic audible or visual alarm in the event of loss of port communication, or either (or both) power supply inputs.
      b. Switch to be equipped with an LED to indicate the status of the alarm contact.
   4. Power Supply LED.
      a. Switch will have a separate power indication LED for each power supply connection.

K. Internal Switch Functions:
   1. Simple Network Management Protocol (SNMP).
      a. The switch will support SNMP v1, v2 for network monitoring and configuration.

b. The switch will operate with any industry MIB browser.
c. Switch will have a system of fully configurable SNMP Trap messages.

2. Device Addressing.
   a. The switch will, by default, support dynamic device addressing via BootP.
   b. The switch will be capable of operation with a static IP address assignment.
   c. Support for switch IP address assignment via DHCP will be available.
   d. Switch address can be set via serial port connection.
3. Redundancy.
   a. Rapid Spanning Tree Protocol (RSTP).
      i. The switch will conform to the IEEE standard 802.1w for redundancy.
      ii. The switch will support redundant port connections and loops without causing network operation failure
      iii. The system of redundancy will be applicable for any network topology
      iv. Entire redundancy method will be integral to the individual switch and not dependent upon a separate management device.
   b. Fast Ring Detection (FRD).
      i. The Switch shall support the RSTP extension Fast Ring Detection to enable data channel recovery times faster than standard RSTP.
   c. Media Redundancy Protocol (MRP).
      i. Switch will support MRP in accordance with the IEC protocol 62439.
4. Web-Based Management.
   a. The switch will be programmed with an embedded web server.
   b. The web server will provide a comprehensive configuration, and diagnostic mechanism for the switch.
5. Security.
   a. The switch will provide the user the ability to entirely disable the Web-based management interface.
   b. Switch will support an IP address based method for restriction of Web server access.
   c. Modifications to switch settings will be protected by a user selectable/changeable password.
   d. The switch will support an optional MAC address based mechanism for controlling port access.
6. Port Mirroring.
   a. The switch will have the capability to send a copy of all network packets seen on one switch port to a network monitoring connection on another switch port.
   b. The switch will support mirroring of both ingress and egress traffic.
7. Firmware Administration.
   a. The switch will be structured so that future functionalities can be added through firmware upgrades.
   b. The switch will have the capability to receive firmware upgrades as a field serviceable process.

c. Firmware upgrades will be performed via the integrated web server in conjunction with any TFTP server software, or via the serial connection.

8. IGMP Snooping and Query.
   a. The switch will be capable of passively monitoring IGMP (multicast) messages and dynamically creating appropriate groups for proper message forwarding.
   b. The query interval and snoop aging times will be user configurable to up to 60 minutes.
   c. The switch will support up to 128 multicast groups.
9. Large Ring Networks.
   a. The switch will support a configurable "Large Tree" extension to the Rapid Spanning Tree option, making a ring topology suitable for 28 switches along the relevant path from the Root.
   b. This support option will provide the capability of constructing an RSTP ring topology of up to 57 switches, when all switches are configured with same function.
10. Traffic Prioritization.
   a. The switch will support multiple priority queues for adjusting the internal packet processing sequence.
   b. The switch will employ "Strict Priority" for transmitting data telegrams to ensure all high-priority data packets are transmitted.
   c. Switch will have a user settable internal prioritization for individual ports, so that the processing of Ethernet data for a particular port can be optimized.
11. Power over Ethernet (PoE).
   a. Switch shall provide support of Power over Ethernet in compliance with IEEE standard 802.3af.
12. Virtual LAN (VLAN).
   a. The switch is able to maintain up to 32 concurrent VLANs.
   b. The switch will support GARP VLAN Registration Protocol (GVRP) for dynamic VLAN implementation.
13. Link Layer Discovery Protocol (LLDP).
   a. The switch will support LLDP according to IEEE 802.1ab, for topology detection of devices that also have LLDP activated.

L. Managed Ethernet switches shall be Allen Bradley, N-Tron, Cisco, Phoenix Contact, Hirschman, or accepted equal.

2.06 UNMANAGED ETHERNET SWITCH SPECIFICATION

A. Ethernet Interfacing & Switching Capabilities
   1. The Unmanaged Ethernet switch will be IEEE 802.3 compliant.
   2. The switches must be capable of reading and processing high priority Ethernet packets before low priority during times of heavy network traffic in accordance with the priority levels of IEEE 802.1P/Q.
   3. Auto-negotiation:
      a. All Copper TX ports will support auto negotiation. Each TX port will be able to interface to 10/100 meg or full/half duplex devices.

4. Auto Cross:
    a. All TX ports will provide cable autocross capability.
5. Accuracy & Capacity of switching table.
    a. The switch will only forward valid Ethernet frames using the store and forward or equivalent method.
    b. The address table will have a minimum capacity of 4000 addresses.

B. Diagnostics.
1. Port Status LED's.
    a. Link Active: Each port will have a LED indication that there is a proper electrical connection to the attached device.
    b. Communications Status: Each port will have an LED indication of communications activity.
    c. To simplify the process of troubleshooting, the status indication of heavy communications traffic vs. the status of an active link with no communications traffic will be unambiguous.

C. Installation Requirements.
1. Mounting.
    a. The Switch will be din rail mountable out of the box and without the need to add/assemble adaptor or similar mounting plates.
    b. All power connections will be wired using removable connectors.
2. Port Security.
    a. The switch will be configured to accept optional security frames. When installed, these frames will lock inserted cables or plugs into place, then requiring the use of a small mechanical key for cable or plug removal.

D. Environmental Specifications & Agency Approvals.
1. Temperature & Humidity.
    a. The Switch will have an operating temperature range of 0 to 60c or greater. For extended application life, the maximum temperature will be a minimum of 10 degrees C lower than the specified operating temperature of the internal switch chips.
    b. The switch will withstand a maximum continuous operating humidity of 95% without condensation.
2. Electrical Noise Immunity.
    a. The switch will conform to the IEC61000-4-2 to 4-8 series of noise specifications as specified below:
        i. IEC 61000-4-2 Electrostatic Discharge: Criterion B.
        ii. IEC 61000-4-3 Radiated Noise Immunity: Criterion A.
        iii. IEC 61000-4-4 Fast Transient (Burst) Withstand: Criterion B.
        iv. IEC 61000-4-5 Surge Voltage: Criterion B.
        v. IEC 61000-4-6 Conducted Noise Interference: Criterion A.
        vi. IEC 61000-4-8 Electromagnetic Field withstand: Criterion A.

3. Shock & Vibration.
   a. The operating shock rating will conform to IEC60068-2-27 and withstand a shock pulse of 25G or more for 11ms.
   b. The operating vibration spec will conform to IEC60068-2-6 (Criterion 3) at 5G 150Hz, in all 3 axis.
4. Agency Certifications.
   a. The switch will be certified for UL/Cul 508.

E. Unmanaged Ethernet switches shall be Allen-Bradley, N-Tron, Hirschman, Phoenix Contact, Weidmuller, or accepted equal.

2.07 ETHERNET COMMUNICATION NETWORKS

A. General
1. Ethernet links shall be provided to connect all PLC's to Network Interface Panels (NIP), Motor Starters (MCC), and Control Panels as shown on the Contract Drawings. The Ethernet communication system shall use modular rack or back of panel mounted components for interfacing with required field connections. Provide necessary racks, interface modules, gateways, segment couplers, power supplies, Fiber-to-Ethernet converters, fiber patch panels and all other components as necessary for a complete and operable Ethernet communications system.

PART 3 - **EXECUTION**

3.01 PROGRAMMABLE LOGIC CONTROLLER APPLICATION SOFTWARE & DEVELOPMENT

A. Provide programming to produce completely annotated application programs. Application programs shall be produced on equipment supplied by the Contractor as part of the Work. The application programming shall be developed as follows:
1. The application programs shall be developed in a neat, professional, logical, and efficient manner such that the available PLC memory is not wasted. The application programming shall be completely documented with detailed rung comments and address comments that correspond to tag numbers provided on the Contract Drawings or in the description of operation. Application programming that manipulates analog signals shall utilize values that are scaled in the proper engineering units and are of the correct magnitude. Formulas utilized shall be described in detail.
2. Use the system descriptions from Contract Drawings, process equipment manufacturer supplied information, and other application-oriented documents to develop the application programs.
3. The application programming shall account for the fact that an HMI operator interface will be communicating with the PLC. The programming and addressing schemes shall allow efficient and logical block mapping of points between the various pieces of equipment.
4. Provide programming package software and hardware tools at the conclusion of the Project, including USB Memory drives and reference manuals.

B. The manufacturer's license agreements for software packages shall be made out to the Owner.

3.02 SCADA HMI APPLICATION SOFTWARE DEVELOPMENT

A. Data Management.

1. The workstations shall scan the PLC's on demand and as necessary to retrieve and send analog, discrete and virtual input information for displays, control and related operator workstation functions. The current database shall be resident in the distributed network devices as appropriate.
2. Elapsed running time values shall be maintained in the database for all process drives. This data shall be expressed in hours and tenths of hours and shall be updated every sixty seconds using the last scanned value for each associated discrete input. Accumulated runtime data shall be periodically updated (once per hour) in disk memory. The exact time and date of initiation shall be maintained for each runtime accumulation. The operator may, at any time, from any operator workstation, access historical or current accumulated runtime values and either display or print reports containing accumulated runtime for certain specified equipment (i.e., sorted by accumulated hours, equipment ID, etc. within a user specified range) or all equipment. The operator shall be able to selectively reset any or all runtime accumulations to zero (or other legal values). The specified spreadsheet and database software shall be furnished with all required macros/applications to perform the reporting functions.
3. For reporting purposes, the database shall perform averaging and integration on a point basis over the following time periods:
    a. Five second – derived from readings accumulated at scan rates, stored for 3 days.
    b. Five minutes – derived from above 5-second valves, stored for 3 days.
    c. Hourly – derived from above five-minute values, stored for 1 year.
    d. Daily – derived from above one-hour values, stored for 1 year.
    e. Monthly – derived from above shift values, stored for 1 year.
    f. Annually – derived from above monthly values, stored for 1 year.

B. Graphic Display Organization - General

1. The display system described in the following paragraphs only defines those types of displays commonly used during normal operations and overall display organization. Displays shall be based upon information contained on the process flow diagrams, mechanical sheets, electrical drawings, other related drawings, and written narrative descriptions contained in the Specifications. The Contractor shall provide sufficient displays to satisfy all specified plant instrumentation and control system requirements
2. The description of the workstation operation in the remainder of this Section is based on the use of a mouse with screen icons. Should an alternate device be provided, operation shall be functionally equivalent to the procedures outlined below.
3. Alternative, but equivalent, graphic display formats and organization may be submitted for acceptance by the Engineer. However, any such substitutions shall conform to all functional requirements specified herein.
4. Each display format may consist of more than one page. If so, the display shall contain the message MORE (or other suitable descriptive text) as an icon on the bottom line and the next page shall be obtained by a strike on the "page forward" (PF) or the MORE icon. Backpaging shall be accomplished by a strike in the "page back" (PB) icon.

5. The Page Forward (FRWD) and Page Back (BACK) icons shall permit the user to page forward and backpage on a multipage listing. If a listing is larger than the capacity of a single CRT page, a MORE icon shall appear on the display. MORE means that there is more data for this display which can be accessed a page at a time with the MORE or FRWD icon. The BACK icon shall be used to reverse the forward display sequence, a page at a time. FRWD or BACK icons shall not be used on a single page display.
6. For map based and/or site plan displays, system pan/zoom features as well as system vertical horizontal and vertical scroll bars may be used for this purpose.
7. Vector targets shall be employed to move vertically and laterally between related displays or, alternatively, the vertical and horizontal window can be used, where appropriate.
8. The formats for all schematic diagrams (e.g., unit process, process partition and control strategy diagrams) shall be based on the site plan, mechanical and electrical power distribution drawings and shall be submitted to the Engineer for review. Process displays shall generally be site plan oriented, unless otherwise accepted by the Engineer.
9. The operator screens shall be made of any number of the following components, as appropriate:
    a. Static and dynamic alphanumeric information.
    b. Static and dynamic graphic objects.
    c. Dynamic bar graph displays.
    d. Dynamic analog trending displays.
    e. Password protected operator actions.
    f. Screen navigation commands.
10. Dynamic analog information shall be capable of at least eight value related color changes with or without flashing in response to a change in value, state, or alarm condition for linked tags. Dynamic displays linked to digital tags shall be capable of displaying at least three states with corresponding color/flash indications.
11. All data displayed in operator screens on each workstation shall be valid and current. Current values displayed in operator screens shall be instantly replaced with an error indication for "bad" data, loss of data or loss of communications for each individual tag. These conditions shall be treated as alarms, with specified reporting and routing.
12. When communications are restored and/or errors are cleared, data displays shall automatically display actual values, and "change in status" messages shall be routed to all alarm reports and files.
13. While viewing screens, and through password access, operator interaction with individual, modifiable data points shall include: value changes; placing points on/off scan; manual/automatic mode changes; alarm acknowledge; alarm enable/disable; etc.
14. A "pick" point in an operator screen indicates possible operator interaction for data entry, screen navigation or task switching. When the mouse pointer is "dragged" across operator "pick" points, a highlight box shall appear around each. In addition to pointing and clicking, the operator may press the "down" arrow key, to select a "pick" point and then press enter.
15. Point-click procedures shall be available for all operator/screen interface for navigation, data entry, etc. Operator data entry procedures shall be configured as keyboard entry; point-click calculator; multiple choice point-click, up/down ramping or data value slide.

16. Provide user changeable lower, upper and rate-of-change limits on all screen setpoint entry points. Initial limits shall be set at: lower = 10%, upper = 85% and rate-of-change = 10% of value. The user shall not be able to enter setpoint changes beyond these valid limits.
17. Configure the software at each workstation to check, verify and require appropriate password login prior to each start/stop action, setpoint change, tuning parameter change or any other equipment control or functional change.
18. The system shall respond to each operator request to perform any of these actions in the following manner:
    a. Present a "pop up" start/stop faceplate screen with start and stop push buttons for each individually or grouped equipment start/stop system requirement.
    b. Present a "pop up" setpoint entry faceplate screen for each system setpoint change requirement.
    c. Present a "pop up" control parameter tuning faceplate screen for each system control parameter tuning requirement.
    d. English language operator prompting prior to any system response to operator request. Prompting shall inform the operator of the action about to be taken and provide a confirming "proceed" or "quit" choice.
    e. Each action and system response shall be clearly displayed in the appropriate "pop up" screen.
    f. System response indication shall be the most positive feedback required by this specification. At a minimum, the actual PLC register containing the data to be verified shall be displayed and shall be used for any sequential, interlocked or other related control scheme.
    g. At a minimum, each "pop up" screen shall provide for operator input/action and positive feedback indication. Each digital and feedback control display shall provide an English word rather than a digital number indicating conditions. These shall be: start, stop, enable, disable, etc.
    h. Each variable input shall allow operator keyboard or vertical slide bar data entry. Each variable, input, and feedback shall be displayed in number and bar graph formats, both individually and in color-coded multiple bar chart for system evaluation.
19. Objects in screens shall indicate field status, such as "stopped" or "running" by appropriate animation, positioning and color coding.
20. The software at all workstations shall be configured to allow password protected user screen configuration without the use of dedicated programmers, the need to change or reconfigure hardware or cabling, or the need to reboot.

C. Graphic Screen Navigation
1. Each operator screen display shall be configured with a multiple choice Menubar at the top of the screen. Each selection button shall display a related pull down menu of additional selections, screen navigation, system administration, diagnostics and task switching with appropriate password protection.
2. Each selection shall be made by a single point-click or by pressing the "down" arrow to the appropriate selection and then pressing [ENTER]. None of these selections shall cause screen updating, database updating, data collection, alarm monitoring or any other system function to pause or stop.

3. When a Menubar selection is made, the Menubar button and text for that selection shall protrude and become bold to positively indicate user's selection, and the pull-down menu shall be displayed. When pull-down menus are closed or when a new operator screen is displayed, Menubar selections return to previous, normal states.
4. Menubar selections and related pushbutton menu selections and functions shall include:
    a. SYSTEM Menubar selection: shall display a pull down menu with the following selections:
        i. SECURITY LOGIN selection: shall display a password login dialogue box, enabling the system user to login by entering an assigned login name and password.
        ii. SYSTEM ADMINISTRATION selection: shall provide a pull down menu with the following selections:
            a) SECURITY CONFIGURATION selection: shall display workstation security configuration dialogue boxes enabling the user, through password protection, to modify or disable/enable workstation security functions.
            b) FILE MANAGEMENT selection: shall provide the user with password protected access to Windows file manager.
            c) TASK MANAGER selection: shall provide the user with password protected access to the Windows Task Manager through which any Windows program can be run.
            d) HISTORICAL CHART CONFIGURATION selection: shall provide password protected access to workstation historical chart, pen and time group configuration through which the user shall be able to view, add and modify historical data charts.
            e) SYSTEM BACKUP selection: shall provide password protected access to the workstation on-board CD-ROM or tape drive backup function, through which the user shall be able to partially or totally backup workstation software files.
        iii. MESSAGE CENTER selection: shall provide access to a personal message center, through which users shall be able to provide brief messages to other users at any workstation on the network.
        iv. DIAGNOSTICS selection: shall display a pull down menu providing the following selections:
            a) NETWORK STATUS selection: shall provide workstation network diagnostics indicating status of all network sessions, activity and trouble.
            b) I/O COMMUNICATION STATUS selection (available on the field I/O server workstations): shall provide password protected interactive display indicating data request/transmit communications status and error conditions between the field I/O server workstation and the PLC data highway.
            c) COMPUTER DIAGNOSTICS selection: shall provide password protected total workstation review and diagnoses of computer hardware, memory, drives, ports, etc. This function shall also provide hard copy reporting of the entire diagnostics review or any portion thereof.
        v. FIELD I/O AND PLC CONFIGURATION selection: shall provide a set of screens for each PLC including:
            a) Manufacturer

b) Model Number
c) Rack I.D.
d) Model number, type and location for each rack module.
e) I/O device, associated database tag, and module position for all field I/O points.

vi. SYSTEM ACTIVITY selection: shall provide a password protected pop-up display of live system activity including alarms, alarm resets, operator entries, communication errors, system messages and database configuration activity. This display shall be used to provide real time feedback for operator requests, troubleshooting, alarm management assistance, etc. This pop-up display shall be sized, moved, closed and set to be always "on-top" during screen navigation by user request and at any time without pausing or stopping data updates, data collection or alarm monitoring.

b. ALARM Menubar selection; shall provide user interactive alarm summary screen as specified in the alarms section of this specification.

c. HELP Menubar selection: shall provide project-specific full-function Microsoft Windows help including: "contents", "search", "back", etc.

d. TREND Menubar selection: shall provide a pull down menu selection listing for:

i. LIVE TREND choice: shall provide a multiple trend menu of predefined live trends.

ii. HISTORICAL TREND selection: shall provide a menu selection listing of predefined historical trends.

e. REPORTS Menubar selection: shall provide access to a menu listing for all configured reports with features as described herein.

f. DISPLAY MENU Menubar selection: shall display a menu of all plant area displays for screen navigation.

g. OVERVIEW Menubar selection: shall display the plant overview screen.

h. PRINT Menubar selection: shall print the current display.

i. CONTROL PANEL Menubar selection: shall provide date and time display and access to Microsoft Windows Control Panel. A single point-click action from a supervisor's security level or above shall display the Control Panel icon group through which modification can be made for:

i. System Date and Time.

ii. System Fonts.

iii. Printers Setup.

iv. Other Standard Windows Control Panel Functions.

D. Process Overview Display(s)

1. The process overview graphic display shall be obtained by selecting the OVERVIEW icon. One or more targets or icons shall be provided for each unit process and shall permit the operator to directly access an associated unit process display. The plant site plan layout shall be used as the basis for the process overview display, which shall provide display vectoring functions to subordinate unit process displays. A separate display containing a text-based listing of all system graphic displays shall also be provided, accessible from the Overview Display or a separate Menubar selection.

2. Intermediate process overviews shall be provided to summarize information from a number of similar or identical unit process equipment items (e.g., filter overview showing all filters, aeration system overview, etc.). These intermediate overview displays shall allow vectoring to/from the plant overview(s) and the individual equipment detail displays, and shall show appropriate summary process data.

E. Functional Area Display (s)

1. Functional Area Display(s) Unit Process Graphic Displays shall be provided to show all plant process areas and equipment in detail. Except where specified otherwise, all operator control actions shall be performed at the Unit Process Display level. Any unit process display shall be selectable from the process overview display or from an adjacent process area or otherwise related process display. A unit process display shall be a schematic representation of a process and use standard symbols to represent process equipment such as pumps, tanks, motors, etc. Process status shall be indicated using both color and alphanumeric annotations. Symbol color coding for all displays shall be based on the following convention:
2. All text shall be shown in white except alarm condition statements that are illuminated in either yellow or magenta.
    a. Yellow blinking = device has a noncritical alarm not yet acknowledged.
    b. Yellow = device has a noncritical alarm that has been acknowledged.
    c. Magenta blinking = device has critical alarm not yet acknowledged.
    d. Magenta = device has a critical alarm that has been acknowledged.
    e. Cyan = device off or not available. This may represent future equipment or equipment that has been taken off line for maintenance purposes.
    f. Red = device is on, running, energized, open.
    g. Green = device is available, ready to run, de-energized, closed.
    h. White with a black target background = device is in automatic (or semi-automatic) control mode.
    i. White with a blue target background = device is in manual mode.
3. The displays shall show all ID number, current status values and setpoints associated with a given process display and shall be updated with current values every five seconds or less.
4. The control status of each controllable device shall be modifiable and shall be displayed in text adjacent to that device. Control status shall be AUTO, MANUAL, AVAILABLE, etc., and shall be updated continuously. When the operator wishes to take control of the device or modify setpoints, the procedure shall be as follows:
    a. The operator shall click on the device symbol with the mouse.
    b. A dialog box shall appear which provides the current state or setpoint and enables the operator to make the appropriate change.
    c. For two-state devices, the dialog box shall allow the operator to start or stop, open or close, or otherwise change the state of the device.
    d. For setpoints and modulating final control devices (analog outputs), the dialog box shall display the old value, and shall allow the operator to enter a new value using standard Windows editing techniques. It shall also be possible for the operator to ramp the current value up and down by clicking on ramp targets.

e. Prior to the execution of the operator-commanded action, a confirmation message and target shall be displayed stating the old and new values and asking the operator to confirm the modification.

f. Control strategies shall be changed from AUTO to MAN or OFF (or vice versa) in the same manner as two-state devices.

F. Alarm & Event configuration

1. The operator workstation software shall be configured to provide alarm handling, reporting and archiving. Alarm grouping, printing and display shall be coordinated with Engineer and Owner prior to configuration.
2. Alarm management shall be provided for each database field input and shall include:
   a. Alarm reporting enable or disable.
   b. Alarm suppression to avoid nuisance alarms such as start up spiking.
   c. Re-alarming.
   d. Alarm routing to specific workstations and printers as appropriate.
   e. Alarm grouping for specific visual and audible group notification.
   f. Analog alarm types to include at least: low low; low; high; high high; rate of change; deviation; deadband; bad input; and off scan.
   g. Discrete alarm types to include at least: change from normal; return to normal; change of state; bad input; and off scan.
   h. Alarm acknowledgement and condition clear format.
3. The operator workstation software shall provide date and time stamped alarm reporting to at least five destinations. These destinations shall be:
   a. Operator screen alarm summaries.
   b. Alarm printers.
   c. System alarm and history file.
   d. System alarm and history display.
   e. Workstation network.
4. All points or modules that have the capability of being alarmed for amplitude or rate of change limit violations, and all discrete alarm inputs shall be linked to an associated discrete point for alarm suppression under specified conditions. For example, when there is no flow through a flow meter, the "not running" signal from the associated prime mover shall be used to suppress all alarms associated with the flow signal. Time delays shall be provided as necessary to eliminate transient alarm annunciation under start-up/shutdown conditions.
5. All alarms shall be OLE and Windows Sound System enabled. Sound files shall be individually assigned to each alarm point.
6. The system shall provide an alarm summary display as a pre-defined dynamic link within the graphics package. This alarm summary display shall show a list of the pending alarms in the system. As new alarms are detected, entries shall be made to the display list. As the alarm conditions clear, the entries shall be removed from the list.
7. The alarm summary display shall be user-configurable to the extent that the user can select the placement of tag name, current value, descriptor, time of alarm, and alarm status on the line as well as the color codes to be used to indicate the various alarm conditions.

8. Only alarms, including the loss of network, data highway and individual field I/O point communications, shall be reported to operator screen alarm summaries, which shall allow the operator to sort alarms in descending or ascending time order. The operator shall also be allowed to apply various priority level filters and to reconfigure alarm summary columns for detailed analyses, while viewing.
9. Alarms shall be acknowledged from the alarm summary display either individually (by clicking on an alarm acknowledgement field) or by a full page using a menu pull-down. The system shall support up to twenty (adjustable) alarm messages in the summary display.
10. Each graphic display shall be configured with the indication of the last three alarms at the bottom of the screen.
11. An unacknowledged alarm shall flash in configured foreground/background colors until it is acknowledged. When an alarm is acknowledged, it shall stop flashing but remain displayed until the alarm condition is cleared.
12. When an alarm condition has been both acknowledged and cleared, the alarm statement shall be removed from the alarm summary.
13. Alarm summaries shall use system colors and provide at least the following column information:
    a. Date and time.
    b. Workstation name.
    c. Tag number.
    d. Tag description.
    e. Alarm condition.
    f. Tag value.
14. Configure alarm summaries with a distinctive color format for:
    a. Background color.
    b. High value alarms.
    c. Low value alarms.
    d. Rate-of-change alarms.
    e. Digital status alarms such as change of state, change from normal, etc.
    f. Plant area/access alarms.
15. The following color codes shall be used in conjunction with alarm displays:
    a. Cyan = normal.
    b. Yellow, blinking = noncritical, not acknowledged alarm.
    c. Yellow = noncritical, acknowledged alarm.
    d. Magenta, blinking = critical, not acknowledged alarm.
    e. Magenta = critical, acknowledged alarm.
16. The following alarm condition statements shall be provided as a minimum:
    a. RTN NRML - Return to Normal.
    b. HIHI LMT - Second High Limit.
    c. HI LMT - High Limit.
    d. LO LMT - Low Limit.
    e. LOLO LMT - Second Low Limit.

f. ROC LMT - Rate of Change Limit.
g. STAT CHGE - Status Change.
h. OFF SCAN - Off Scan.
i. OPEN FAIL - Open Failure.
j. CLOSE FAIL - Close Failure.
k. START FAIL - Start Failure.
l. STOP FAIL - Stop Failure.
m. FAULT – Fault.
n. HI DEV - High Deviation.
o. LO DEV - Low Deviation.
p. DISCREP – Discrepancy.
q. UNAVAIL – Unavailable.

17. Date and time stamped alarm reporting shall be sent to alarm printers with similar formatting, configuration and routing procedures as specified for alarm summaries.
18. Configure alarm and history files for sequential date and time stamped activity reporting for the entire system, on each workstation. This file shall be a daily text file with a file name indicating the date that the file was created, and shall include all system wide activity including:
    a. Alarms.
    b. Alarm acknowledgement.
    c. Loss and recovery of network, data highway and individual field I/O point communications.
    d. Status changes.
    e. Alarm clear and return to normal messages.
    f. Operator keyboard entries.
    g. Other system related activity (system startup, save/reload database, etc.).
19. Information format shall include:
    a. Date and time.
    b. Description.
    c. Condition.
    d. Current value.
20. Alarm and history files shall be saved to computer backup media including CD’s or tapes if selected by the operator.
21. The alarm and history display shall provide live viewing of alarm and history file entries, giving the operator instantaneous activity review and operator action verification.
22. The system alarm and history display, with on-line height and width adjustment capabilities, shall be displayed as part of operator screens, upon demand. The operator shall be able to size and move the display, as desired. Further, the operator shall be able to close this display, upon demand, or cause it to be continually displayed as the operator navigates through operator screens.

23. The opening, closing, moving or resizing of this display shall not cause screen updating, database updating, historical data collection, alarm monitoring or any other system function to pause or stop.
24. Workstations shall be configured to report all alarm conditions, operator activity, etc. to all other workstations.
25. The system shall be configured to provide a periodic date stamp on the alarm printout at the alarm printer to provide clear date/time evaluation of printed alarms.
26. Each workstation shall be configured for alarm and history activity file backup and archiving to the on-board tape or CD drive. Provide alarm and history file backup, and disk space management procedures.

G. System Security
1. Observer.
   a. Graphic display viewing and navigation.
   b. Historical data display.
   c. Password login and logout.
   d. Observer shall be the system default security mode.
2. Operator.
   a. Observer privileges.
   b. Password protected start/stop, setpoint entries, system activity display, etc.
   c. Lead Operator/Supervisor.
   d. Operator privileges.
   e. Historical data chart configuration.
   f. Report viewing, modification and exporting/printing.
   g. Task switching to the Windows operating system.
   h. Software system shut down.
   i. Windows NT Task Manager access.
3. System Administrator/Engineer.
   a. All privileges.
4. The software at each workstation shall be configured to automatically log in the observer group upon system startup.
5. The security system at each workstation shall be configured to not allow SCADA software shut down or Windows NT security access unless requested through Supervisors' or System Administrator security privileges.
6. The security configuration shall be exportable to a text file, which shall not include passwords. This text file shall have a user defined acronymic, mnemonic file name and shall be capable of being imported into the system to modify or create workstation security configuration.
7. All workstation security activity, including violations, shall be reported in a date and time stamped format to a daily text file for review and evaluation at any time. This security text file shall have a file name indicating the date that the security file was created. It shall be possible for any text editor to edit these files.

8. Each workstation shall be configured for security activity file backup and archiving to the on-board tape drive.

H. Trend Configuration
1. The system shall provide multiple sets of live trends in operator screens. Each set of live trends shall be capable of the following:
   a. Displaying up to eight pens.
   b. Being temporarily modified, while viewing.
   c. Displaying straight line or varying data value "target" curves.
   d. Full screen trend curve displays when trend screen is opened.
2. Each live trend chart shall allow temporary, on-line pen, range and chart X-Y parameter changes by the user. Each trend display shall allow on-line user modifiable straight-line "target" curve for each trended data point and, as specified, a user selected varying data value "target" curve based on pre-defined modeling for trended data points.
3. Trends shall automatically shut down and release system resources when closed.

I. Historical Data Management Configuration
1. The operator workstation SCADA, database, spreadsheet and reporting software shall be configured to provide historical data gathering for system and operations validating, testing, maintenance and regulatory reporting.
2. The system shall provide multiple choice options for historical data file size and shall automatically assign file names indicating the date and duration for data contained in each file. The installed system shall be configured for sequential data files beginning at midnight.
3. For data and system resource management the system shall allow the assignment of any number and type of database tags and tag groups for historical data collection with the following attributes:
   a. Collection rate and phasing.
   b. Data collection start/stop condition.
   c. Data collection deadband.
4. For additional resource management, the operator workstation software shall be configured to automatically delete historical data files when they reach a certain age, which is user selectable from a multiple choice options list. Set initial automatic file deletion at 20 days with backup and archiving procedures occurring prior to deletion.
5. Configure each workstation for historical data files backup and archiving to Cloud Storage and local external Drive.
6. Provide historical data files backup, and disk space management procedures.
7. All attributes of each historical display chart shall be able to be configured or modified at any time.
8. In addition, the user shall be able to make temporary, view only modifications, while viewing historical trend charts.
9. The system shall be configured for the following on-line historical data user functionality, without pausing or stopping any system function:
   a. Zoom to any specific area of a chart.
   b. Automatic real time update of historical data, upon demand.

c. Reset to original trend chart parameters, upon demand.
d. Request completely different start/stop time and duration parameters, upon demand.
e. Chart data display update forward or backward in time, by a single point-click for two sets of modifiable time increments in each direction.
f. Export displayed trend chart data into a text file with a user defined acronymic, mnemonic file name.
g. Print any displayed historical trend chart, upon demand.
h. Display multiple historical trend charts at the same time with time synchronizing for detailed analyses.
i. Data trend charts configured by combining any pen and time groups.
j. Trend chart display format changes including colors, titles, legends, etc.

10. When configuring tag pen groups, the system shall provide for user configuration of at least:
    a. Individual tag and related attributes.
    b. Default or specific data value range.
    c. Individual color for each tag pen.
    d. A specific letter to further document each pen related curve.
    e. Trend chart display format.
11. Time group configuration shall include at least the following:
    a. Start/stop dates and times.
    b. Duration.
    c. Sample, average value, high value and low value displays individually or together.
    d. Trend chart display format.
12. Historical data files shall be saved to computer backup media including diskettes, tapes or optical disks if the operator chooses this option. The system shall allow these files to be restored to the appropriate system file path and reviewed with all system functions at any time, as if they had continued to be hard disk resident.
13. The collection of historical data shall begin automatically upon software system start-up.
14. All analog and digital field inputs shall be historically collected. Provide collected data in the "sample" mode with collection rate, phasing, etc. attributes assigned to maximize data collection and system resources.
15. Provide the following time groups:
    a. The previous hour.
    b. The previous twenty-four (24) hours.
    c. The previous thirty (30) days.
16. Operator access for viewing or printing any individual project specific, pre-defined historical trend chart shall be through a single point-click action while viewing operator screens via the TREND Menubar selection.

J. Reports Configuration

1. The report generator shall employ the specified electronic spreadsheet, report writing and database programs to provide the user with an interactive method to define, change, and replace report formats. The specified database, spreadsheet, and reporting software shall be

furnished with all required applications and macros to perform the specified reporting functions.

2. The report generator shall permit arithmetic, relational, logical and statistical operations on individual or groups of data values contained in the distributed database and shall be employed to build shift, daily, equipment runtime and other specified reports utilizing network based dynamic data exchange access to the databases.
3. The reporting module shall provide the user with all standard Excel-type interactive spreadsheet formats, functions, linking, various kinds of charts, live spreadsheet/database interaction, fonts, math functions, macros, print options, and report saving.
4. All tags in the Control and Information System, including inputs, outputs, calculations and historical data shall be available for use in reports. Points shall be referenced in report formats by tag names or pen/time groups, and linking to reports shall be automatic and transparent to the user.
5. Each report shall be capable of linking and displaying the following:
    a. All attributes of database tags including:
        i. Current value.
        ii. Engineering units.
        iii. Descriptors.
        iv. Field I/O equipment addresses.
        v. Alarm parameters.
    b. Any combination of historian pen/time groups.
    c. Manually entered data.
    d. Text.
    e. Date and Time.
6. The report package shall allow on-line user selection of a value or groups of values, and instantaneously create charts in X-Y, bar graph, pie and other formats. Charts shall be modifiable upon viewer demand. Chart printouts, on demand, shall be provided.
7. Reports shall display entries indicating "no data" and "bad data" to distinguish error conditions from zero values for individual report data links.
8. Report generation or configuration shall not cause screen updates, database updates, historical collection, alarm monitoring nor any other system operation to pause or stop.
9. The report module shall open on top of operator screens, so that, upon exiting, the previous operator screen shall be automatically displayed, and shall be fully functioning and updating.
10. The reporting of system operating data shall occur once per day at user-specified times. Data recorded on these reports shall be extracted from the operator workstation data files as required. Report data shall consist of the arithmetic average and sums of variable readings taken by the control system on scans made during the previous 24-hour period and from manually entered data. Where applicable, total, average, maximum, and minimum values shall be provided for each column of data on each report.
11. User access to any individual report shall be provided by means of a single point-click from a menu of all project specific reports.
12. Password protected access to reports shall also enable the user to create and/or modify reports through standard Microsoft Excel configuration and system macro procedures.

13. No reports access, work, viewing or any other reports related activity shall require the suspension, modification or the stopping/starting of the reports scheduler. Nor shall this activity cause any pausing or stopping of data updating, data collection, alarm monitoring, or any other Control and Information System function.

3.03 SYSTEM CONFIGURATION AND EXPANSION

A. The system shall provide an on-line installation and configuration program for configuring the various computers on the network. This configuration software shall allow assigning unique node names to each computer as well as selecting the functions that the machine will perform.

B. The system shall allow additional computers to be added to the network while on-line, without disrupting the operations of the other machines.

3.04 DIAGNOSTICS

A. The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.

B. An additional display shall show the current session status (established, pending, offline) of all stations on the network. A session monitor program that automatically monitors and recovers communications shall be supplied with the system.

3.05 LICENSE AGREEMENTS/SECURITY

A. The manufacturer's license agreements for software packages shall be made out to the Owner.

B. Contractor developed application programs shall become the property of the Owner at the conclusion of the Contract. There shall be no license agreements of any kind for these programs.

C. The Owner shall be provided with passwords required to access the PLC application programs and operator interface configuration data. There shall be no Contractor programmed security schemes that prevent access to the application programs or configuration data.

END OF SECTION 40 94 03

SECTION 43 25 13 - SUBMERSIBLE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Automatic triplex submersible pump station with controls, rails, accessories, and appurtenances as specified or shown on the plan drawings.

B. Related Requirements:

1. Section 03 31 00 – Anchorage In Concrete
2. Div. 26 - Execution requirements for electrical connections to equipment specified by this Section.
3. Section 33 051 6.13 – Precast Concrete Utility Structures for Wetwell and Valve Vault
4. Section 40 05 13 - Common Work Results for Process Piping: Piping components, appurtenances, and identification requirements common to process piping systems.

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

B. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.

C. Certified Pump Curves

D. Shop Drawings:

1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
2. Include manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.

E. Manufacturer's Certificate: Certify that pump and accessories meet or exceed specified requirements.

1. Certify installation is completed according to manufacturer's instructions.

F. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

G. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.5 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for pumps and components.

1.6 QUALITY ASSURANCE

A. The pump manufacturer shall have a minimum of 1,000 units of similar type pumps, installed and operating for no less than five (5) years in the United States.

B. The pump manufacturer shall perform the following inspections and tests on each pump before shipment from factory:
1. Impeller, motor rating and electrical connections shall first be checked for compliance to the customer's purchase order.
2. A motor and cable insulation test for moisture content or insulation defects 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) feet under water.
5. After operational test No. 4, the insulation test (No. 2) is to be performed again.

C. A written report stating the foregoing steps have been performed shall be supplied with each pump at the time of shipment upon request.

D. The pump cable end will be sealed with a high quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

1.7 SPARE PARTS

A. The pump manufacturer shall furnish one (1) set of recommended spare parts.

B. The pump manufacturer shall furnish a complete list of recommended spare parts.

C. The pump manufacturer shall furnish any special tool for the Owner to service, maintain, repair, and disassemble the pumps.

1.8 WARRANTY

A. The pump manufacturer shall warrant the units being supplied to the Owner against defects in workmanship and material for a period of five (5) years or 10,000 hours under the Municipal Wastewater - Permanent Installation Warranty Policy.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE PUMPS

A. Identification

1. INFLUENT PUMPS (P2010, P2020)
2. SCUM PUMP (P4310)

B. Manufacturers:

1. INFLUENT PUMPS
   a. Flygt.
   b. KSB.
   c. Or Pre-Approved Equal.

2. SCUM PUMP
   a. ABS
   b. Or Pre-Approved Equal.

C. Design Criteria:

1. INFLUENT PUMPS
   a. Quantity of Pumps: 2
   b. Design Point of Each Pump: 1,570 GPM @ 49 ft
   c. Static Head: 40 ft
   d. Motor: 30 HP, 460V, 3 Phase, 60 Hz
   e. Inlet Size: 200 mm
   f. Discharge Size: 6 in
   g. Impeller Size: 244 mm

h. Impeller Material: Ductile iron

2. SCUM PUMP
   a. Quantity of Pumps: 1
   b. Design Point of Each Pump: 130 GPM @ 18 ft
   c. Static Head: 8 ft
   d. Motor: 1 HP, 460V, 3 Phase, 60 Hz

D. Each pump shall be furnished with a submersible electric motor suitable for continuous submergence, a cast iron discharge connection with anchor bolts, upper guide bar bracket, 45 feet of stainless steel lifting chain, and 100 feet of hypalon jacketed type SPC cable, P-MSHA approved and sized according to N.E.C. and ICEA standards.

E. The pumps shall be capable of handling raw, unscreened sewage. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place, and shall be easily removed for inspection or service. There shall be no need for personnel to enter pump well. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pumping unit shall be guided by no less than two 304 stainless steel guide rails and pressed tightly against the discharge connection elbow with metal-to-metal contact. Sealing of the discharge interface by means of a diaphragm, o-ring, or other devices will not be acceptable. No portion of the pump or the guide support system other than the discharge connection shall bear directly on the floor of the sump. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 30 ft.

F. Accessories:

1. The influent pumps shall be provided with the following accessories:
   a. Discharge connections.
   b. 304 stainless steel rail system with top, bottom, and intermediate guide bars.
   c. 304 stainless steel lifting chain, or equal.
   d. 304 stainless steel electrical cable holders.
   e. 304 stainless steel chain hook.
   f. Float switches and mounting hardware with one (1) spare. Manufacturer shall be Anchor Scientific or pre approved equal. The cable shall be of sufficient length such that it can be routed in conduit to the pump control panel without splicing.
   g. 316 stainless steel or titanium submersible pressure transducer and mounting hardware with one (1) spare. Manufacture shall be Cerlic, Endress & Hauser, KPSI TM, or pre approved equal. The cable shall be of sufficient length such that it can be routed in conduit to the pump control panel without splicing. Pump Manufacturer shall provide submersible pressure transducer as part of pump package. Pump Manufacturer shall provide performance and compatibility guarantee of included pressure transducer for level measurement.
   h. Anchor bolts for rail system and pump discharge base shall be 316 SS.
   i. Covers shall be delivered to the precast wetwell supplier for installation in the wetwell top slab as specified in Section 33 05 16.13 Precast Concrete Utility Structures.

2. Control Panel:

a. Pump control panel shall be provided and shall control all influent pumps.

3. Lifting Chains:

a. Minimum length equal to wetwell depths plus 5 feet at minimum.
b. Material: 304 Stainless Steel
c. Load Rating: Sufficient to permit lifting and lowering the pump.

2.2 PUMP CONSTRUCTION

A. Major pump components shall be of gray cast iron, Class 35B, with smooth surfaces devoid of blow holes and other irregularities. Where watertight sealing is required, O-rings made of nitrile rubber shall be used. All exposed nuts and bolts shall be of AISI-type 304 stainless steel. All surfaces coming into contact with sewage, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump. The impeller shall be coated with an acrylic dispersion zinc phosphate primer.

B. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machine surfaces. This will result in controlled compression of nitrile rubber O-rings without the requirement of a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

C. The cable entry water seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by 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 the motor interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

D. Each pump shall be provided with a tandem mechanical rotating shaft seal system. Seals shall run in an oil reservoir. Lapped seal faces must be hydrodynamically lubricated at a constant rate. The lower seal unit, between the pump and oil chamber, shall contain one stationary and one positively driven tungsten carbide ring. The upper seal unit, between the oil sump and motor housing, shall contain one stationary tungsten carbide ring and one positively driven rotating tungsten carbide ring. Each interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment but shall be easily inspected and replaceable. The following seal types shall not be considered acceptable or equal to the dual independent seal specified: shaft seal without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower units. Cartridge type seal systems shall not be acceptable.

E. Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall not require an oil pressure equalizer ring for oil pressure compensation. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside.

F. The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

G. The pump shall have shall have a separate seal leakage chamber to capture any leakage past the upper secondary mechanical seal. The leakage chamber shall have a float type switch that will signal if the chamber should reach 50% capacity.

H. The pump shaft shall rotate on two (2) permanently lubricated bearings with an L-10 bearing life of 50,000 hours when operating at any usable portion of the pump curve. The upper bearing shall be a single roller bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row bearings shall not be acceptable.

I. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be AISI-type 431 stainless steel.

J. The impeller shall be of gray cast iron, ASTM A-48 Class 35B, dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design unless specified otherwise. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impellers shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

K. The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have integral spiral-shaped, sharp-edged groove(s) that is cast into the suction cover. The spiral groove(s) shall provide the sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The internal volute bottom shall provide effective sealing between the multi-vane semi-open impeller and the volute.

L. The Pump volute shall be manufactured to accommodate a device designed by the pump manufacturer to produce a flushing action at the start of the pump cycle. Water from the pump will be forced through the device into the wet well as a jet flushing stream. This device is mounted on the pump and is based on the ejector principle with a ball as a closing device. The operation is automatic and induced by the pump flow and pressure. Electrical components or cabling will be not accepted.

2.3 MOTOR

A. Motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180 °C (356 °F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of

bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40 °C (104 °F) and capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125 °C (260 °F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

B. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40 °C (104 °F) ambient and with a temperature rise not to exceed 80 °C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting current and torque.

C. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

D. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

E. Motors shall be sufficiently cooled by the surrounding environment or pumped media. A cooling jacket is not required.

2.4 CONTROLS & CONTROL PANEL

A. Furnish and install one automatic pump control center (FCP2200) in NEMA 4X stainless steel enclosure .
   1. Pumps shall be controlled by the level monitor system specified below as a standard triplex pumping station (the third pump will not be installed under this contractor but provision shall be made in the panel to accommodate a third pump in the future.
   2. For each pump there shall be included individual motor circuit breakers, variable frequency drives, three phase overload protectors, manual reset, hand-off automatic selector switches, running lights, ammeters and elapsed time meters.
   3. Provide phase failure / undervoltage relay to de-energize motors and include auxiliary contacts for remote indication
   4. Provide alarm system consisting of an alarm light and horn, with silencing switch
   5. Provide 24 volt control circuit transformer with disconnect and overload protection
   6. Provide duplex weather proof convenience outlet
   7. Provide terminal strips for interface wiring between control panel and pumping station
   8. Controls shall automatically alternate the operation of the pumps
   9. Provide one 20 amp, one pole breaker in the control panel to serve the slab heater for the backflow preventer.
   10. Provide two 20 amp, one pole breakers in the control panel as spares.

B. Automatic Mode

1. The pump(s) shall operate/run based on wet well water level limits. The pumps shall operate at variable speed based on an operator-entered flow value. The pumps shall also alternate automatically between lead pump and lag pump cycles.

C. Hand Mode

1. In the hand mode, the pumps shall be operated via start and stop push buttons locally at the control panel.

D. Wet Well Low Level

1. In no case shall the pumps continue run below the wet well low level float switch.

E. High Water Level Alarm:

1. Furnish and install a high water level alarm horn and light at the pump station panel. The unit shall be factory constructed on top of the pump control panel. The unit shall consist of a loud audible horn with manual adjustment for pitch; a flashing red light with a 100 watt bulb and red vapor proof globe and guard, and a control center for horn silencer with reset and test switches.

F. Liquid Level Sensors:

1. Furnish and install an ultrasonic level transducer for automatic control of pumps and provide float switches for Low Level, Lead Pump, Lag Pump, and High Level, in case of ultrasonic level transducer failure/fault. The Lead Pump and High Level float switches shall initiate an alarm and SCADA contacts; the Low Level float switch shall be hardwired to shut pumps off in any condition and send an alarm to SCADA.

G. SCADA:

1. The pump control panel shall be furnished with a communication module with an Ethernet/IP connector for remote monitoring by the plant SCADA system. The following data shall be made available to the SCADA system:

   a. Pump Run/On
   b. Pump Stop/Off
   c. Pump Speed
   d. Pump Fault
   e. Wetwell Level
   f. High Level Alarm
   g. Low Level Alarm
   h. Pressure Differential Level Transducer Fault Alarm

H. Control Description/Sequence:

1. Refer to Section 40 70 23 – Process Control Narratives for detailed description for controls of all submersible pump.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of pumps, accessories, and piping connections.

3.2 INSTALLATION

A. Install pumps and accessories where indicated on Drawings and according to manufacturer's instructions.

B. Provide and connect piping, accessories, and power and control conduit and wiring to make system operational, ready for startup.

C. Flush piping with clean water.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Pre-operational Checks:

1. Check pump and motor alignment.
2. Check for proper motor rotation.
3. Check pump and drive units for proper lubrication.

C. Startup and Performance Testing:

1. The pump shall be tested at start-up and voltage, current, and other significant parameters recorded. The manufacturer shall provide a formal test procedure and forms for recording data. Only factory certified service personnel shall perform start-up service. Proof of certification shall be required prior to equipment approval.

D. Verify pump performance by performing time-drawdown test or time-fill test.

E. Check pump and motor for high bearing temperature and excessive vibration.

F. Check for motor overload by taking ampere readings.

G. Equipment Acceptance:

1. Adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3. Document adjustments, repairs, and replacements in manufacturer's field services certification.

H. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one trip of one day on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

I. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 25 13

SECTION 43 41 45 - POLYETHYLENE TANKS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes polyethylene tanks for storage of the following chemicals:

1. Sodium Hypochlorite

B. Related Requirements:

1. Section 03 30 00 - Cast-In-Place Concrete.
2. Division 40 – Process Interconnections.
3. Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment.
4. Section 46 – Water and Wastewater Equipment

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
3. RTP-1 – Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. America Society for Testing and Materials:

1. D618 Conditioning Plastics and Electrical Insulating Materials for Testing
2. D638 Tensile Properties of Plastics
3. D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
4. D883 Definitions of Terms Relating to Plastics
5. D1505 Density of Plastics by the Density-Gradient Technique
6. D1525 Test Method for Vicat Softening Temperature of Plastics
7. D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
8. D1998 Standard Specification for Polyethylene Upright Storage Tanks
9. D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction
10. D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
11. D3892 Practice for Packaging/Packing of Plastics
12. F412 Definitions of Terms Relating to Plastic Piping Systems

C. ARM (Association of Rotational Molders) Standards: Low Temperature Impact Resistance (Falling Dart Test Procedure)

D. ANSI Standards: B-16.5 Pipe Flanges and Flanged Fittings

E. OSHA Standards: 29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids
F. UBC CODE: Uniform Building Code 2006 Edition
G. IBC CODE: International Building Code 2009 Edition
H. CBC Code: California Building Code 2010 Edition

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.
C. Shop Drawings: Submit detailed certified dimensional Shop Drawings showing tank size, layout of accessories, and anchoring system.
D. Manufacturer's Certificate:

1. Certify that products meet or exceed specified requirements.
2. Certify that products are suitable for chemical usage in this application.
3. Submit certified list of tank installations, storing same chemical and concentration, in service for period of not less than five years.

E. Owner Installation Certificate: Obtain from equipment manufacturer's representative and submit, attesting equipment has been properly installed and is ready for startup and testing.

F. Delegated Design Submittals: Submit signed and sealed design calculations and assumptions for determination of shell thickness, nozzle reinforcement, and special elements of vessel construction and support.
G. Test and Evaluation Reports:

1. Submit certified data on physical properties of laminates being used to include laminate tensile modulus and flexural modulus in hoop and axial directions, and data on laminate makeup to include number and thickness of layers and layer glass content.
2. Submit certified factory test results.

H. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including tank handling procedures, anchoring, and layout.
I. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.
J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
K. Manufacturer Reports: Submit certification after installation that tanks have been installed according to manufacturer's instructions.
L. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.
B. Project Record Documents: Record actual locations and final orientation of tank and accessories.
C. Operation and Maintenance Data: Submit maintenance instructions for tank and accessories.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept tanks on-Site. Inspect tanks for damage.
C. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

1.7 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
B. The Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.
C. The Manufacturer shall furnish a three-year warranty for replacement due to breakage, yellowing, abrasion, loss of light transmission, and coating delamination. Furnish three year manufacturer's warranty on fittings and accessories supplied by the tank manufacturer.

PART 2 - PRODUCTS

2.1 TANKS

A. Manufacturers:

1. The equipment, polyethylene tanks, shall be manufactured by:

    a. Snyder Industries, Inc.
    b. Assmann USA.
    c. PolyProcessing, Inc.
    d. Or approved equal.

2. Specifications and equipment arrangements for the polyethylene tanks are based on Synder Industries, Inc. Changes to the arrangement indicated in the specifications and in the plan set shall be at the expense of the installing contractor. No change orders will be issued to the contractor for modifications to the laying length, footprint, concrete layout, electrical, mechanical, etc.

B. Description:

1. This specification covers upright, cylindrical, flat bottom, single wall tanks molded in a one-piece seamless construction by the rotational molding process (laminated or fabricated tanks will not be accepted). The tanks are designed for above-ground, vertical installation and are capable of containing chemicals at atmospheric pressure. Included are requirements for materials, properties, design, construction, dimensions, tolerances, workmanship, and appearance. Tank capacities are from 500 gallon (1,816 L) up to gallon (62,453 L).
2. Use materials of construction to resist and retain process fluid without leakage or damage to structural integrity of tank; use same resin throughout construction of each tank.
3. Minimum thickness: 0.187 inch.
4. Vertical, non-sloping flat bottom; integral closed top.
5. Furnish liquid level gage sight glass, with flanges, indicating 10 to 90 percent of tank capacity.

C. Tank Designation

1. TB8110

D. Materials

1. Tanks are classified according to type as follows and it is the responsibility of the purchaser to specify Type I or Type II.

    a. Type I – Tanks molded from cross-linkable polyethylene resin.
    b. Type II - Tanks molded from linear polyethylene resin (not cross-linkable resin).

2. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Type I tanks shall be made from crosslinked polyethylene (XLPE) resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties. Type II tanks shall be made from high density linear polyethylene (HDLPE) resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties.
3. All polyethylene resin material shall contain a minimum of a U.V. 15 stabilizer as compounded by the resin manufacturer. Pigments may be added at the purchaser's request, but shall not exceed 0.25% (dry blended) of the total weight.
4. See mechanical properties of Type I and Type II tank materials in Table 1.1 and 1.2 below.

Table 1.1: Type I tank material: Cross-linked (XLPE)

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.938-0.946 g/cc
Tensile (Yield Stress 2"/min)	D638	2830 - 3000 PSI
Elongation at Break (2"/min.)	D638	700 - 800%
ESCR (100% Igepal, Cond. A, F50)	D1693	>1000 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	>1000 hours
Vicat Softening Degrees F. Temperature	D1525	250
Flexural Modulus	D790	87,000 – 110,000 PSI

Table 1.2: Type II tank material: High density Linear (HDLPE)

PROPERTY	ASTM	VALUE
Density (Resin)	D4883	0.941-0.948 g/cc
Tensile (Yield Stress 2"/min)	D638	3000 PSI
Elongation at Break (2"/min.)	D638	>1000%
ESCR (100% Igepal, Cond. A, F50)	D1693	550 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	50 hours
Vicat Softening Degrees F. Temperature	D1525	235
Flexural Modulus	D790	130,000 PSI

E. Design Criteria:

1. The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187 in. thick.

   T = P x O.D./2 SD = 0.433 x S.G. x H x O.D./2 SD
   T = wall thickness
   SD = hydrostatic design stress, PSI
   P = pressure (.433 x S.G. x H), PSI
   H = fluid head, ft.
   S.G. = specific gravity, g/cm^3
   O.D. = outside diameter, in.

   a. The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application. The hydrostatic design stress is 600 PSI at 73 degrees Fahrenheit for Type I and Type II materials. In accordance with the formula in 9.1, the tank shall have a stratiform (tapered wall thickness) wall.
   b. The hydrostatic design stress shall be derated for service above 100 degrees Fahrenheit and for mechanical loading of the tank.
   c. The standard design specific gravity shall be 1.5 or 1.9.

2. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support.
3. The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The top head of tanks with 2000 or more gallons of capacity shall be designed to provide a minimum of 1300 square inches of flat area for fitting locations.
4. Tanks with 2000 or more gallons of capacity shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of an empty tank.

5. The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head. The tie-down lugs shall be designed to allow tank retention in wind and seismic loading. Refer to section 12.8 for tank tie-down accessories.

Note: The designed specific gravity of the tank shall be based upon the actual chemical, its' concentration and temperature. From these factors it can be determined if polyethylene can be used and if so which family of polyethylene is to be used. There are chemical applications where both the (cross-linked - Type 1) XLPE and HDLPE (high-density linear - Type 2) resin will work. There are also applications where only one of these families of resin is recommended. If FDA or NSF 61 is required the Type II HDLPE resin will be required.

2.2 NOZZLES AND ATTACHMENTS

A. Fittings - Threaded Bulkhead

1. Threaded bulkhead fittings are available for below liquid installation depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from the tank knuckle radius' and flange lines. Consult the manufacturer for placement questions. The maximum allowable size for bulkhead fittings placed on a curved sidewall section of tanks 48 in. to 142 in. in diameter is 2 inch size. Tank wall thickness must be considered for bulkhead fitting placement. The maximum wall thickness for each fitting size is shown below. The following chart is based upon PVC and CPVC fittings. Contact the manufacturer for other fitting materials

Fitting Size	Maximum Wall Thickness
1/2 in.	2 in.
3/4 in.	2 in.
1 in.	2 in.
1 1/4 in.	2 in.
1 1/2 in.	2 in.
2 in.	2 in.
3 in.	2.125. (Flat Surface Only)

2. The bulkhead fittings shall be constructed of PVC or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton, or other specified material.

B. Fittings - Bolted Double 150 lb. Flange Fittings

1. Bolted double flange fittings are required for below liquid level installation for sizes above 2 in. depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. Consult the manufacturer for placement questions. Bolted double flange fittings provide the best strength and sealing characteristics of any tank fitting available. Allowable fittings sizes based on tank diameter for curved surfaces are shown below.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 in. - 86 in.	3 in.

90 in. - 102 in.	6 in.
120 in.- 142 in.	8 in.

a. The bolted double flange fittings shall allow tank wall thickness up to 2 1/2 in.

2. The bolted double flange fitting shall be constructed with 2 ea. 150 lb. flanges, 2 ea. 150 lb. flange gaskets, and the correct number and size of all-thread bolts for the flange specified by the flange manufacturer. The flanges shall be constructed of PVC Type I, Grade I, or other specified material.
3. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton or other specified material. There shall be a minimum of 4 ea. full thread bolts.
4. The bolts diameter is to meet ASNI standards based upon the flange size. The bolts may have gasketed flanged metal heads or bolt heads encapsulated in Type II polyethylene material. The encapsulated bolt shall be designed to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene encapsulation shall fully encapsulate the bolt head. The polyethylene shall be color coded to distinguish bolt material (white - 316 S.S., yellow - Hastelloy C276, green - Titanium). Each encapsulated bolt shall have a gasket to provide a sealing surface against the inner flange.
5. Standard orientation of bolted double flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B-16.5 unless otherwise specified.

C. Fittings - Bolted Stainless-Steel Fittings

1. Bolted stainless steel fittings are available for below liquid level installation depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. Consult the manufacturer for placement questions. Allowable fittings sizes based on tank diameter for curved surfaces are shown below.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 in.	3 in.
64 n. - 142 in.	4 in.

a. The bolted stainless-steel fittings shall allow tank wall thickness up to 2 1/2 in.

2. The bolted stainless-steel fittings shall be constructed with a minimum of 4 fully threaded 3/8 in. studs. Each fitting shall have one gasket and two flanges. The gasket shall be compressed between the inside of the tank wall surface and the inside flange of the fitting. The stainless-steel fittings come standard with female x female pipe threads. The fittings shall be constructed of Type 316 stainless steel. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton or other specified material.

D. Fittings - Siphon Tube Fittings

1. Siphon tubes may be added to the fittings specified in sections 11.1, 11.2 and 11.3. Siphon tubes will allow these fittings, when used as drainage fittings, to provide better tank drainage.

E. Fittings - Molded Outlet

1. The outlet fitting shall be an integral part of the tank and provide complete drainage of liquid through the sidewall of a flat bottom container without the use of a special support structure or concrete pad.
2. The tank attachment shall be constructed from a PVC schedule 80 male adapter and is standard in 2,3,4 or 6 in. sizes on select tank sizes. This provides a schedule 80 pipe socket attachment (Except for the 6 in. size). Other outlet attachments are available in a variety of materials. The fitting orifice shall not be less than schedule 80 interior pipe size per ANSI B36.10-1979. O-rings shall be constructed of 70 +/- 5 durometer Viton, FKM, FPM, or approved equal. The inside diameter of the outlet is to be molded and is not to be drilled out to increase chemical flow.

F. Fittings - Self-Aligning Threaded Bulkhead

1. Self-Aligning fittings are available for installation in vapor phase applications on curved surfaces depending on the spherical dome radius and the placement of the fitting on the tank dome. Fittings must be placed away from tank radiuses. Consult the manufacturer for placement questions. The maximum allowable size for self-aligning fittings placed on a spherical section of the tank is shown below.

Tank Diameter	Maximum Fitting Size Allowable
45 in. - 48 in.	2 in.
64 in. - 142 in.	3 in.

2. Tank thickness and fitting angle may need to be considered for self-aligning fitting placement. The maximum thickness and installation angle for fitting sizes are shown below.

Fitting Size	Maximum Angle	Maximum Thickness
1 in.	27 degrees	1.000 in.
2 in.	25 degrees	0.750 in.
3 in.	20 degrees	1.0 in.

3. The self-aligning fittings shall be constructed of PVC or CPVC. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton, or other specified material.

G. Vents

1. Each tank must be properly vented for the type of material and flow rates expected. Vents must comply with OSHA 1910.106 (f) (2) (iii) or other accepted standard. All tanks must be vented for atmospheric pressure as well as any pressure created by filling and emptying the tank. Some applications may require a sealed tank with a vent line going to a scrubber system for proper chemical safety. Venting equipment should be sized to limit pressure or vacuum in the tank to a maximum of 1/2" of water column (0.02 psi). U-Vents are offered in sizes from 1 in. to 6 in. with or without mesh insect screening. U-Vents with mesh screening may require additional sizing due to reduced air-flow rates. Consult the manufacturer for necessary venting and placement information.

2. All u-vents shall be constructed of PVC or other specified materials.
3. When a tank is being filled from a pressurized tanker truck or rail car steps need to be taken to avoid pressurizing the tank. The tank may require a secondary surge protection lid to avoid any pressure build up. The surge protection lid is to be a 14" or 18" hinged and be design that it is self-closing.

H. Flange Adapters

1. Flange adapters may be purchased as optional equipment to adapt threaded or socket fitting outlets to 150 lb. flange connections for connection to piping system components. Flange adapters are available in PVC, CPVC or other specified materials. Flange adapter construction shall utilize schedule 80 components in sizes ranging from ¾" to 8" depending on material required.

I. Flexible Connections

1. All tank fitting attachments shall be equipped with flexible couplers or other movement provisions provided by the tank customer. The tank will deflect based upon tank loading, chemical temperature and storage time duration. Tank piping flexible couplers shall be designed to allow 4% design movement. Movement shall be considered to occur both outward in tank radius and downward in fitting elevation from the neutral tank fitting placement.
2. The flexible connection is to be manufactured of the same material as the tank or a compatible material approved by the project engineer. If an elastomer flexible connection is used control bolts are required if recommended by the manufacturer. The flexible connection is to be designed for a minimum of 4% movement. The flexible connection is to be designed with 150# flange connections to allow for attachment to the tank and the piping system. The flexible connection is to be attached as close as possible to the tank to reduce stress.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. Factory Test Report:

1. Certify through visual inspection of tanks after fabrication that Acceptance Level II requirements of ASTM D2563 are met.
2. Certify following during shop inspection:

a. Compliance with Drawing dimensions.
b. Surface cure by acetone wipe test; no surface tackiness is permitted.
c. Liquid tightness by minimum 24-hour hydrostatic test.

C. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

2.4 ACCESSORIES

A. Reverse Level Indicators

1. Furnish and install liquid level indicators on the exterior of the storage tanks. The level indicator shall be actuated by a float within the tank through a polypropylene tape with high visibility numbers in feet and inches to a weighted indicator on a pulley system. All wetted parts, parts subject to condensation or exposure to the atmosphere within the tank shall be suitable non-corrosive durable material approved by the Engineer. The indicator board shall be marked in one hundred-gallon increments and labeled every 500 gallons. All moving parts shall be vapor tight fully enclosed but easily accessible for maintenance. The indicator shall utilize the 3" top opening in the tank and shall be mounted on the side wall of the tank with appropriate anchor materials.

B. Ultrasonic Level Indicator

1. Per Specification 40 72 13 - Ultrasonic Level Meter
2. The ultrasonic enclosure is to be an all plastic design with a NEMA 4X rating. The ultrasonic transducer is to have a 12" dead band and beam with a 20 ft range. The supply voltage can be 110, 220 VAC or 24 VDC. The connection to the tank is to be 2" or 3" NPT.
3. The ultrasonic level indicator shall provide a visual display of liquid level in the tank showing gallonage in measurement of hundreds of gallons along with 4-20 mA output for other alarm or control systems as well as four independent contacts capable of handling 10 amps each. Each contact can be programmed to operate in different opening and closing methods (7 modes). Contacts can be used to control pumps, valves, alarms, etc.

C. Fill Stations

1. A permanent fill station shall be constructed as shown on the drawings and shall be fitted with quick couplers. Quick Coupler Adaptors and caps for making quick connections shall be Kamlok 633A and 634B, respectively or equal. Couplers for Sodium Hypochlorite shall be titanium

D. Manway and Fill Cap (Non-sealed)

1. Fill caps shall be in a 10 in. vented-threaded style on various tank sizes with a minimum opening diameter of 7.125 in. Cap attachment shall be provided with all standard 10 in. cap placements with a polyurethane cap tie. Check the manufacturer's specification drawing for availability and position.
2. Manways shall be 18 in. vented or non-vented threaded design or hinged style (minimum opening diameter of 15 in.) and a 24 in. vented or non-vented threaded or hinged style (minimum opening diameter of 22 in.) on various tank sizes. Check the manufacture's specification drawing for availability and position.
3. All caps and manways shall be constructed of polyethylene material.

E. Bolted Sealed Top Manway

1. Sealed manways are shall be 18 or 24 in. sizes depending on availability in tank size. Consult the manufacturer for placement positions.

2. The sealed manway shall be constructed of polyethylene material. The bolts shall be polypropylene or other specified material. The gaskets shall be closed cell, crosslinked polyethylene foam and Viton O-rings to seal the bolts.

F. Surge Protection Lid

1. The hinged lid is to be manufactured of polyethylene. The lid will be a 14 in. size with 11 in. access opening or 18" with 15" access. The opening of the lid is to be restricted by a tether. The lid is to be designed so that it will close when the pressure has been released. Check SII specification drawing for availability and position.

G. Down Pipes and Fill Pipes

1. Down pipes and fill pipes shall be prepared per the customer approved drawings and specifications. All down pipes and fill pipes shall be supported at 5 ft. maximum intervals with support structures. Standard support structure design shall utilize bulkhead fitting tank attachments or welded attachments on Type II tanks. All designs shall be done according to the specific needs of the customer.
2. All down pipes and fill pipes shall be constructed of PVC or other specified materials.

H. Tank Attachments – External Fill Pipes - Optional on certain tanks

1. External fill pipes shall be prepared per the customer approved drawings and specifications. All external fill pipes shall be supported at 3 ft. maximum intervals with a support structure independent of the tank (ground supported). All designs shall be done according to the specific needs of the customer.
2. All external fill pipes shall be constructed of PVC or other specified materials.

I. Ladders

1. Ladders shall be constructed of stainless steel or FRP.
2. Safety cages shall be provided with ladders as optional equipment unless required by OSHA standards.
3. All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.
4. Ladders must be mounted to the tank to allow for tank expansion and contraction due to temperature and loading changes. All top ladder mounts shall be connected to integrally molded in attachment lugs that allow for tank movement due to temperature and loading changes.

J. Tie Down Systems

1. The tie down system shall be designed to withstand 150 MPH wind loads. Tie down systems must meet seismic requirements per IBC 2009 / CBC 2010 code with seismic loads $\leq$ .445g (Seismic Design Category "D" - Fa=1.0, Fv=1.5, Ss=1.4, S1=0.5). Anchor bolts shall be provided by the contractor per the calculations and the base plates for the system. A registered engineer's wet stamped calculations and or drawings may be required.
2. The tie down system shall be offered galvanized, 304 or 316 stainless steel.
3. Mild steel parts shall be deburred and galvanized.

K. Tank Nameplate

1. Mark each tank with encapsulated paper tag or stainless-steel nameplate not less than 4 by 6 inches in size; attach to outside of tank wall.
2. Print the following information on nameplates:

    a. Name of manufacturer.
    b. Capacity in gallons.
    c. Manufacturer serial number.
    d. Year built.
    e. Maximum specific gravity.
    f. Design pressure and temperature.
    g. Resin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify layout and orientation of tank accessories and piping connections.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Thoroughly clean chemical storage tank pad, removing loose concrete, dust, and other debris. Place two layers of building paper on pad according to tank manufacturer's recommendations prior to placing tank.

3.3 INSTALLATION

A. Install chemical storage tank as indicated on Drawings and according to manufacturer's instructions.
B. Connect piping to tank.
C. Install tank accessories not factory mounted to complete installation.
D. Heat Tracing: Install heat tracing and tank heating systems in accordance with the manufacturers' printed in instructions

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
C. Field Testing:

1. Hydrostatically test each chemical storage tank by filling with water to the overflow pipe level.
2. Conduct test minimum of 48 hours.
3. No leakage permitted.
4. Adjust, repair, modify, or replace components of system failing to perform as specified, and rerun tests.

D. Furnish services of manufacturer's representative experienced in installation of products supplied for not less than two, eight-hour days on-Site for installation inspection, field testing, and instructing Owner's personnel in maintenance of equipment.
E. Obtain Installation Certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing, and furnish to Owner.

3.5 ATTACHMENTS

A. Polyethylene Storage Tank Schedule:

1. TB8110

a. Material Stored: Sodium Hypochlorite (12%)
b. Chemical Specific Gravity: 1.16
c. Configuration: Vertical Tank
d. Dimensions: 72”Ø x 114” nom
e. Capacity: 2,000 gallon
f. Tank Material: HDLPE or XLPE
g. Fitting Material: PVC
h. Gasket Material: Viton, FKM, FPM, or approved equal
i. Bolt Material: Titanium
j. Accessories: Reverse Level Indicator, Down Pipes and Fill Pipes, External Fill Pipes, Ultrasonic Level Indicator, FRP Ladder and Tank Nameplate.
k. Fittings:

1) 1 – 4” Vent
2) 1 – 3” nozzle, flanged, top mounted for liquid level
3) 1 – 2” nozzle, top mounted, for fill
4) 1 – 3” side bottom drain
5) 1 – 3” overflow positioned above the volume elevation
6) 1 – 18” ID bolted sealed manway in top

END OF SECTION 43 41 45

SECTION 43 53 54 - BLOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Positive displacement blower package including accessories as specified herein.
   a. Blower Application: Fine Bubble diffusers tank, Quantity: 2
   b. Blower Application: Aerobic Digester, Quantity: 2
   c. All equipment specified in this section shall be designed and furnished by the blower manufacturer, who shall be responsible for the suitability and compatibility of all included equipment per this section.

B. Related Sections:

1. Section 40 90 00 – Instrumentation and Control for Process Systems
   a. Blower package controls are to be supplied by the System Integrator and are not part of the blower package.
2. Div. 26 - Execution requirements for electrical connections to equipment specified by this Section.

1.2 SCOPE

A. Contractor:

1. Furnish, unload, store and install positive displacement blower equipment with accessories necessary to provide a complete operational system as shown on the plans and as specified.

2. Shall be responsible for startup and training activities under the direction of the qualified manufacturer’s representative.

1.3 QUALITY ASSURANCE

A. Manufacturers’ Qualifications:

1. All equipment furnished under this section shall be manufactured in a plant whose quality management system is certified / registered as being in conformity with ISO 9001 and who shall assume complete responsibility for the design and performance of the blower package.
2. All equipment furnished under this section shall be new, unused, and shall be the standard product of the manufacturer, who shall have a minimum of 10 years’ experience in producing blower packages and be able to produce evidence of at least 5 installations of similar size in satisfactory operation in the United States, if requested.

B. Factory Tests:

1. All cast parts to be manufactured in a plant whose quality management system is certified / registered as being in conformity with ISO 9001.
2. All critical dimensions of the blower components provided by the manufacturer shall be verified and documented prior to assembly.
3. On completion of final assembly of the packaged blower and prior to shipment, each blower package shall be mechanically run at the prescribed design conditions to confirm machine operation.
4. Each blower package provided by the manufacturer shall be guaranteed to provide performance to ISO 1217, Annex C.

C. Reference Standard:

1. American Society of Testing and Materials (ASTM)
2. National Electrical Manufacturers Association (NEMA)
3. Occupational Safety and Health Act (OSHA)
4. National Electrical Code (NEC)
5. American Gear Manufacturers Association (AGMA)
6. Anti-Friction Bearing Manufacturers Association (AFBMA)
7. International Organization of Standardization (ISO)
8. International Electrotechnical Commission (IEC)
9. German Institute for Standardization (DIN)

1.4 WARRANTY

A. Manufacturer's standard submittal for establishing compliance to this section shall include the following items; following submittal procedures in accordance with Section 013300
1. Table of contents
2. A complete and detailed list of any and all variations to the specification
3. Descriptive literature, bulletins, and/or catalog cut sheets of the equipment
4. Scope of supply
5. Blower package performance data sheets showing at least the following:
    a. Package model name
    b. Bare blower model name
    c. Design conditions as listed in this section
    d. Air flow in ICFM and SCFM for design conditions listed
    e. Discharge Pressure
    f. Motor size
    g. Brake horse power required for blower
    h. Bare blower speed with percentage of its maximum speed
    i. Process air connection size
    j. Operating Voltage required for both main motor and enclosure ventilation fan
    k. Sound pressure and power levels
    l. Dimensions
    m. Package weight
    n. Discharge temperature
    o. Accessories being supplied
6. Installation Data sheets

7. Manufacturer's standard performance curve showing blower rpm, pressure differential, capacity in ICFM, blower shaft horsepower, temperature rise at standard conditions
8. Blower package drawing showing all important details required for installation including dimensions, anchor bolt locations, size and location of connections to other works and weight of equipment.
9. Motor manufacturer's data sheet showing at least the following:
    a. Motor manufacturer's name and model number
    b. Efficiency class and %
    c. Efficiency at ½, ¾, and full load
    d. Amp draw
    e. Motor RPM
    f. Code letter
    g. Motor frame
10. Electrical connection diagram for motor, enclosure ventilation fan and any blower accessory requiring an electrical connection.
11. Inlet filter documentation
12. Data sheets for supplied instrumentation and accessories
13. Spare parts overview drawing
14. Recommend spare parts list
15. Paint specification for blower package
16. Maintenance overview
17. Blower startup check list
18. Lubrication requirements
19. SDS sheet (oil)
20. Warranty information
21. Manufacturer's standard for equipment standards
22. Compliance with Machinery Standards for sound and performance certificate

B. Manufacturer's standard Operation and Maintenance Manual shall include the following sections; following submittal procedures in accordance with Section 013300
1. Regarding this document
2. Technical Data for the blower package
3. Safety and Responsibility
4. Design and Function
5. Installation and operating conditions
6. Installation
7. Initial Start-Up
8. Operation
9. Fault Recognition and Rectification
10. Maintenance
11. Spare parts, Operating Materials, Service
12. Decommissioning, storage and transport
13. Annex with drawings and diagrams

1.5 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery and handling of Equipment:
1. Manufacturer and Contractor shall coordinate the delivery schedule for just in time delivery to minimize the period the Blower package is on site before installation.

2. Contractor shall unload and inspect all equipment and materials against reviewed shop drawings at the time of delivery. Any damage shall be reported to the freight company immediately upon receipt.
3. Equipment and materials damaged or not meeting the requirements of the reviewed shop drawings shall be immediately returned for replacement or repair.
4. Each box or shipping crate shall be properly marked to show its net weight and its contents.

B. Storage:
1. Contractor shall prepare for storage and label all equipment and materials after they have been inspected. The Contractor shall be responsible for the equipment and materials while in storage.
2. Contractor shall prepare for storage and label all equipment and materials after they have been inspected. The Contractor shall be responsible for the equipment and materials while in storage.

1.6 SPARE PARTS

A. Furnish the following manufacturer's recommended routine maintenance spare parts for each blower package provided:
1. Two (2) integral inlet silencer filter elements
2. Lubrication for first year of operation
3. One (1) belt set
4. One (1) tube of motor grease (50HP or larger)

B. All parts shall be furnished in clearly identified packaging

1.7 WARRANTY

A. The manufacturer shall warrant the bare blower being supplied against all defects in workmanship and materials for a period of sixty (60) months from date of startup, not to exceed sixty-six (66) months from date of shipment from the manufacturer of the blowers. All other package components shall be warranted for a period of twelve (12) months from date of startup, not to exceed eighteen (18) months from the date of shipment.

B. The contractor shall be responsible for proper storage of the equipment so as to remain in "as shipped" condition. If the equipment remains in storage at the job site for longer than six (6) months before installation, the contractor shall provide factory service personnel for a complete inspection of the equipment. Any work necessary to restore the equipment to "as shipped" condition shall be the responsibility of the contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. The equipment specified herein is intended to be standard equipment for use in low pressure air systems and be supplied by a single manufacturer or authorized sales representative to assure uniform quality, ease of maintenance, and minimal parts storage.

B. Manufacturers:

1. Kaeser Compressors, Inc.
2. Or Pre-Approved Equal.
   a. Reference Section 016000 for product substitution procedures for information pertaining to alternate products

C. Plan layouts, weights, and pertinent specification language used in the design have been based upon Kaeser Compressors, Inc. equipment. Any changes required to accommodate equipment other than the basis of design shall be provided by the Contractor at no additional expense to the Owner. Furthermore, a complete and detailed deviation list from the specification shall be provided with proposal.

2.2 DESIGN CRITERIA

A. Standard Conditions for SCFM:
1. Elevation: 14.7 PSIA (0’ elevation)
2. Temperature: 68 deg F
3. Relative Humidity 36%

B. Design (site) Conditions for ICFM:
1. Elevation: 14.4 PSIA (507’ elevation)
2. Maximum Blower Inlet Temperature: 100 deg F
3. Relative Humidity*: 50%
   *Relative humidity at maximum blower inlet temperature

C. Fine Bubble Diffusers Tank Blowers Performance Data:
1. Quantity: 2
2. Blower Packaged Controlled by a VFD: YES
3. Flow Required: 151 SCFM
4. Blower Package Discharge Pressure: 9.8 PSIG
5. Motor Horsepower: 30 HP
   a. Motor shaft power shall account for belt losses in addition to internal package losses
   b. The motor shall not operate in its service factor at design conditions.
   c. VFD efficiency loss shall be accounted for.
6. Power supply voltage:
   a. Main Motor: 460v/3ph/60hz
   b. Enclosure ventilation fan motor: 115v/1ph/60hz
7. % of Maximum Blower Speed at 60hz: <= 81%
8. Sound pressure level = 73 dB(A) *

9. Sound power level = 91 dB(A) *
   *In accordance with ISO 2151, +/- 3 dB(A), with insulated piping.

D. Aerobic Digester Blowers Performance Data:
1. Quantity: 2
2. Blower Packaged Controlled by a VFD: YES
3. Flow Required: 1066 SCFM
4. Blower Package Discharge Pressure: 10.6 PSIG
5. Motor Horsepower: 75 HP
   a. Motor shaft power shall account for belt losses in addition to internal package losses
   b. The motor shall not operate in its service factor at design conditions.
   c. VFD efficiency loss shall be accounted for.
6. Power supply voltage:
   a. Main Motor: 460v/3ph/60hz
   b. Enclosure ventilation fan motor: 115v/1ph/60hz
7. % of Maximum Blower Speed at 60hz: <= 81%
8. Sound pressure level = 73 dB(A) *
9. Sound power level = 91 dB(A) *
   *In accordance with ISO 2151, +/- 3 dB(A), with insulated piping.

2.3 BLOWER PACKAGE CONFIGURATION:

A. Installation Location: Outside

B. Inlet Configuration: Ambient

C. All components and instrumentation are to be mounted and pre-piped; no field installation shall be required by the contractor. The manufacturer shall be responsible for all aspects of the engineering, from the blower package's air inlet to its discharge connection.

2.4 DESIGN CRITERIA:

A. Blower Type:
1. The bare blower shall be mounted for vertical air flow, be of the oil-free, positive displacement, rotary three lobe type, designed for air or other inert gas service, and belt driven via electric motor
2. The bare blower assembly must operate at the effective value for vibration velocity in frequency range A and B, according to VDI 3836.

B. Material:
1. AISI, ASTM, GJL, GLS, DIN, etc.…, numbers types, and grades specified are typical of material composition and quality, equivalent materials will be considered.

C. Housing:
1. The casing shall be made of high strength, close grained, cast iron, and shall be adequately ribbed to prevent casing deflection and facilitate cooling. Casing shall be of EN GG 20 material.

2. The casing shall be precision machined to allow for minimum clearances.
3. The casing shall include channels integrated on the discharge to reduce blower pulsation and dampen noise
4. The casing shall include threaded atmospheric vent ports between its air-side and oil-side labyrinth seals for safe separation of the conveying and oil chamber.
5. Inlet and discharge ports shall be drilled and tapped for studs to allow solid connection of mating surfaces. Through bolting shall not be allowed. Flange style blower ports, which may be subject to loading, causing cylinder distortion, shall not be allowed.
6. Bearing fits shall be precision machined to ensure accurate positioning of the rotors in the casing.

D. Rotors:
1. The rotors shall be precision machined out of a one piece casting made of EN GGG 50 material. Stub shafts or two-piece impellers shall not be allowed.
2. The rotor assemblies shall be statically and dynamically balanced to ISO standard 1940/1- Q2.5 (turbine rotor). Modifications to the face of the rotors for balancing purposes are not acceptable.
3. The rotors shall be a tri-lobe design in order to minimize pulsation and noise.
4. The rotor must be solid or closed-end to prevent build-up of contaminants inside the rotor causing imbalance.
5. Cored rotors must be closed using threaded iron plugs which are permanently fixed. Impeller end caps of stamped sheet metal shall not be allowed.
6. The rotors shall have an integral sealing strip for improved efficiency.
7. The rotors shall operate without rubbing, liquid seals or lubrication in the air chamber.

E. Cover Plates:
1. The gear-end and drive-end cover plates shall be high strength, close grained, cast iron made of EN GG 20 material. Aluminum cover plates shall not be allowed.
2. The cover plates shall have a precision machined sealing face.
3. The drive-end cover plate shall include at least two precision machined holes to allow for the use of fitting bolts to accurately align the opening for the input shaft seal.

F. Timing Gears:
1. The rotor timing gears shall be precision machined and ground from alloy steel made from case hardened 16 MnCr5 material.
2. Each timing gear shall be straight cut and beveled to quality standard 5f 21, which will eliminate axial bearing loads and ensure long life as well as quiet operation. Helical gears, which cause axial loading, shall not be allowed.
3. Each timing gear shall be manufactured in accordance with:
   a. DIN 3960, Specifications for Spur Gear Sets
   b. DIN 3961 & Din 3962, Tolerances for Spur Gear Mesh
   c. DIN 3964, Specifications for Shaft Centering
4. The timing gear set shall be taper-mounted on the rotors. Keyed, hub mounted, taper-pinned, or splined shaft timing gear mounting designs are not acceptable.

G. Bearings:
1. All four rotor shaft support locations shall incorporate large, heavy-duty, full complement, cylindrical roller bearings with PEEK cages, designed with at least 5-times the dynamic capacity of ball bearings. Ball bearings shall not be allowed.
2. The bearing maximum speeds must be at least two times the maximum recommended blower speed

3. The bearings minimum acceptable L10 design life shall be as follows;
   a. At least 40,000 hours at blower's maximum rated speed and maximum rated differential pressure
   b. At least 100,000 hours at design conditions

H. Lubrication:
1. Both the gear end and the drive end of the blowers shall be oil splash lubricated via a disc slinger for minimal maintenance and long service life. Grease lubricated bearings in the blower are not acceptable.
2. The lubrication design shall ensure adequate lubrication of the timing gears and bearings.
3. The drive-end and gear-end oil chambers must not be interconnected and each oil chamber shall have a domed design sight glass to allow visual inspection of oil level and oil condition, viewable from the front of the blower.
4. Blower to be factory filled with a synthetic lubricating fluid that is rated for the design conditions specified.

I. Rotor Seal Assembly:
1. Each rotor shall include one labyrinth seal assembly on each end, four assemblies in total per blower.
2. Each seal assembly shall consist of the following;
   a. Oil splash guard ring.
   b. Shaft guide wear sleeve with vent holes located between the dual air and oil ring seals. Wear sleeve shall protect the blower casing.
   c. Four piston ring type labyrinth seals made from heat treated GG/42CrMo4 material. Two seals located on the air side and two seals located on the oil side of the grooved rotor sleeve. The use of rubber lip seals shall not be allowed.
   d. Grooved rotor sleeve which will protect the rotor shaft and be used to hold the four piston ring seals.

J. Input Shaft Seal Assembly: (Compak BBC, CBC, DBC, and EBC series)

1. The input drive shaft seal shall be a high temperature radial lip type seal made from Viton elastomer. The seal shall prevent oil leakage from where the input shaft goes thru the drive end cover

2. The seal design shall incorporate a replaceable wear sleeve on the input drive shaft.
   a. The sleeve exterior to be tungsten carbide coated to reduce friction and wear
3. The input shaft seal design must allow for the lip seal and the shaft sleeve to be replaced without removing the drive end cover plate

K. Input Shaft Seal Assembly: (Compak FBC and HBC series)
1. The input drive shaft seal shall be a sliding ring type mechanical seal that will prevent oil leakage from where the input shaft goes thru the drive end cover plate
2. The mechanical seal assembly shall consist of the following;
   a. Replaceable wear sleeve on the input drive shaft
   b. Cover plate with a machined sealing surface
   c. Mechanical sliding ring seal
3. The input shaft seal design must allow for the mechanical seal assembly to be replaced without removing the drive end cover plate

2.5 MOTORS:

A. Drive Motor:
1. Motor shall be designed, manufactured, and tested in accordance with the latest revised editions of NEMA MG-1, IEC, DIN, ISO, IEEE, ANSI, and AFBMMA standards as applicable and shall be capable of continuous operation
2. Motor must meet or exceed Energy Independence and Security Act (EISA 2007) standards for NEMA Premium efficiency. It shall also be marked with a Department of Energy Certification Compliance Number to assure compliance.
3. Motor shall comply with Low Voltage Directive 2006/95/EC or equivalent and be UL listed.
4. Motor must be inverter rated with impulse peak resistance in accordance with IEC 60034-1:2010 or equivalent for operation with an IGBT frequency converter or equivalent
5. Motor horsepower nameplate rating shall not be exceeded at the design discharge pressure when operating at 60hz
6. The temperature rise of the motor windings shall not exceed IEC and NEMA standards when the motor is operated continuously at the rated horsepower, rated voltage, and frequency in ambient conditions at 104ºF / 40ºC
7. Motor shall be suitable for Full Load/Direct On-line starting, Solid State Ramp starting, VFD, and/or Wye-Delta reduced current starting
8. Motor to be supplied, mounted and aligned by the blower package manufacturer
9. VFD controlled motor (=>75HP) shall have an isolated non drive end “B-side” bearing
10. Motor shall confirm to the following:
    a. Motor Voltage: 460v/3ph/60hz
    b. Type: Squirrel cage induction
    c. Speed: Single
    d. Torque: Constant
    e. Service Factor: 1.15
    f. Enclosure: TEFC
    g. Mounting: Horizontal
    h. Speed: up to 3,600 rpm @ 60 hz (maximum)
    i. Design: A
    j. Duty Cycle: continuous (24hr/day)
    k. Winding Insulation: F
    l. Temperature rise: B
    m. Thermal motor protection: Positive Temperature Coefficient (PTC) thermistors (one per winding) wired in series. The use of thermostats is not allowed
        1) Connection of the PTC thermistors to the control system and signal processing is not part of the blower manufacturer’s scope of supply
    n. Conduit box location: Top
    o. Wiring Connection: Terminal strip inside conduit box. Use of wire nuts for connection of motor wiring to power source shall not be allowed
    p. Bearing L10 life: >40,000 hours
    q. Bearing lubrication: Grease
    r. Bearing type:
        1) ≤ 40 HP: Permanently greased
        2) ≥50HP: Regreaseable
            a) Lubrication fittings must be located towards the front of the blower package so that both bearings can be safely lubricated while the blower package is running.

b) Grease drain holes to be closed for protection of the environment. A spent grease cavity in the bearing cover should be large enough to hold spent grease required for 40,000 operating hours.

s. Bearing design: Cantilever forces (belt drive)
t. Condensation winding 110v heater: No

11. Motor shall be as manufactured by Siemens
12. Connection and control of the drive motor to the control system is not part of the blower manufacturer's scope of supply

B. Sound enclosure ventilation fan motor:
1. Motor voltage: reference Performance Data – power supply voltage
2. Motor shall be UL listed
3. Motor starter/ overload protection is the responsibility of the control system provider
4. The fan motor should turn "on" when the main motor starts and turn "off" 10 minutes after the main motor stops. Controlling the fan motor via a thermostat shall not be allowed.
5. Connection and control of the fan motor to the control system is not part of the blower manufacturer's scop e of supply

2.6 BLOWER PACKAGE

A. Drive:
1. The blower shall be driven by the drive motor through a V-belt drive assembly designed to meet the blower conditions specified with a 1.2 or larger service factor
   a. V-belts shall have a XPZ/XPB profile with embedded low-stretch polyester tension cords. The v-belts shall be designed for high rotational speeds and be heat and oil resistance. Ribbed, banded, or multi groove belts shall not be allowed
   b. Sheaves shall have a SPZ/SPB profile and be balanced to G16 for below 30m/s and G6.3 for sheaves above 30m/s
   c. Keyed taper bushing shall be used for easy installation and removal. QD type bushings shall not be allowed
2. The blower drive must have a fully enclosed guard which protects the operator when the blower package enclosure is open while in operation
   a. Belt guard shall be OSHA approved
   b. The belt guard made from the manufacturer's standard sheet metal, shall be designed to duct the cooling air flow from the drive motor fan across the front of the blower to supplement blower input shaft seal cooling
   c. The mounting fasteners for the belt guard shall be retained on the housing to prevent loss during maintenance
3. Belt tension shall be accomplished by the use of a motor swing base and automatic tensioning assembly
   a. The drive motor shall be mounted on a pivoting swing base with an axial adjustment for proper alignment of the v-belts. The weight of the drive motor shall provide the primary belt tension. The use of a sliding motor mount shall not be allowed
   b. A tensioning assembly consisting of a threaded rod with spring shall be used to adjust the v-belt tension to prevent belt slippage and efficiently transmit power to the blower. It shall include a visual indication showing whether or not the v-belt tension is within the correct belt tension range

c. Adjustment of the tensioning assembly shall be accomplished without removal of the guard or loosening of the motor mounting bolts
d. The design of the swing base with tensioning assembly shall prevent the swing base from falling and creating a personnel hazard in the event of a belt failure. The tensioning assembly adjusting nut shall raise the motor swing base facilitating v-belt changes without the use of pry bars or jacks

B. Inlet Silencer:
1. An inlet silencer designed for the frequency range of the blower, shall be provided to reduce the noise of the blower package as specified
a. The inlet silencer shall be of carbon steel construction and be of the wear-free absorptive type, directly connection to the inlet port of the blower, and shall be mounted horizontally
b. The inlet silencer shall be lined with replaceable polyether absorptive material.
c. The inlet silencer shall have an integral filter designed to protect the blower from particulates. It shall be located between the absorptive material and the blower inlet
1) The filter element shall be a washable and reusable polyester element for minimal pressure drop
2) The filter efficiency shall meet ASHRAE 52.2 MERV7 50-70%% @ 3-10 microns corresponding to EN779 G4
3) The filter element integral to the silencer shall be supplied no matter if the inlet configuration of the silencer is ambient or piped. If required on piped inlet configuration, any additional filtration or screening at the inlet location of the piped inlet air source is not the responsibility of the blower manufacturer
4) Filter element shall be removable without disconnecting the inlet duct
d. The filter maintenance cover and element must be removable by hand (without the use of tools)
e. The pressure loss thru the inlet silencer assembly shall be accounted for in the motor horsepower selection of the blower package

C. Base frame with integrated discharge silencer:
1. The blower base frame with integrated discharge silencer shall be designed for the frequency range of the blower, shall be provided to reduce the noise of the blower package as specified
a. The blower base frame shall be of formed steel construction and designed for horizontal mounting of blower with vertical air flow. Flange-mounting only of the bare blower to the blower base frame shall not be allowed, additional support by use of the base frame shall be required; preventing the loading of the blower casing and discharge silencer shell
b. The blower base shall incorporate the pivoting motor swing base and tensioning assembly to insure proper alignment of the drive assembly
c. The discharge silencer shall be an integral part of the base frame
d. The discharge silencer type shall be a combination of absorption, reflection and diffusion
1) The design of the discharge silencer shall incorporate a solid outer and perforated inner cylinder with absorptive material in between the cylinders
a) Absorptive material shall be long, flexible, knotted polyester fibers to allow for lowering the noise and heat emissions inside the sound enclosure. The use of mineral wool shall not be allowed

2) The discharge silencer shall have connections ports for pressure relief, discharge pressure, and discharge temperature. Unused ports shall be capped or plugged

e. The pressure loss thru the discharge silencer assembly shall be accounted for in the motor horsepower selection of the blower package

D. Blower Sound Enclosure:

1. A sound enclosure shall be provided which fully covers the blower, motor, drive assembly, inlet silencer, blower base frame with integrated discharge silencer, and be shipped fully assembled
   a. The sound enclosure shall be the product of the blower manufacturer to insure proper integration of blower package components
   b. The sound enclosure shall meet the sound level specified
   c. The sound enclosure acoustic material shall comply to FMVSS 302 with a burning rate B or lower than 100 mm/min
   d. The sound enclosure assembly shall be of self-supporting bolted steel panel construction on a fabricated steel skid
      1) All maintenance removable panels or doors shall be located in the front of the sound enclosure and must have a slotted key lock. A door key shall be provided. All maintenance panels shall meet OSHA weight requirements
      2) The enclosure base shall be designed to enclose the full bottom of the sound enclosure and include fork lift guides for easy transportation and installation
   e. The sound enclosure ventilation cooling air circuit shall be separate from the process air circuit. Mixing of the two air circuits within the enclosure shall not be allowed
   f. The sound enclosure shall have a set of inlet louvers positioned on the blower-side of the enclosure to allow for the flow of ambient cooling air across the blower oil sumps
   g. A screened inlet louver shall be located on the back of the enclosure and designed to provide a laminar flow of ambient cooling air across the blower drive motor
   h. The sound enclosure ventilation air exhaust and the ventilation fan shall be located at the top of the sound enclosure
      1) The ventilation fan shall be sized to provide adequate cooling of the blower package at all blower speeds
      2) The ventilation fan voltage shall be as specified and run concurrent with the main motor. The ventilation fan shall not be controlled by a thermostat
   i. The back of the sound enclosure shall have predrilled holes with grommets for easy pass-thru of electrical wiring
   j. When installed outdoor, reference Blower Package Configuration Part 2.3. An outdoor stainless steel weather hood shall be installed on top of the enclosure to protect the unit from the elements. The weather hood shall be designed to allow access to the sound enclosure and panel mounted instruments

E. Blower Package Accessories:

1. Pressure Relief Valve
   a. The relief valve(s) shall be factory installed within sound enclosure. Relief valve may not be shipped loose for field installation in the discharge piping.
   b. The relief valve(s) shall be spring type and must be sized for 100% of the design flow specified. Weighted relief valves shall not be used

c. The relief valve(s) shall be set to protect the blower from excessive differential pressure based on the design conditions specified. A seal shall be affixed that must be broken if set point is changed
d. The relief valve(s) exhaust shall be vented out of the sound enclosure. Exhaust vented into the sound enclosure shall not be allowed
e. The relief valve shall be ASME Section VIII, UV, CE, and PED certified
f. The relief valve shall be manufactured by Kunkle

2. Check Valve
   a. A check valve to prevent back flow through the blower shall be factory installed and not shipped loose for field installation in the discharge piping
   b. The check valve flapper shall be swing type made from a steel disc embedded in a high temperature silicone elastomer. The valve shall be designed so that, in the event of failure, the valve element is retained in the valve housing. Split disc or center hinged designs shall not be used
   c. The check valve capacity shall exceed the blower package's maximum discharge pressure and temperature
3. Flexible Connector
   a. An elastomeric compensator/flex connector shall be provided to isolate the connection of the blower package to the self-supporting system piping. Restraining rods shall not be used. Flex connectors located between the bare blower and silencers shall not be allowed
   b. The flexible connector capacity shall exceed the blower package's maximum discharge pressure and temperature
   c. Discharge connection
      1) 4" and smaller connection, a web reinforced silicone rubber sleeve with corrosion resistant clamps shall be provided. (Compak BBC, CBC, and DBC series)
      2) 6" and larger connection, an ANSI/DIN flanged arch-type EPDM web reinforced connector shall be provided. (Compak EBC, FBC, and HBC series)
   d. Piped Inlet connection – When required, Reference Blower Package Configuration 2.3.
      1) 6" or smaller connection, a web reinforced silicone rubber sleeve with corrosion resistant clamps shall be provided. (Compak BBC, CBC, DBC and EBC series)
      2) 8" and 10" piped inlet connection, an arch-type EPDM web reinforced sleeve with corrosion resistant clamps shall be provided. (Compak FBC series)
      3) 10" ANSI/DIN flanged inlet connection, an ANSI/DIN flanged arch-type EPDM web reinforced connector shall be provided. (Compak HBC series)
4. Blower instrumentation gauges
   a. The following gauges shall be pre-piped and panel mounted on the front of the sound enclosure. Gauges shall not be shipped loose for field installation
   b. Discharge pressure gauge
      1) The discharge pressure gauge shall measure the pressure at the discharge of the blower.
      2) The discharge pressure gauge shall be dual unit (English – PSI / Metric – Bar) with a range of 0 – 23 psi (0 – 1.6 bar). Minimum dial diameter shall be 2 ½", made with a stainless steel case and be glycerin filled for pulsation dampening
   c. Discharge temperature gauge with adjustable switch

1) The discharge temperature gauge shall measure the temperature at the discharge of the blower package
2) The discharge temperature gauge shall be dual unit (English - ºF / Metric - ºC) with a range from 32 – 392ºF (0 – 200ºC) and include an adjustable set point dial. Minimal dial diameter shall be 2 ½", made with a black plastic case and have a liquid filled measuring system that is converted by a Bourdon tube into a rotary movement of the pointer. The rotary movement of the pointer spindle shall operate a SPDT microswitch through a lever system. Voltage rating up 220v, 5amps
3) The high temperature set point shall be as recommended by the blower manufacturer
4) Connection of the switch to the control system is not part of the blower manufacturer's scope of supply. The switch shall be wired to shut down the blower package when actuated

d. Filter differential pressure gauge
1) The filter differential pressure gauge shall measure the pressure difference from ambient to the back side of the filter that is integral to the blower package's inlet silencer. When the filter starts to become dirty, the resistance shall be shown on a resettable red dial indicating when the filter shall be changed

5. Oil Drains
a. An oil drain from the blower drive-end and gear-end lubricating oil sumps shall be separately piped to the front of the blower base with flexible tubing. Common fill and drain shall not be allowed
b. Each oil drain shall include a drain valve installed for ease of maintenance. The drain valves shall be 90° nickel plated brass valves and include a fully retained gasketed threaded cap to prevent accidental discharge of the blower lubricant

6. Vibration Isolators
a. Vibration isolators shall be provided between the base frame with integrated discharge silencer and sound enclosure skid to prevent transmission of vibration to the foundation
b. A ground wire shall be installed between the blower base and the sound enclosure base to allow for grounding of the complete blower package

F. Optional Blower Package Accessories – the following options shall be supplied
1. Unloaded start valve
a. The blower package when started with a "wye-delta" or "soft/reduced start" starter shall include a diaphragm operated, mechanical unloaded start valve that is mounted between the blower and the discharge check valve
b. The unloaded start valve shall allow the blower drive motor to accelerate unloaded up to full speed before the discharge check valve opens

2. Inlet filter differential pressure switch
a. The blower package shall include an installed filter differential pressure switch that shall measure the pressure differential across the integral inlet silencer's filter
b. The filter differential pressure switch shall be field adjustable up to .73 PSI (50 mbar) and factory set at .5 PSI (35 mbar)
c. The filter differential pressure switch shall be a SPDT switch, Voltage rating up to 250v, 10A
d. Connection of the switch to the control system is not part of the blower manufacturer's scope of supply. The switch shall be wired to shut down the blower package when actuated

3. Discharge Pressure Switch
   a. The blower package shall include an installed discharge pressure switch that shall measure discharge pressure of the blower
   b. The discharge pressure switch shall be field adjustable
   c. The discharge pressure switch shall be a SPDT switch, Voltage rating up to 250v, 1A
   d. Connection of the switch to the control system is not part of the blower manufacturer's scope of supply. The switch shall be wired to shut down the blower package when actuated
4. Enclosure Safety Switch
   a. The blower package shall include an installed enclosure safety switch that shall thermostatically measure the temperature inside of the blower package's enclosure
   b. The enclosure safety switch shall be field adjustable and set at 140 deg F (60 deg C)
   c. The enclosure safety switch shall be a SPDT switch, Voltage rating up to 250v, 2.5 A
   d. Connection of the switch to the control system is not part of the blower manufacturer's scope of supply. The switch shall be wired to shut down the blower package when actuated. It shall not be wired to turn on the enclosure vent fan
5. Oil Temperature Switch (Compak DBC, EBC, FBC and HBC series)
   a. The blower shall include an installed oil temperature switch, one for each oil sump that shall measure the oil temperature in each oil sump of the blower
   b. The oil temperature switch shall be preset at 248 deg F (120 deg C)
   c. The oil temperature switch shall be a SPST switch, Voltage rating up to 250v, 10 A
   d. Connection of the switch to the control system is not part of the blower manufacturer's scope of supply. The switch shall be wired to shut down the blower package when actuated
6. Oil Level Monitoring (Compak DBC, EBC, FBC, and HBC series)
   a. The blower shall include and installed oil level monitoring, one for each oil sump that shall measure the oil level in each oil sump of the blower
   b. The oil level monitor shall be preset for low oil condition
   c. The oil level monitor shall be a SPST switch, Voltage rating up to 250v, .5 A
   d. Connection of the monitor to the control system is not part of the blower manufacturer's scope of supply. The monitor shall be wired to shut down the blower package when actuated
7. Enclosure Heater Assembly
   a. The blower package when installed where temperatures could be between 5 to 23º F shall include an installed 115v/1ph/60hz enclosure heater with a thermostatically controlled switch that shall heat the inside of the enclosure
   b. The enclosure heater switch shall be field adjustable and be factory set to come on at 41 deg F (5 deg C)
   c. Connection of the enclosure heater system to the control system is not part of the blower manufacturer's scope of supply
8. Instrumentation Junction Box
   a. The blower package shall include an instrumentation junction box where all the provided instrumentation is wired to a terminal strip making for a central electrical connection point (except for the main blower drive motor)
   b. Connections from the instrumentation junction box to the control system are not part of the blower manufacturer's scope of supply

G. Nameplates:
1. The blower package shall have at least two weather proof corrosion resistant type nameplates which includes the manufacturer name, model number, year, max pressure difference, equipment number, part number, serial number, voltage, phase, HP, motor rpm, rated temperature, and FLA attached on the outside and inside of the blower package

H. Anchor Bolts and Hardware
1. Anchor bolts, washers, hex nuts, and all other fastening hardware shall be stainless steel and be supplied by the contractor

I. Paint Specification:
1. The blower manufacturer is responsible for surface preparation, priming and finish coating of the blower package and components requiring paint in accordance with the manufacture's standard procedures. Field painting of blower equipment or supplying components that are only prime painted is not acceptable
   a. Cast parts are to be painted with a two part gray epoxy primer and two part top coat
   b. Fabricated parts are to be painted with a two part gray epoxy primer and two part top coat
   c. Sound enclosure parts are to be powder coated
      1) Panels and base paint finish shall be pretreated by de-greasing and phosphate cleaning, then powder coated to a thickness of 70 µm -100 µm on both sides
2. The blower package to be painted the blower manufacturer's standard colors

PART 3 - EXECUTION

3.1 INSTALLATION

A. The blower package shall be handled and installed in accordance with the manufacturer's recommendations and instructions as shown in the location on the drawings

B. Contractor shall field verify all dimensions and elevations. The engineer shall be notified of any specific differences

C. The blower package shall arrive on site ready for installation. Aligning, adjusting and filling the blower with lubrication shall not be required by the contractor

3.2 FIELD QUALITY CONTROL

A. Furnish the services of a manufacturer's authorized representative for proper installation to inspect and approve the installation, and to supervise a test run of the blower package.

B. After the installation and test run has been completed; the blower package shall be given a field test in the presence of the Engineer to verify that operation is satisfactory and in compliance with the Specification. If the blower package does not meet the Specification, corrective measures shall be taken to ensure the machine meets compliance

3.3 TRAINING

A. Furnish the services of a manufacturer's authorized representative, who will instruct plant personnel in the operation and maintenance of the blower package. All procedures shall be covered including preventive maintenance, method of controlling the blower package and troubleshooting.

SECTION 46 21 01 - MANUAL BAR SCREEN

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual Bar Screen.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's product data for system materials and component equipment.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit dimensional drawings, installation and anchoring requirements, fasteners, and other details.

D. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

G. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed screen.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish one (1) set of manufacturer's recommended spare parts.

2. Furnish a complete list of manufacturer’s recommended spare parts.

C. Tools: Furnish special tools and other devices required for Owner to maintain, disassemble and repair manual bar screen and associated components.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging, including application instructions.

C. Inspection: Accept screen and associated components on-Site in original packaging. Inspect for damage.

D. Store materials according to manufacturer's instructions.

1.7 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date of the project in its entirety.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Or-Tec

B. JWC Environmental

C. Or Pre-Approved Equal

1. Specifications and equipment arrangements for the equipment referenced are based on Or-Tec. Changes to the arrangement indicated in the specifications and in the plan set shall be at the expense of the installing Contractor. No change orders will be issued to the contractor for modifications to the laying length, footprint, concrete layout, electrical, mechanical, etc.

2.2 DESCRIPTION

A. A manually cleaned bar screen shall be installed in the bypass channel of coarse mechanical screen at the influent pump station. The manual bar screen shall be used to remove large debris including stringy rag-like materials from the influent sewage. The manual bar screen shall only be in service when the coarse mechanical screen is overflowed or taken out of service for maintenance.

2.3 PERFORMANCE AND DESIGN CRITERIA

A.	Peak Flow:	8.4 MGD
B.	Channel Width:	36 inches
C.	Channel Depth:	60 inches
D.	Screen Grid Opening:	1 inches (25 mm)
E.	Screen Angle:	45°

2.4 BAR SCREEN

A. Structure:

1. The Manual Bar screen shall consist of a bar screen panel, two side frames, perforated drying deck and manual rake.
2. Equipment shall be installed so as not to obstruct the flow of raw wastewater to bar screen. Screen components including shapes (rods, angles, and channels), side frames, bar rack, rake, drying deck, fasteners and anchor bolts shall be manufactured from Type 304 stainless steel. Manual bar screen with any of these items manufactured from materials other than 304 stainless steel shall not be acceptable.

B. Bar Screen Panel:

1. Screen panel face shall be made of a parallel array of bars with even spaces between them. Bars shall be 1/4” wide and 1” deep. Bars shall be fully welded in a stainless steel frame.
2. The mid-section of the bar is cross-supported by support beams at every 20” interval.
3. All material for bars, drying deck, rake and the support beams shall be made of 304 Stainless Steel. The bar screen panel shall be mounted and bolted between a pair of side frames. Screens which utilize material other than stainless steel as the main screen media shall not be acceptable for this project.

4. The screen shall be supplied with a rake that allows operators to manually clean the screen face. The rakes penetrating teeth shall fully clean the gaps between the bars and keep the screen operational. Screening shall be drawn up the face of the screen and discharged onto a perforated drying deck above the channel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

3.2 INSTALLATION

A. Install screen and associated components according to manufacturer's instructions and as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. After installation, inspect and test for proper operation.

C. Manufacturer will provide factory service during one (1) trip, for one (1) day, for inspection of installation, equipment start-up, and operator training.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

END OF SECTION 46 21 01

SECTION 46 21 15 – MECHANICAL SCREEN AND SCREENINGS WASHER/COMPACTOR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanically cleaned perforated plate screen.
2. Screenings washers/compactor.

B. Related Requirements:

1. Section 01 33 00 – Submittal Procedures
2. Section 01 40 00 – Quality Requirements
3. Section 01 60 00 – Product Requirements
4. Section 01 70 00 – Execution and Closeout Requirements
5. Division 40 – Process Interconnections
6. Division 26 – Electrical

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's product data for system materials and component equipment, including electrical characteristics.

C. Provide headloss information.

D. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit wiring and control diagrams, installation and anchoring requirements, fasteners, and other details.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

H. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed screenings washers/compactors.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with a minimum of ten (10) years of experience manufacturing these products.

B. All equipment specified in this Section shall be supplied by a single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging, including application instructions.

C. Inspection: Accept mechanical screen and screenings washer/compactor on-site in original packaging. Inspect for damage.

D. Store materials according to manufacturer's instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish a warranty extending twelve (12) months after substantial completion date of the project in its entirety for mechanical screen, screenings washer/compactor, and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment shall be manufactured by:

1. JWC Environmental
2. Hydrodyne
3. Huber
4. Or Pre-Approved Equal

    a. Specifications and equipment arrangements for the mechanical screening and compacting equipment are based on JWC Environmental. Changes to the arrangement indicated in the specifications and in the plan set shall be at the expense of the installing contractor. No change orders will be issued to the contractor for modifications to the laying length, footprint, concrete layout, electrical, mechanical, etc.

2.2 MECHANICAL SCREEN (SCR1010)

A. Description:

1. The manufacturer shall supply one (1) continuous belt type screens with perforated plate grid.
2. Screen shall automatically discharge screenings into header of screenings washer/compactor.
3. Each screen shall consist of a screen frame with screen mounting brackets, an adjustable continuous screen belt, a screen belt cleaning system, spray wash system, covers, and seals to eliminate the bypass of flow or screenings.
4. Mechanical screen and components shall be stainless steel.

B. Design Requirements

1. Number of Screens: one (1)
2. Peak Flow per screen: 4.2 MGD
3. Avg Flow per screen: 1.0 MGD
4. Screen Opening: 0.125 inches (3 mm)
5. Channel Depth: 60 in.
6. Channel Width: 36 in.
7. Inclination angle: 65 degrees
8. Screen Drive Motor: 2 hp (max), 460 V, 3 phase
9. Brush Drive Motor: 1 hp (max), 460 V, 3 phase
10. Wash Water Requirement per screen: 42 gpm, 50 psi (max)
11. Downstream Water Depth at Peak Flow: 9 inches
12. % screen panel blinding: 50%

13. Head drop at 50% blinding: 24.91 inches
14. Water level upstream at 50% blinding: 33.91 inches at peak flow
15. Hydraulic flow regime: Subcritical flow (standard open channel flow)

C. Components

1. Screen

a. The rotating screen shall consist of perforated panels intermittently rotating through the wastewater flow. Debris combs shall be intermittently affixed to panels as required
b. Screen panels shall be manufactured from stainless steel or UHMWPE. Each screen panel shall be provided with side seals mounted on each end of the panel.

2. Chain, Sprockets, and Drive Shaft Assemblies

a. Each screen panel shall be mounted to the stainless steel roller chains driven by stainless steel sprockets mounted on the drive shaft.
b. The chains shall be roller type with stainless steel side plates. The rollers, pins and bushings shall be hardened stainless steel or polyamide.
c. The stainless steel drive shaft shall be supported on each side by grease lubricated take-up bearing assemblies.

3. Side Frames

a. The screen shall include side frames and bracing designed to support the chain, screen panels, spray wash, discharge, and drive assemblies.
b. Each side frame shall be designed to house the replaceable stainless steel or UHMW polyethylene tracking system.
c. The tracking system in each frame shall be UHMW polyethylene in the vertical, UHMW polyethylene for the outer and stainless steel for the inner track at the bottom.

4. Covers

a. The portion of the screen above the operating floor level shall have stainless steel covers.
b. The covers shall provide quick access to the equipment for maintenance.

5. Spray Wash Assembly

a. Each screen shall have a spray wash assembly consisting of a spray wash manifold, solenoid operated valve, manually operated ball-valve and Y-strainer, supplied by the screen manufacturer.
b. Spray wash manifold shall consist of stainless steel pipes and fittings.
c. The manually operated ball valve shall provide adjustment for the spray wash water flow.
d. The Y-strainer shall have a plugged blow-off outlet
e. Screen spray wash water requirements shall be 42 gpm at 50-60 psig.

6. Rotating Brush Assembly

a. A rotating brush assembly shall be used to help with the removal of the screenings from the panels. The brush assembly shall have a separate drive.
b. The brush assembly shall be mounted on an adjustable pivot for easy access and adjustments.

7. Stationary Seal Assembly

a. A replaceable stationary brush and flexible rubber seal assembly shall be used to eliminate debris from bypassing the screen at the bottom

8. Drive Assemblies

a. The screen drive assembly shall be a shaft-mounted reducer with electric motor.
b. The brush drive assembly shall be a shaft-mounted reducer with an electric motor.

9. Discharge Chute

a. An enclosed discharge chute shall receive screened debris that has been removed from the screen panels and transport the discharge to the washer/compactor.

2.3 SCREENINGS WASHER/COMPACTOR (SWC1015)

A. Description:

1. Screenings washer/compactor shall wash out organics and dewater screenings in an automatic sequence.
2. Screenings shall enter top of unit and be agitated by a rotating compaction screw under a spray of wash water.
3. Washed screenings shall be transferred into a compactor section, then exit through a discharge pipe to the discharge location indicated on the Drawings.
4. Unit shall consist of wash water spray, screenings screw, compactor with motor, discharge assembly, and other components to make a complete and operable system.
5. Screenings washer/compactor and components shall be stainless steel.

B. Design Requirements

1. Discharge Drain Connections: Number and size of drain connections to be determined by manufacturer.
2. Maximum Solids Capacity (Continuous): 206 ft^3/hr.
3. Maximum Water (Launder) Capacity: 160 GPM including Wash Press spray water.

C. Wash Tank

1. Wash tank shall consist of tank with removeable cover and end plates, allowing for removal or installation of compaction screw from either end or above.
2. Construction material: 304 stainless steel
3. Inspection ports and covers: Three ports for viewing, located on either side of tank and on top cover.
4. Spray water manifolds: Spray pipes located on either side of perforated screen for washing of material.

D. Perforated Screen:

1. Screen shall provide separation of solids and water through use of perforated holes that control particle size throughput.
2. Welded or removable.
3. Drain pan shall be removable.
4. Screen perforated hole diameter shall be 1/8 inch (3 mm) with 40% open area, Construction Material: 304 stainless steel.

E. Spray Water Control Assembly:

1. Spray water control assembly shall filter, control, and regulate spray water to the tank spray water manifold and hopper spray water manifold.
2. Water requirements: 30 gpm at 40 psig
3. Delivery, frequency and duration shall be programmable through the controller.
4. Basket strainer: Primary filtration of spray water with 20 mesh screen. Basket strainer shall have 136 stainless steel housing and 304 stainless steel screen.
5. Y-Strainer: Secondary filtration of spray water with 80 mesh screen.
6. Solenoid Valves: Control flow of water to manifolds with 120VAC coil, explosion proof.
7. Ball Valves: Manual regulation of water flow and shut off. Ball valves shall be stainless steel.
8. Pressure Gauge: Visual indication of operating pressure.
    a. Freeze resistant design.
    b. Range: 0-100 PSI
9. Pressure Regulating Valve: regulate the pressure of the spray water to the desired operating pressure.
10. Reinforced hose shall be used to connect Wash Water Control Assembly to spray water manifolds.

F. Paddle Compaction Screw:

1. Screw design shall provide disruptive movement of the material creating a turning or flipping action that enhances the wash process by continually exposes additional surface area to the wash water. Compaction screw shall be constructed with specific purpose flight zones for pre-wash zone, wash zone and compaction zone.
2. Pre-wash zone flights: 12-inch outer diameter with min. ¼-inch thick sectional flights. No brush shall be used in this zone to prevent solids buildup.
3. Wash zone flights: 12-inch outer diameter with min. ¼-inch thick sectional flights and three 3/8-inch-thick paddle sections for disruptive movement of material.
    a. Flight brush shall be segmented for each full pitch of spiral to scrub perforations in wash zone.
        1) Base: HDPE
        2) Bristles: Level cut nylon
    b. Paddle brush shall be segmented for each paddle
        1) Base: HDPE

2) Bristles: Crimped nylon

4. Compaction zone flights: Dual helix design, 11-1/4 inch diameter with a nested 1-inch thick outer spiral and a ½ inch thick inner spiral.

   a. Second helix for one full pitch of spiral.
   b. Hard face weld applied with two layers to face of dual helix flights using Stoody 2134, Lincoln electric wear shield 60, or Hardox 400.

5. Torque Tube: 3-inch diameter tube inserted and welded through center of all flight zones.

   a. End of tube shall have dome shaped protrusion to create "donut" form of solid plug in compaction zone for easier transport.
   b. Hard face weld applied with two layers to dome using Stoody 2134 or Lincoln electric wear shield 60.

G. Compaction Elbow:

1. 45-degree bend aiding formation of solids plug and inclined to lift solids to discharge point.
2. Construction Material: 304 stainless steel.

H. Tapered Transport Tube:

1. Transport tube tapered 12-1/2 to 13-5/8-inch diameter to allow for reduced restriction on movement of capered solids and allow proper air flow to further dry material.
2. Transport tube lifting bracket shall be designed to lift tube empty or full with solids.
3. Construction Material: 304 stainless steel.
4. Manufacturer shall fabricate transport tube to convey screenings to the dumpster as required. Drawings show the intent of screenings transport to the dumpster but manufacturer shall verify all details and supports required.

I. Straight Transport Tube:

1. Transport tube 13-5/8 inch diameter to provide additional length to discharge.
2. Construction material: 304 stainless steel

J. Discharge Tip:

1. Discharge tip shall be mounted to end of tapered transport tube or straight transport tube to directional discharge material plug in a downward direction.
2. Construction Material: 304 stainless steel.

K. Shaft Seal:

1. A shaft seal shall provide sealing for Paddle Compaction screw shaft and wash tank.
2. Tungsten carbide dynamic and static seals faces.
3. Bearing shall provide support for axial thrust loads.
4. Static and dynamic race housings: AISI 304 stainless steel.
5. Elastomers: BUNA-N (Nitrile).

L. Speed Reducer:

1. Reduction ratio and design: 123.3:1, helical bevel shaft mounted.
2. Lubrication: Synthetic oil.

M. Motor:

1. TEFC Motor: Baldor Electric Company

a. Horsepower (max): 5 HP.
b. RPM: 1750.
c. Motor Service Factor: 1.15 minimum
d. Motor Efficiency Factor (at full load): 89.5 minimum

2.4 CONTROL PANEL (FCP1010)

A. Control Panel Description

1. A control panel shall be provided for each screen that controls the screen and the associated washer/compactor.
2. The screenings washer/compactor shall be interlocked with the mechanical screen for automatic operation.
3. Control panel shall have a stainless-steel enclosure.
4. The control panels will be mounted locally at the mechanical screens and screenings washer/compactor on top of the headworks structure.
5. Control panel shall be NEMA 4X and UL listed
6. Control panel shall contain a programmable logic controller (PLC). PLC shall be Allen Bradley Micrologix.
7. The PLC shall include a Modbus TCP communications card.
8. Control panel shall contain an HMI.
9. Control panel shall be provided with sun shield.
10. The control panel shall contain the motor starters. Starters shall comply with Division 26 – Electrical.
11. Surge protection shall be according to Specification 26 43 13 – Surge Protection for Low-Voltage Electrical Power Circuits
12. The panel shall include a fiber optics switch to provide connectivity to the plant SCADA System.
13. All other electrical components shall be in accordance with Division 26 – Electrical.

B. Mechanical Screen Controls

1. The mechanical screen controls shall include the following:

a. H-O-A switch for screen operation.

1) When HAND mode is selected, the screen shall run continuously.
2) When the OFF mode is selected, the screen shall stop.
3) When the AUTO mode is selected, screen shall start by a signal from one of the following:

a) Differential level system: If the screen starts by differential level, the screen shall run until the differential drops below the set point and the off timer times out. If one of the level transducers has an error, the screen shall run continuously.
b) Timer (backup)
c) Input error from transducer (loss of echo)
d) High level alarm: If the screen starts on high level it shall run until the high level drops below the set point and the off timer times out.
e) High level start

b. H-O-A switch for wash water system of mechanical screen.

1) When HAND mode is selected, the spray shall be continuous.
2) When the OFF mode is selected, the spray shall stop.
3) When the AUTO mode is selected, the spray shall run while the screen is running.

c. CONTROL POWER ON indicating light.
d. RUN indicating light for screen.
e. Torque OVERLOAD indicating light for screen.
f. Reset pushbuttons
g. Elapsed Time Meter.
h. Main Disconnect Switch.
i. Emergency Stop Push Button.
j. Hardwired Interlock: Level Switch
k. Local Control Station (FCP1010A)

1) Each screen and washer/compactor shall have a local control station mounted locally to the screen and contain the following:

a) HAND/OFF/AUTO selector switch for screen
b) HAND/OFF/AUTO selector switch for washer/compactor
c) FORWARD/OFF/REVERSE selector switch for screen
d) FORWARD/OFF/REVERSE selector switch for washer/compactor
e) Emergency stop pushbutton

C. Screenings Washer/Compactor Controls

1. The screenings washer/compactor controls shall include the following:

a. H-O-A switch for operation of compaction screw.

1) When HAND mode is selected, the screw shall run continuously.
2) When OFF mode is selected, the screw shall not run.
3) When AUTO mode is selected, the screw shall operate in accordance with pre-configured operating parameters as controlled by a Run Permissive signal from an upstream feed device.

b. H-O-A switch for wash water system.

1) When HAND mode is selected, the spray wash shall run continuously.

2) When OFF mode is selected, the spray wash shall stop.
3) When AUTO mode is selected, the spray wash shall run while the compaction screw is running.

c. CONTROL POWER ON indicating pilot light.
d. RUN indicating pilot light.
e. FAULT indicating pilot light (torque overload).
f. WASH VALVE OPEN indicating pilot light.
g. ELAPSED TIME METER.
h. Reset Pushbutton.
i. Emergency Stop Pushbutton
j. All required timers.
k. Programmable run sequences to optimize washing and compacting.
l. Power monitor
m. Programmable wash water duration and frequency.

2.5 DIFFERENTIAL LEVEL CONTROL SYSTEM

A. Manufacturer shall provide a differential level control system consisting of ultrasonic transducers to start the mechanical screen and screenings washer/compactor system.

2.6 NAMEPLATES

A. Conform to the requirements of Section 46 05 53 – Identification for Water and Wastewater Equipment.

2.7 SPARE PARTS

A. Furnish one set of manufacturer's recommended spare parts.

B. Furnish special tools and other devices required for Owner to maintain screening equipment and screenings washer/compactor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that facility is ready to receive mechanical screen and screenings washer/compactor.

3.2 INSTALLATION

A. Install mechanical screen and screenings washer/compactor according to manufacturer's instructions and recommendations.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Manufacturer Services:

1. Start-up

a. Furnish the services of a factory representative, having complete knowledge of proper operation, start-up procedure and maintenance requirements, for not less than three (3) eight (8) hour days, to inspect the final installation and supervise a test run of the mechanical screen and screenings washer/compactor.

2. Training

a. Furnish the services of a factory representative, having complete knowledge of the operation and maintenance requirements of the system, to instruct the Owner's personnel in the proper operation of the equipment. Training for proper operation and maintenance of the equipment shall be scheduled for one (1) eight (8) hour day and shall be concurrent with trip to site required for start-up.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 ASSEMBLY, INSPECTION, AND TESTING

A. Following installation, operating tests will be performed to demonstrate to the Engineer that each mechanism and the system as a whole will function in a satisfactory manner. The Contractor shall make, at Contractor's own expense, all necessary changes, modifications, and/or adjustments required to ensure satisfactory operation.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 21 73

SECTION 46 23 23 - GRIT REMOVAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation of the grit removal system as shown on the drawings and specified herein. The manufacturer shall supply the equipment and the general contractor shall install the equipment.

B. Related Requirements:

1. Section 05 50 00 - Metal Fabrications: Fasteners, brackets, and other miscellaneous metal fabrications as required by this Section.
2. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting as required by this Section.
3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to equipment specified by this Section.
4. Section 46 05 13 - Common Motor Requirements for Water and Wastewater Equipment: Execution requirements for motors specified in this Section.
5. Section 46 05 53 - Identification for Water and Wastewater Equipment: Nameplates for equipment specified in this Section.

1.2 SUBMITTALS

A. Manufacturer shall provide, at a minimum, the following information in accordance with Section 01 33 00 – Submittals.

1. Product Data/Information: Descriptive literature, bulletins and/or catalogs of the equipment.
2. Certified general arrangement drawings showing all important details including materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.
3. Complete data on motors and gear reducers.
4. Maintenance Instructions
5. Installation Instructions
6. Wiring diagrams and electrical schematics for all control equipment to be furnished.
7. Parts List
8. Sample Warranty

1.3 COORDINATION

A. The Contractor shall review design and layout drawings to ensure that installation arrangements are suitable for the specified equipment. Any potential conflicts or recommended modifications shall be coordinated with the Engineer and noted on the shop drawings or by a pre-submittal request for information, if appropriate.

B. Coordinate installation and startup of Work of this Section with Plant Operations.

1.4 SCHEDULING

A. Section 01 31 00 – Project Management and Coordination: Requirements for scheduling.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed grit removal equipment.

C. Operation and Maintenance Data: Submit instructions for equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.7 QUALITY ASSURANCE

A. Certificate of Compliance
1. The MANUFACTURER shall warrant that the Grit Removal System to be supplied shall be manufactured in strict compliance with the Contract Specifications.

B. The system shall be furnished by a MANUFACTURER who is ISO 9001:2015.

C. MANUFACTURER shall be successful in the experience of manufacture, operation, and servicing of Grit Removal Systems of type, size, quality, performance, and reliability equal to that specified for a period of not less than ten (10) years.

D. If equipment other than that shown on the Drawings is submitted to the Engineer for consideration as an equal, it shall be the responsibility of the MANUFACTURER requesting approval to submit with the request a revised design and layout of the mechanical equipment acceptable to the ENGINEER. Revised drawings shall show the proposed location of the alternate unit, and area required for withdrawal space of replacement or serviceable components. This drawing shall also show clearances of adjacent equipment and service area required by that equipment.

E. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the alternate shall be the responsibility of the Manufacturer requesting approval. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the MANUFACTURER and not the OWNER. Seller shall warrant its products against infringement upon, or violation of, any patent, copyright, trade secret, or any other proprietary right of any third party. In the event of a claim by any third party against the Owner, the Owner shall promptly notify the Seller. The Seller

shall then defend such claim, in the Owner's name, but at Seller's expense, and shall indemnify the Owner against any loss, cost, expense or liability arising out of such claim whether or not such claim is successful.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging, including application instructions.

C. Inspection: Accept materials on-Site in original packaging. Inspect for damage.

D. Store materials according to manufacturer's instructions.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Contractor shall furnish a warranty extending twelve (12) months after substantial completion date of the project in its entirety.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. The entire Grit Removal System shall be manufactured by Hydro International, Hillsboro, OR.

B. Or Pre-Approved Equal

1. Specifications and equipment arrangements for the equipment referenced are based on Hydro International. Changes to the arrangement indicated in the specifications and in the plan set shall be at the expense of the installing Contractor. No change orders will be issued to the contractor for modifications to the laying length, footprint, concrete layout, electrical, mechanical, etc.

2.2 GRIT CONCENTRATOR

A. Design Data

1.	Number of Units:	1
2.	Size:	6' diameter
3.	Number of Trays per Unit:	6
4.	Surface Area/Unit:	170 ft^2
5.	Peak Loading Rate:	16.8 gpm/ft^2

6.	Performance at Ave Flow:	95% removal of all grit (specific gravity 2.65) ≥ 75 microns at average flow
7.	Performance at Peak Flow:	95% removal of all grit (specific gravity 2.65) ≥ 150 microns at peak flow
8.	Average Flow/Unit:	2 MGD with no more than 3" headloss
9.	Peak Flow/Unit:	4.11 MGD with 12" headloss
10.	Discharge:	Weir
11.	Underflow Connection:	4"
12.	NPW Connection:	1" NPT
13.	Materials of Construction:	304SS Support structure/duct/underflow; LDPE trays

B. Operation

1. Flow shall transition from the inlet channel or pipe to the trays via an inlet duct positioned above the trays. Each tray shall be connected to the inlet duct by a horizontal nozzle with a rectangular cross section and large clear openings. Round nozzles which reduce cross sectional area shall not be allowed. Designs with hydraulic turns greater than 45 degrees shall not be allowed.
2. The Grit Concentrator shall have a maximum surface loading rate of 18.4 gpm/square foot to ensure adequate surface area for settling and specified particle removal efficiency. No exceptions shall be allowed.
3. The Grit Concentrator shall be characterized by a controlled boundary layer flow to enhance settleable solids concentration and removal.
4. The Grit Concentrator shall be all-hydraulic consisting of self cleaning corrosion resistant, non-metallic trays with no moving parts within the unit.
5. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.
6. Water shall be intermittently supplied to the solids underflow sump.

C. Construction

1. The inlet flume shall be constructed of Minimum 14 gauge formed stainless steel sheet with minimum 3" clear openings. Multiple flexible connections to the trays shall not be allowed. Units using a piped upflow influent distribution design shall not be accepted. Designs with hydraulic turns greater than 45 degrees shall not be allowed.
2. Grit Concentrator trays shall be molded thermoplastic with a minimum ¼ inch thick LDPE on the pans and sidewalls. Formed and welded stainless steel trays shall not be allowed.
3. The stack of trays shall securely fit into a stainless steel support frame. The support frame shall fit and secure to the bottom of the CONTRACTOR supplied concrete support structure.
4. The sump bottom with fluidizing ring shall be installed in the CONTRACTOR supplied concrete tank and incorporate a threaded connection to the water supply line.
5. No gap in the grit basin shall be less than 3 inches
6. All pipe flanges shall conform to ANSI B16.1 bolt patterns.

D. Valves and Accessories

1. The Grit Concentrator shall be provided with the following accessories:
   a) One (1) 1" bronze globe valve to regulate the system water flow rate to the grit collector.

b) One (1) 1" bronze ball valve for shut off
c) One (1) 1" brass solenoid valve for automation
d) One (1) 8-40 gpm acrylic flow meter

2. Unions or quick disconnects are to be incorporated into the piping on either side of the flow meter for ease of removal and cleaning. The quick disconnects or couplings are to be supplied and installed by the contractor.

2.3 GRIT CLASSIFICATION/CONCENTRATION UNIT

A. Design Data

1.	Number of Units:	1
2.	Size:	24" diameter
3.	Performance:	95% removal of all grit (specific gravity 2.65) ≥ 75 microns at design flow
4.	Influent Solids Concentration:	≤ 1.0 %
5.	Design Flow/Unit:	150 gpm @ 27" headloss
6.	Influent Connection:	3" flanged pipe
7.	Effluent Connection:	8" flanged pipe
8.	Underflow Connection:	6" flanged pipe
9.	Material of Construction:	304 SS
10.	Operation:	Continuous

B. Operation

1. The Grit Classification/Concentration unit shall be designed to handle screened raw wastewater.
2. The Grit Classification/Concentration unit shall be characterized by a dominant, strong free vortex which utilizes centrifugal and gravitational forces and secondary boundary layer velocities to effect the separation, collection and classification of grit from the unit's inflow.
3. Defining characteristics of the dominant free vortex / secondary boundary layer velocity type units are as follows:
   a. Dominating increasing tangential velocity profile toward the center of the unit.
   b. The ability to handle increasing flows with no loss of the specified grit removal efficiency and with increasing headloss requirements.
   c. No requirements for electrical or mechanical components, flow deflecting/guiding weirs or baffles, or compressed air lines within the unit to meet the specified performance.
   d. Continuous removal of grit.
4. The Grit Classification/Concentration unit shall be all-hydraulic with no moving parts within the unit.
5. Vortex grit units which do not have a dominant, strong free vortex / secondary boundary layer velocity and whose performance decreases with increasing flow shall not be allowed.
6. The grit underflow from the Grit Classification/Concentration unit shall be transported by gravity to the Grit Dewatering unit.

C. Construction

1. The Grit Classification/Concentration unit shall be fabricated from stainless steel. The vessel walls shall be 3/16 inch thick.
2. A coating of Belzona shall be applied to the inside bottom part of the Grit Classification/Concentration body to add a secondary layer of abrasion resistance.
3. The Grit Classification/Concentration unit shall be designed to withstand a maximum working pressure of 14.7 psig. The actual maximum pressure at the inlet shall be no more than 14.7 psig.
4. All flanges shall be rotatable and conform to ANSI B16.1 bolt patterns.
5. A minimum 12 inch diameter visual access shall be provided in the top of the Grit Classification/Concentration unit. All internal elements shall be removable from inside the unit.
6. The Grit Classification/Concentration unit shall be free standing on three legs and mounted above a Grit Dewatering unit. Clearance shall be provided between the bottom of the grit underflow pipe and the Grit Dewatering unit clarifier surface.

2.4 GRIT DEWATERING CONVEYOR

A. Design Data

1.	Number of Units:	1
2.	Maximum Design Flow Rate:	125 gpm
3.	Maximum Grit Load:	0.75 cyd/hr
4.	Clarifier Size:	60” Wide
5.	Clarifier Surface Area:	14.5 sq. ft
6.	Spiral Diameter:	12”
7.	Maximum Spiral Speed:	2 rpm
8.	Inlet Connection:	6” flanged pipe
9.	Overflow Connection:	6” flanged pipe
10.	Drain Connection:	3” threaded pipe
11.	Motor:	1.0 hp
12.	Material:	304 SS

B. Operation

1. The Grit Dewatering Conveyor unit shall be designed to capture and dewater concentrated grit slurry from the Grit Classification unit.
2. The Grit Dewatering Conveyor unit clarifier shall be designed based on a settling rate not to exceed 1 gpm/ft^2.

C. Construction

1. The Grit Dewatering Conveyor shall be provided with an integral clarifier which shall provide at least 3 inches of freeboard.
2. The conveying screw shall have 3/16-inch-thick flights mounted on a 3 1/2 diameter schedule 40 pipe.
3. The housing for the Grit Dewatering Conveyor auger shall be fitted under the clarifier. The housing for the Grit Dewatering Conveyor auger shall be stainless steel and shall be inclined at 25 degrees.
4. The clarifier and auger housing shall be fully covered. All covers and hardware shall be stainless steel.

5. The auger housing shall be provided with one (1) threaded drain.
6. The Grit Dewatering Conveyor unit support structure shall be as shown on the general arrangement drawing and anchored to a stable base.
7. All flanges shall be spinning flanges, a minimum of 1/2 inch thick, and drilled to match ANSI 150 lb. pipe flanges.
8. The Grit Dewatering Conveyor unit shall be supplied as standard with access to ease maintenance:
   a. Externally accessible bearing unit.
   b. Clarifier observation and maintenance hatches.
   c. Rodding/Flushing water access point opposite of the unit drain.

D. Drive Unit

1. The Grit Dewatering Conveyor shall be provided with a drive unit consisting of the motor and the helical gear reducer, mounted as a single integrated unit.
2. The motor shall be 3 phase, 460 VAC, 60 Hz, NEMA Design B, TENV enclosure.
3. The helical gear reducer shall have hardened alloy steel gears accurately cut to shape.
4. The drive speed shall be adjusted by a variable speed drive housed in the control enclosure. The auger speed shall be adjustable from 1-10 rpm.

E. Valves and Accessories

1. The Grit Dewatering Conveyor unit shall be supplied with One (1) 3" full port stainless steel ball valve located on the unit drain.

2.5 RECESSED IMPELLER GRIT PUMP

A. Design Data

1. The pumps shall be designed for continuous operation and will be operated continuously under normal service.
2. Grit pump shall be Trillium, WEMCO Model C

B. Operation Criteria

	Flow GPM	TDH FT	Max. Pump RPM	Solids Passage	Min. Suction Dia.	Min. Disch. Dia.	Motor HP (max)	Motor RPM
Design Condition	150	20	900	3.0"	3.0"	3.0"	7.5 HP	1800 RPM

C. Design

1. As these pumps will be used to pump abrasive grit and other solids, the pumps shall be specifically designed to both optimize wear resistance and maintain hydraulic performance as wear occurs.
2. The pump(s) shall be of a fully recessed, Slurry Type design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connection, so that solids are not required to flow through the impeller. All flow path clearances within the

pump shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.

3. The impeller shall be constructed of 650 Brinell Hi-Chrome Iron ASTM A532, Class III, Type A and specifically designed to maintain hydraulic pumping performance as wear occurs.
   a. The impeller shall be of cup design such that the deepest portion of the vane is not located at the vane tips and the tips are surrounded by a thick-sectioned rim of the following thickness:

Pump Size	Minimum Impeller Dia. Outside Rim	Minimum Rim Thickness at Wear Area	Minimum Vane Thickness at Base of Wear Area	Impeller Minimum Weight
3-inch	14-1/16 in.	1 in.	1-3/8 in.	55 lbs.

   b. The hydraulic design shall be such that the length of the impeller vane increases as wear occurs to the rim, allowing as-new or better pumping performance throughout the wear cycle of the impeller.
   c. The hydraulic design of the impeller shall preferentially direct flow to a sacrificial, independently replaceable suction piece. The suction piece shall be easily accessible and replaceable, without the need to disassemble any other component of the pump.
   d. Pump-out vanes on the rear shroud of the impeller are not acceptable.
   e. Impellers of a radial design that incorporate the impeller in a recessed portion of the volute or wearplate are not acceptable.

Pump Size	Casing Minimum Thickness	Suction Piece at Wear Area	Weight of Wearing Parts*
3-inch	9/16 in.	1 in.	360 lbs.

*Suction piece, impeller, casing, and wearplate.

4. The pump's head vs. capacity curve shall slope upward toward shutoff in one continuous curve with no points of inflection capable of causing hunting at any pump operational speed.
5. Pump(s) shall be equipped with slotted raised-face flanges to receive 125 lb. standard bolting. Special case slots shall be cast in to retain bolts and to fasten the case to the bearing housing and to the intake for easy case removal.

D. Materials Of Construction

1. The parts exposed to abrasive wear - case, removable suction piece, impeller, and wearplate shall be of Ni-Hard, ASTM A532 Class I Type A; material, and be a minimum of 650 Brinell hardness for maximum wear resistance. Brinell values below this are not acceptable.
2. Test bars shall be cast integrally with the case and suction piece and shall remain attached to the casting upon final delivery to the owner. Test bars shall be of sufficient thickness to represent the average thickness of the cast part. After receipt of final delivery, the owner may at any time prior to the final acceptance, remove the test bar and independently verify compliance to the material and hardness specification. Failure of the tested bars to meet the specified requirements shall be cause for rejection.

E. Bearing Housing

1. The bearing housing shall be of cast iron, ASTM A48CL-25A.
2. The shaft shall be of AISI Grade 1045 (or equal) steel, and shall be protected throughout the packing area by a removable, hardened 416 or 420 stainless steel shaft sleeve.
3. Bearings shall be oil bath lubricated. The oil reservoir shall be sealed at both ends to prevent entrance of foreign matter. The thrust bearings shall consist of three angular contact ball bearings for maximum protection from all thrust loads. The bearing housing will be equipped with a pressure venting device and oil fill and drain taps. A built-in sight glass shall be furnished to check proper oil level. The bearings shall be rated for a minimum B10 life of 100,000 hours, without credit for any rear pump-out vanes to balance hydraulic thrust.

F. Shaft Sealing

1. Mechanical Seal: A single cartridge mechanical seal requiring no external flushing shall be furnished in the pump.
   a. The seal shall utilize a rotational sealing ring with an o-ring or elastomeric cup mounted rotational ring, a stainless steel rotating body with an o-ring mounted stationary ring loaded by a non-fouling, conical spring encapsulated in Viton. Installation of the seal shall require no measurements or scribe marks on the shaft.
   b. The rotational sealing ring shall be made of tungsten carbide with a 6% cobalt binder, the surface of which shall be lapped to a flatness not to exceed three helium light bands.
   c. The stationary sealing ring shall be constructed of sintered silicon carbide. The surface shall be lapped to a flatness not to exceed three helium light bands. The stationary ring shall be o-ring mounted into the stainless steel stationary body. Stationary sealing rings of converted carbon or other surface-only treatments are not acceptable.
   d. The spring that loads the rotational sealing ring shall be cone-type, non-fouling design and shall run in the pumped product without fouling or hang-up. The spring metal material shall be SAE1075 Carbon Steel, ASTM A-684 heat-treated to a Rockwell C hardness of 42 to 46 and be totally encapsulated in Viton for protection from the pumped fluid. The product side of the spring shall have a minimum 1/4" thick Viton rubber covering for corrosion/abrasion protection. Seals which use single coil, multiple coil, bellows and rubber-in-shear designs are not acceptable.
   e. To minimize the number of points where the slurry must be sealed, the mechanical seal assembly shall have no more than four (4) o-rings: two (2) seal face o-rings, one (1) shaft sleeve o-ring, and one (1) retainer o-ring. O-rings are to be made of Viton. Seals using more than four (4) o-rings are not acceptable.
   f. The seal shall be fitted with an integral shaft sleeve. The shaft sleeve shall be made of CD4MCu ASTM A-743 duplex stainless steel or type 316 stainless steel. The rotating body of the seal shall be positively driven by no less than two (2) stainless steel drive keys.
   g. All metal components not encapsulated in Viton shall be constructed of abrasion-resistant CD4MCu ASTM A-743 duplex stainless steel or type 316 stainless steel. Surface finish shall be a maximum of 64 RMS.
   h. The seal shall be capable of running with up to ± 0.025" radial shaft deflection and ± 0.040" axial shaft deflection without damage or loss of performance.

i. A seal chamber of Hi-chrome iron, ASTM A-532, minimum 600 Brinell hardness, shall be provided to mount the seal and to provide a reservoir of adequate volume for the pumped product to contact and to lubricate the seal faces. The seal shall be installed into the seal chamber from the impeller side of the pump so that only the casing/suction piece and impeller need to be removed to gain complete access to the seal for inspection and/or maintenance.

j. Seals requiring a water or product flush may be furnished in lieu of the non-flushed seal, provided the contractor furnishes, at no extra charge, all of the external auxiliary equipment necessary for the flushing system, including, but not limited to:
   1) Isolated water/flush supply system to the seal, including pump, reservoir, pressure reduction valve, solenoid valve, bypass piping and check valve, all furnished in a suitable enclosure, associated wiring, and modifications to the motor control center to actuate the solenoid valve.
   2) A pressure gauge, flowmeter, shutoff and isolation valves, manual throttle valve, and strainer at the pump.
   3) All tubing/piping shall be stainless steel.

G. Mounting: Belt Drive

1. The pump manufacturer shall provide a common pump and motor base, constructed of minimum 3/8 inch thick fabricated steel, suitably reinforced to support the full weight of the pump, motor, belt drive and guards.
2. The pump manufacturer shall furnish and install a separate, adjustable motor base. The motor base shall be provided with a threaded screw for adjustment so that the motor can be easily moved for V-belt tensioning and adjustment.
3. The pump manufacturer shall supply and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions.
4. The drive shall be of the stationary control variable speed TB Woods type JVS, type SVS, or equal, which allows a speed change by means of an adjustment to the motor sheave when the drive is not in operation.
5. An approved fiberglass or thermoplastic belt guard shall be provided to safely enclose the belt drive. If metal guards are furnished, they shall be of all 316 stainless steel construction with suitable lifting eyes and handles to aid in removal.

H. Motor

1. Motor shall be TEFC type, 7.5 HP, 3-Phase, 60 Hz. Cycle, 460Volt, 900 RPM, and shall be connected to the pump by the drive method specified. All motors shall be of nationally known manufacture and shall conform to NEMA standards and specifications.

2.6 CONTROLS AND INSTRUMENTATION

A. Control Panel

1. One (1) control panel shall be furnished, completely pre-wired and tested.
2. The control panel shall adhere to the following specifications:
   a. Enclosure Rating: NEMA 4X
   b. Material: 304SS
   c. Voltage: 480 Volt

d. Phase: 3 Phase
e. Frequency: 60 Hz
f. Logic: Programmable Relay

3. The Control panel shall contain all timers, VFDs, switches, indicator lights, and other components necessary to operate the following equipment:
   a. One (1) Grit Concentrator
   b. One (1) Grit Pump
   c. One (1) Grit Dewatering Conveyor
4. The control panel shall be supplied with applicable control relays and time delay relays with a minimum one extra normally closed and one extra normally opened contact is provided for each relay.
5. Where remote monitoring is required, the panel shall be provided with all dry contacts necessary.
6. The panel door layout shall include the following items:
   a. Front panel mounted combination main disconnect switch and circuit breaker
   b. Back lit, push-to-test Power On indicating light
   c. System three position HOA switch
   d. System Emergency Stop push button
   e. System Alarm Reset push button
   f. Grit Concentrator fluidizing valve OPEN light
   g. Grit Concentrator fluidizing water HOA switch
   h. Grit Pump running light
   i. Grit Pump three position HOA switch
   j. Grit Pump fail indicating light
   k. Grit Pump manual START push button
   l. Grit Pump manual STOP push button
   m. Grit Pump manual speed potentiometer
   n. Grit Dewatering Conveyor running light
   o. Grit Dewatering Conveyor fail indicating light
   p. Grit Dewatering Conveyor three position HOA switch
   q. Grit Dewatering Conveyor manual START push button
   r. Grit Dewatering Conveyor manual STOP push button
   s. Grit Dewatering Conveyor manual speed potentiometer
   t. Grit Dewatering Conveyor FAIL RESET push button

2.7 SEQUENCE OF OPERATION

1. The system shall be controlled to provide automatic or manual operation, manual starting and stopping and system shut down when a fault is detected.
2. Clarified plant water shall be supplied to the Grit Concentrating unit.
3. Grit Concentrator
   a. Grit shall be intermittently discharged from the sump via the Grit Pump. Prior to the Grit Pump operating, the fluidizing valve shall open for a predetermined period of time and remain open for a duration.
   b. If the time between grit discharge cycles exceeds a certain threshold, the fluidizing valve shall open for a period of time to ensure that the grit stays liquefied.
4. Grit Classification/Concentration unit
   a. Screened raw wastewater shall be pumped to the Grit Classification /Concentration unit intermittently.

b. An accumulating timer (AT) shall reset and begin timing out when a signal is received indicating flow of plant influent to the Grit Classification/Concentration unit. (The signal, provided by others, would be initiated by either the influent pump run signal, by the opening of the valves that provide flow to the Grit Classification/Concentration unit, or from a flow transmitter indicating flow to the Grit Classification/Concentration unit.) The AT regulates the length of time between GBC, (Grit Bowldown Cycles). When the AT times out it shall send a signal to initiate a GBC. The timing between, and duration of, the grit blowdown sequence is site specific; the AT should be adjustable between 5 min to 8 hr, normally set at 3 hrs. The panel shall be equipped with two timers, one for dry weather, and one for wet weather. For higher grit loads, the wet weather timer shall increase the frequency of the GBC as compared with the dry weather timer. The timer being used shall be selected by a local switch or by remote contact closure on terminals provided in the panel.

c. During the GBC grit pump will stop and the contents of the Grit Classification/Concentration unit will empty into the Grit Dewatering Escalator.

5. Grit Dewatering Conveyor unit

a. The Grit Dewatering Conveyor auger shall run on a pre-determined intermittent schedule as Grit slurry is transported to the unit to suit site conditions.

b. The auger speed shall be adjustable via the control panel.

c. After a System Shut Down the Grit Dewatering Conveyor shall continue to operate for a pre-determined amount of time to allow for the removal and dewatering of all grit accumulated in the clarifier. The off delay timer shall be adjustable from 0-60 minutes with a typical delay off time of 15 minutes.

2.8 UTILITY REQUIREMENTS

A. Water

1. The Grit Concentrator Unit shall require a minimum intermittent supply of 20 gpm clarified non-potable water at a minimum 50 psig.

B. Electrical

1. The system shall require one (1) 480 VAC, three phase electrical service connection to operate

2.9 MATERIALS AND FINISHES

A. Materials

1. All stainless steel used for the fabrication of the equipment shall conform to the following standards:

Plate and Sheet	ASTM A 167
	ASTM A 240
Bar	ASTM A 276
	ASTM A 479

Tube	ASTM A 312

B. Exterior Surface Finishes

1. All surfaces shall be free of sharp edges, weld spatter and residue. All welds shall be ground smooth.
2. All stainless steel weld surfaces shall be acid washed.
3. All non-submerged exterior surfaces shall be Glass Bead Blasted to a uniform finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

3.2 INSTALLATION

A. Install the grit removal equipment according to manufacturer's instructions.

3.3 START-UP, TRAINING AND MANUFACTURER'S SERVICES

A. A factory trained representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for a maximum of four (4) 8-hour man-days (two (2) visits) for installation inspection, plant startup, functional testing, and operator instructions; travel time excluded. A minimum of 30 days notice is required to schedule manufacturer's services.

3.4 FUNCTIONAL TESTING

A. Prior to plant startup, all equipment shall be inspected for proper alignment, operation, connection, and satisfactory operation by means of a functional test. It is the General Contractor's responsibility to duly notify the MANUFACTURER of any inabilities to perform functional testing prior to operator training.

3.5 MANUFACTURER'S CERTIFICATE(S)

A. Provide MANUFACTURER'S certificate of installation and commissioning following functional testing and startup.

B. Provide MANUFACTURER'S OEM Software Licensing Agreement following and final payment.

END OF SECTION 46 23 23

SECTION 46 33 41 - LIQUID CHEMICAL FEED SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Skid- Mounted Sodium Hypochlorite Feed Pumps
2. Control panels.

B. Related Requirements:

1. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting devices specified by this Section.
2. Sections 40 42 13 - Process Piping Insulation: Insulation requirements for piping and appurtenances.

1.2 REFERENCE STANDARDS

A. Instrument Society of America:

1. ISA 5.1 - Instrumentation Symbols and Identification.
2. ISA 20 - Specification Forms for Process Measurement and Control Instruments Primary Elements and Control Valves.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Integrate instrumentation and control devices provided under other Sections.
C. Resolve signal, power, or functional incompatibilities among interfacing devices.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer's information with each instrument data sheet.
C. Shop Drawings:

1. Symbology and Nomenclature: Comply with ISA 5.1.
2. Indicate interfaces between instruments, motor starters, control valves, variable-speed drives, flow meters, and chemical feeders.

D. Data Sheets:

1. Comply with ISA 20.
2. Submit following:

a. Manufacturer's model number or designation.
b. Component system or loop.
c. Installation location.
d. Input and output characteristics.
e. Scale, range and units.
f. Requirements for electric and plant water requirements.
g. Materials of component parts in contact with process chemicals.
h. Special requirements or features.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.
H. Qualifications Statements:

1. Submit qualifications for system integrator.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Complete loop and schematic diagrams including field and panel wiring, piping and tubing runs, routing, mounting details, and point-to-point diagrams with cable, wire, tube, and termination numbers.

1.6 QUALITY ASSURANCE

A. Instruments Using Common Measurement Principle:

1. Furnish by single manufacturer.
2. Furnish same type, model, or class.

B. System Integrator: Company specializing in integrating chemical feed products specified in this Section with minimum three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
C. Store materials according to manufacturer instructions.
D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
B. Panels and Enclosures: Suitable for operation in locations as indicated on Drawings.
C. Temperature Range: 32 degrees F to 104 degrees F.
D. Relative Humidity: 20 to 90 percent, noncondensing.
E. Instrumentation in Hazardous Areas: Suitable for use in particular hazardous or classified location.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
B. Furnish five-year manufacturer's warranty for liquid feed equipment systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The H21 Series peristaltic chemical feed pump shall be a heavy-duty modular design suitable for 24-hr/day operation. Flomotion Systems, Buffalo, NY or approved equal.
B. Pump

1. Process Conditions

Pump Model	H21KA8
Quantity	2
Tag Number	Specify
Fluid Being Metered	Sodium Hypo & Ammon Sulfate
Viscosity (cps)	Specify
Specific Gravity	Specify
Tubing Material	Floprene
Min – Max Capacity	0.004-48.5gph
Pump RPM Range	0.8-225
Min Flow Rate (GPH)	0.1
Max Flow Rate (GPH)	38.5
Fittings	1/2" MNPT, NSF61 PVC
Discharge Pressure (Max PSI)	30
Power Input	115/230Vac, 1ø, 60hz

2. Pumphead
   a. The ABS plastic pumphead shall have a spring-loaded roller assembly utilizing high performance 3/32” (2.4mm) thick wall extruded tubing specifically formulated for use in peristaltic pumps.
   b. The pumphead shall be capable of accepting a minimum of 6 different tubing diameters ranging from 1/16” (1.6mm) ID to 3/8” (9.6mm) ID.
   c. The stainless steel roller assembly shall have adjustable occlusion to optimize pump performance. The rollers shall be Nylatron MD. Rigid/fixed roller assembly designs shall not be acceptable.
   d. Pumphead design shall be capable of pressures up to 100-psi depending on tubing sizes with a suction lift to 30 ft. vertical water column and run dry without damage.
   e. One of the two spring loaded roller shall be fully engaged at all times to prevent backflow or siphoning.
   f. The tubing shall be in contact with the inside diameter of the pumphead through an angle of 180 degrees and be held securely on suction and discharge with Viton or Buna N tube seal grommets.
   g. The pumphead shall be a completely sealed design. Any fluid leakage due to a tubing rupture shall be completely contained within the pumphead.

3. Gearmotor
   a. The pumphead/adapter flange shall have a lip seal to prevent fluid leakage between pumphead and speed reducer.
   b. The output shaft and all mounting hardware shall be stainless steel.
   c. Gearmotor shall have corrosion resistant Dupont black powder coat finish.
   d. Gearmotor shall be horizontal configuration with integral junction box wiring.
   e. Gearmotor shall be 3/8HP, TEFC, Inverter duty, 230/460Vac, 3ø, 50/60 Hz.

4. Speed Controller
   a. Controller shall be pump mounted and housed in a NEMA 4X enclosure.
   b. Controller shall have an integral 8-button keypad and display.

c. Controller can be operated in manual or automatic mode via 4-20mA input. In automatic mode the speed range shall have the capability of being optimized to the input signal.
d. Controller shall have the capability to accept a contact closure from an optional tubing rupture detector. The capability of starting a back-up pump shall also be provided.
e. The controller shall have the following additional input and output functions:
   1) Start/Stop Input
   2) Local/Remote input
   3) 4-20mA speed reference output
   4) Fault output
   5) Remote status output
   6) Run output
f. Controller power input 115/230Vac, 1ø, 60Hz with 10' grounded power cord.

5. Tubing and Connectors
   a. Pump tubing shall be extruded from NSF61 Floprene or other suitable material based on chemical compatibility with a wall thickness of 2.4mm.
   b. Connectors shall be leak proof 4pc precision machined specifically designed for peristaltic pump tubing shall be provided. Inserts to be color coded for specific tubing sizes. The use of metal hose clamps will not be permitted

6. Rupture Detector
   a. Tubing Rupture Detector shall be provided to automatically shut down the pump and signal an alarm in the event of a rupture. A pumphead mounted sensor and wall mount controller shall be provided with the following features:
      1) Sensor shall have no moving parts
      2) LED signals alarm condition
      3) 8 amp @ 250Vac DPDT latching relay
      4) Single reset pushbutton
      5) Ability to start back up pump
      6) 115Vac power input.

7. Spare Parts
   a. Three-year supply of pump tubing or pumphead cartridge assemblies.

8. Additional Options/Accessories
   a. CPN2KS Sigmamotor 2000ml Graduated Calibration Cylinder.
   b. P2N499P Sigmamotor 1/2" PVC Pressure Relief Valves with PTFE/EPDM diaphragm. Two port design. Adjustable 5-150 psi range.
   c. FLN12PV Sigmamotor 12 Cu. In. PVC Pulsation Dampener w/ Viton bladder
   d. GIN060PTB Sigmamotor Diaphragm Protected Pressure Gauges, 0-60-psi with PVC isolator body and PTFE diaphragm.
   e. BN499P Sigmamotor 1/2" PVC Back Pressure/Anti-siphon valves with PTFE/EPDM diaphragm.
   f. PES211-H Prepackaged Extrusion Welded Polyethylene Duplex Peristaltic Pump Skid with common suction, common discharge, leak containment and fork lift cut-outs. Tapered floor with rear corner drain. 1/2" schedule 80 PVC piping with transparent true union reversable right side/left side "Y" strainer/flush, PVC ball valves and above accessories included. All pre-mounted, wired and wet tested.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pump skids per manufacturer's instructions
B. Mount skids where shown on Drawings
C. Fit and align connecting piping to eliminate all stresses

3.2 START-UP AND PERFORMANCE WARRANTY TESTS

A. Make equipment adjustments required to place system in proper operating condition.
B. Test each feed system for proper operation in the presence of the Owner. All testing costs are the Contractors.
C. Furnish all testing equipment, special instruments and devices required for performance testing.
D. Modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.
E. Demonstrate the accuracy of each metering pump using job supplied calibration column.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Calibration:

    1. Calibrate each instrument at 40, 60 and 100 percent of its span using test instruments to simulate inputs.
    2. Field-calibrate instruments that were not bench-calibrated.
    3. Tags: Attach calibration and testing tag to each device, signed and dated by device manufacturer's representative after calibration has been completed.

C. After installation, inspect and test for proper operation.
D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 1 days, (8 hours) on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
E. Equipment Acceptance:

    1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
    2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
B. Demonstrate system startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 33 41

SECTION 46 43 21 - TRANS-FLO CLARIFIER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. One (1) Trans-Flo Clarifier suitable for installation in rectangular settling tank.

B. Related Requirements:

1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to equipment specified by this Section.
2. Section 46 05 13 - Common Motor Requirements for Water and Wastewater Equipment: Execution requirements for motors specified in this Section.
3. Section 46 05 53 - Identification for Water and Wastewater Equipment: Nameplates for equipment specified in this Section.

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Gear Manufacturers Association:

1. AGMA 6001 - Design and Selection of Components for Enclosed Gear Drives.
2. AGMA 6013 - Standard for Industrial Enclosed Gear Drives.
3. AGMA 6034 - Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
4. AGMA 6113 - Standard for Industrial Enclosed Gear Drives (Metric Edition).

C. American Society of Mechanical Engineers:

1. ASME B17.1 - Keys and Keyseats.
2. ASME B17.2 - Woodruff Keys and Keyseats.
3. ASME B29.100 - Double-Pitch Roller Chains, Attachments, and Sprockets.

D. ASTM International:

1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer's Product Data for system materials and component equipment, including electrical characteristics.
C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit wiring and control diagrams, installation and anchoring requirements, fasteners, and other details.

D. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
F. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.
B. Project Record Documents: Record actual locations of installed clarifiers and components.
C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

C. Tools: Furnish special tools and other devices required for Owner to maintain and calibrate equipment.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on-Site and inspect for damage.
C. Store materials according to manufacturer's instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

A. Each clarifier shall include:

1. Approximately twelve (12) inlet orifice tubes and deflector plates
2. Inlet skirt battle and support angle
3. Non-metallic collector chain
4. Flights and wear shoes
5. Sprockets
6. Stub shafts
7. Headshaft
8. Wall bearings (headshaft only)
9. Return track with support brackets
10. Floor wear strips
11. Two (2) embedded sludge removal orifice plates
12. One (1) rack and pinion operated scum pipe
13. Effluent weirs and battles
14. One (1) collector drive unit complete with reducer, motor, overload device and appropriate guards
15. Associated attachment bolts and anchor bolts

2.2 DESIGN CRITERIA

A. Influent/Effluent hydraulics shall be designed to handle:

	MIN.	AVE.	MAX.	PEAK
Effluent Flow (MGD)	0.4	0.5	0.75	1.25
Return Flow (MGD)	0.15	0.5	0.75	0.75
Mixed Liquor Flow (MGD)	0.55	1.0	1.5	2.0

B. Maximum headloss for header 0.75 ft
C. Minimum flow velocity in header 0.50 fps
D. Minimum header orifice diameter 2.5-inch
E. Influent channel velocities 0.50 fps minimum
F. Basin to Influent Channel headloss 0.10-fl at average.
G. Selection of collector components shall be based upon design calculations incorporating the following criteria:
   1. Operation under wet tank conditions
   2. Friction factors - 0.20 to 0.30 (UHMW on UHMW)
      - 0.05 to 0.10 (UHMW on stainless steel-water lubricated)
   3. Bearing friction -0.05 per shaft assembly
   4. Shaft deflection - not to exceed 0.033" per foot of shaft length
      In no event shall the collector components be less than specified herein.

2.3 INFLUENT FEED CHANNEL ORIFICE TUBES AND SKIRT BAFFLE

A. The orifices shall be formed from steel tubes sized and furnished by the manufacturer for installation by the General Contractor. The length of orifices shall not be greater than the floor thickness. Spacing of the orifices shall be determined by USFilter, Envirex Products but shall not exceed 6 ft.
B. Orifice baffles shall be constructed of 3/16" thick steel plate. Baffles shall allow no restriction less than the diameter of the orifice, and no greater than one diameter plus one inch.
C. The influent skirt baffle shall be constructed of 0.90-inch thick #825E high impact polystyrene sheets extending 5 ft. beneath the water surface. The skirt baffle shall be fabricated in approximately 10' sections and shall be hung beneath the influent channel floor, supported from a support angle. The skirt shall provide a distributing zone for feed flow from the orifices. This zone shall be open at its lower end for introduction of the feed into the tank at a uniformly low velocity of not more than 5 FPM at maximum flow.
D. The side feed channel design shall be such as to insure hydraulic balance in the tank.

2.4 COLLECTOR CHAIN

A. Collector chain shall be NCS720S non-metallic type having 6-inch pitch links with an average weight of 1.3 lbs/ft. The chain shall have a catalog working load of 2,600 lbs and a minimum ultimate strength of 6,000 lbs. The chain shall be manufactured of unfilled acetal resin and molded with the barrel and side bars as an integral assembly. The chain shall be assembled with pins not less than 15/16" diameter, manufactured of reinforced nylon resin and designed to provide full dead load bearing capacity throughout the full length of the link side bar hubs. The pins shall have a T-head to engage retainer lugs molded integrally with one link side bar hub as a positive means to prevent pin rotation. The pins shall be locked in position by a retainer ring molded integrally with the opposite side bar hub and provide a positive locking contact around the full periphery of the pin. The pins shall be pressed into the link side bar hubs to exclude

abrasives using a tool supplied by the manufacturer. Pins having dual purpose retainer and anti-rotational lugs will not be acceptable.

B. The attachment links shall be of similar construction to the plain chain links, with the flight pusher plate extending the full depth of the flight and molded integrally with the link sidebars. The attachment mounting hole spacing shall conform to ANSI Standard B29.21M81 and shall accommodate four (4) 3/8" diameter type 316 stainless steel hex head attachment bolts. Bolts shall be fastened with brass "Nylock" hex locknuts and type 316 stainless steel cut washers. The attachment link shall be capable of twisting a minimum of 10 degrees across the face of the attachment without failure.

C. Collector chain shall be tested and manufactured per the minimum quality assurance program specified under the Collector Chain Testing Section of this specification.

D. Maximum water absorption shall be no greater than 0.6% after immersion for 48 hrs. at 73.4° F (23°C) in accordance with ASTM D-570. The flight section shall include a scraper lip on the leading edge of the flight to optimize cleaning of the tank floor. Polypropylene filler blocks shall be furnished to allow the flight to be securely bolted to the chain attachment. Flight spacing shall be approximately 10 ft. for longitudinal collectors (and 5 ft. for cross collectors). Flights shall be accurately drilled and notched at the factory and banded together for shipment.

2.5 FLIGHTS

A. Flights shall be 3" x 8" nominal size fiberglass construction, essentially rectangular in cross section. The member shall have a Moment of Inertia of not less than 2.01 in.4 about its minor axis. The flight shall be of pultruded isophthalic polyester composite construction with a minimum fiberglass content of 50% but no greater than 60%, to insure member strength and insure total encapsulation of the glass fibers to prevent wicking. The use of extenders in the resin is prohibited.

B. Maximum water absorption shall be no greater than 0.6% afler immersion for 48 hrs. at 73.4‘ F (23° C) in accordance with ASTM D-570. The flight section shall include a scraper lip on the leading edge of the flight to optimize cleaning of the tank floor. Polypropylene filler blocks shall be furnished to allow the flight to be securely bolted to the chain attachment. Flight spacing shall & approximately 10 ft.. Flights shall be accurately drilled and notched at the factory and banded together for shipment.

2.6 WEARING SHOES

A. Each flight shall be provided with ½” thick wearing shoes to run on floor wear strips and on formed structural tracks on the return run. The shoes shall be cast of UHMW-polyethylene. Wearing shoes running on the floor wear strips shall be located central to the chain attachment to avoid drilling additional holes that would weaken the flight. Where necessary, the return run wearing shoes shall include a guide lug to insure proper tracking of the flight with the return track. All wearing shoes shall be reversible providing two (2) usable wearing surface.

2.7 COLLECTOR CHAIN SPROCKETS

A. Sprockets for the collector chains shall be molded totally of polyurethane having a water absorption rate not to exceed 1.3% at saturation in accordance with ASTM D-570. Sprockets shall be of split construction and have the double life tooth profile compatible with non-metallic chain. Sprocket halves shall be assembled on the shafting with two (2) type 316 stainless steel full width clamping bands which exert compressive force around the full periphery of the hub, thereby clamping the sprocket to the shaft where required. The clamping bands shall include provisions to restrict lateral movement. Stub shaft sprockets shall rotate freely on bearing sleeves (bearing sleeves not used on stainless steel shafts) clamped to the static shaft. Head sprockets shall have chain saver rims. The headshaft sprockets shall have the keyway machined in to the hub in such a way as to restrict lateral movement of the key and to insure chain alignment. Wedge dogs of type 316 stainless steel shall be located along the split line near the periphery and so designed to draw the sprocket halves together in diametrical and lateral alignment.

B. Headshaft sprockets shall not be less than 22.23" pitch diameter and have 23 teeth. Cornershaft sprockets shall not be less than 16.61" pitch diameter and have 17 teeth. Driving sprockets shall be keyed firmly to the headshaft and shall be clamped to the shaft by stainless steel band clamps.

2.8 BEARINGS SLEEVES (Note: Bearing Sleeves are NOT USED for stainless steel stub shafts)

A. Stub shaft bearing sleeves shall be molded of UHMW-polyethylene per ASTM-D4020-81 with a minimum tensile strength of 5600 psi at 57 degrees Celsius (73 degrees Fahrenheit). The sleeves shall be of split construction and shall include a shoulder at each end to restrict lateral movement of the sprocket. The two (2) sleeve halves shall be secured to the stub shaft by two (2) type 316 stainless steel clamping bands, which exert compressive force around the full periphery of each shoulder. The shoulders shall include retainer rings to contain the clamping bands.

2.9 HEADSHAFT

A. Headshaft shall be solid cold-finished steel, straight and true, held in position with split UHMW- polyethylene set collars. The headshaft shall contain keyways with fitted keys and shall be sized to transmit the power required. Headshaft shall extend across the full width of the tank and turn in bearings mounted on the tank walls. Shaft and sprockets shall be shipped unassembled to prevent damage to sprockets during shipping and handling.

2.10 STUB SHAFTS

A. The longitudinal idler sprockets shall be mounted on stub shafts with bearing sleeves (Note: No bearing sleeves if stainless steels shafts are used). The wall bracket is to be a cast ductile iron tripod, attached to the wall with three (3) 3/4" dia. adhesive anchors. The stub shaft shall be a 3 1/2" dia. cold-finished steel. The shaft is to be fixed to the base by three (3) 1/2" dia. set screws.

2.11 BEARINGS

A. Headshaft bearings shall be of cast iron construction of the water lubricated, self-aligning type, having a babbitted sleeve. The housing shall be specially designed to prevent the accumulation of settled solids on its' surfaces. The bearings shall be bolted directly to the concrete wall in a manner that shall permit their easy alignment.

2.12 RETURN TRACKS

A. Return tracks shall be type 316 stainless steel formed shapes attached to stainless steel or non-metallic brackets mounted on the tank walls. Each bracket shall be designed to cantilever the return track approximately 9" off the tank wall. Support brackets shall be spaced approximately 10 ft. apart.

2.13 WEAR STRIPS

A. The door shall have two lines of removable wear strips of 3/8" thick UHMW-polyethylene material in 10 ft sections with each section having five (5) countersunk holes. All splices shall be mitered at 45 degrees to allow for smooth passage of the wear shoes in the direction of flight travel. Wear strips are to be attached to the tank floor with 1/4” dia. type 316 stainless steel flat head self tapping screws used along with 1/4" vinyl anchors. Anchors shall be set in predrilled holes.

2.14 DRIVE UNITS

A. One drive unit shall be provided for each collector mechanism
B. The motor shall be rated at 0.5 hp, totally enclosed, ball bearing, constant speed, of ample power for starting and continuously operating the mechanism under normal operating conditions without overloading. The motor shall conform to NEMA standards and be suitable for operation on 460 volts, 3 phase, 60 Hertz.
C. The drive unit speed reducer shall be of the helical gear type, fully housed, running in oil, with anti-friction bearings throughout. The drive units shall be assembled by the Manufacturer and shipped as a complete assembly to ensure proper assembly of all components.
D. The motor shall be directly connected to the speed reducer and mounted as a common unit. V-belt drives will not be acceptable. Provide a 120 v space heater in the motor.

2.15 DRIVE CHAIN

A. Collector drive chains shall be No. NH78 non-metallic, having 2.609" pitch links with an average weight of 1.4 lbs. per ft.. The chain shall have a maximum catalog working load of not less than 1,750 lbs., based upon strength and fatigue considerations. The chain links shall be manufactured of acetal resin and connected with 7/16" diameter stainless steel pins. The pins shall be constructed to prevent rotation and shall be held in place without the use of pins or

cotters. Chains made of glass reinforced resins that require an abrasion resisting bushing to insulate the pin from the link barrel shall not be acceptable.

2.16 DRIVEN SPROCKET

A. The driven sprocket shall consist of a polymeric toothed rim bolted to a split polymeric dished body. The rim and body shall be molded of high performance polyurethane having a water absorption rate not to exceed 1.3% at saturation in accordance with ASTM D-.570. The body shall be molded concentric and perpendicular to the bore with the rim mounting holes accurately located to insure concentricity of the sprocket assembly. The body halves shall be assembled on the headshaft with two

B. (2) clamping bands to exert compressive force around the full periphery of the hub, thereby clamping the sprocket assembly to the shaft. Wedge dogs shall be located along the split line near the periphery and so designed to draw the sprocket halves together in diametrical and lateral alignment. The body shall have a machined keyway designed to restrict the lateral movement of the key.

C. The rim shall be molded in four (4) segments and each segment shall be bolted to the body with four (4) 5/8" diameter bolts. The sprocket rim shall be not less than 33.25" pitch diameter and have 40 teeth. All sprocket hardware shall be type 316 stainless steel.

D. The drive sprocket shall consist of a polymeric plate section bolted to a cast éon driving hub. The sprocket plate section shall be molded of polyurethane as described under the collector chain sprocket section. The sprocket shall be not less than 9.26" pitch diameter and have 11 teeth.

E. The drive sprocket shall be provided with a shear pin device to provide for protection of the drive equipment in the event of excessive loading. Aluminum shear pins shall be provided to transmit torque from the driving hub to the sprocket shear plate with a polymeric gasket located between the shear faces to prevent seizing.

2.17 OVERLOAD ALARM TRIP

A. The driver sprocket hub shall also be provided with a trip lug that, upon torque overload, shall contact the actuator arm of the double throw limit switch which, in turn, shall shut off the motor and energize the alarm circuit. The limit switch shall have a (weatherproof) (explosionproof) enclosure and shall be provided with a steel support bracket for positioning adjacent to the overload device. The audible alarm and silencing switch shall be furnished by the Electrical Contractor.

2.18 DRIVE CHAIN TIGHTENER

A. The drive chain arrangement shall include a chain tightener to take up excessive slack in the drive chain. The tightener assembly shall include a stainless steel slide base and mounting bracket with a self-centering and self-lubricated molded polyurethane idler sprocket.

2.19 CHAIN GUARD

A. The drive chain and sprockets located above the operating platform shall be covered with a removable metal guard of No.14 gauge type 304 stainless steel.

2.20 SLUDGE REMOVAL HEADERS

A. Manufacturer shall furnish embedded sludge removal header plates as shown on the Contract Drawings. Removal headers shall be formed in the concrete floor slab and shall & provided with 1/4-inch steel removable orifice plates. Orifice plates shall include a series of inlet orifices sized and spaced for a uniform withdrawal of settled sludge over the width of the tank.

2.21 SCUM REMOVAL MECHANISM

A. Each skimmer pipe shall span one (1) tank width. Each mechanism shall be independently operated and shall be capable of 75 degree rotation in either direction.

B. The pipe shall be 12-inch diameter with nominal 1/4-inch wall thickness. A 60 degree wide slotted opening shall be cut symmetrical about the vertical axis to provide a weir over which scum can flow into the pipe when rotated. Edges of the slot shall be parallel to the longitudinal axis of the pipe. Full periphery bands shall be left in the pipe at intervals not exceeding 2.5 ft. to act as stiffeners.

C. The revolving pipe shall be supported at each end in such a manner that a slight misalignment shall not interfere with the smooth operation of the pipe. The pipe shall be supported by and revolve in a rolled steel collar which shall be welded to an adjustable steel plate. The open end support shall have segments welded to the internal periphery of the collar to provide ample bearing surface for the pipe without crushing the seal. Plywood fillers shall be furnished with the open end supports to provide a watertight connection to the tank walls without grouting.

D. A suitable watertight seal shall be provided for the open end of the pipe. This seal shall be so constructed that it shall remain effective even with a slight misalignment of the pipe and collar. The seal shall not be affected by grease, mild acids, or alkalies. The seal shall be readily renewable without removing the pipe from the supporting brackets and shall not bind or impede the smooth action of the revolving pipe.

E. The skimmer pipe shall be manually operated by means of a handwheel with handle and rack and pinion assembly. The handwheel shall be fitted to a structural steel floor stand of welded construction having a non-rising stem. The stem shall be brass and threaded, having four (4) Acme threads and shall turn inside a standard pipe lifting stem, which raises and lowers the sliding rack assembly. The rack assembly shall consist of two (2) angles fastened together by two (2) connecting pins and welded to a plate, which is welded to the lifting stem. The rack assembly shall move in a cast iron guide bracket to assure positive contact of the connecting pins with a steel pinion segment welded to the skimmer pipe. The pinion segment shall rotate on the rack connecting pins so as to permit an easy and accurate means of adjusting the skimmer pipe through a 75 degree angle in either direction, for a total of 150 degree.

2.22 EFFLUENT WEIRS AND SCUM BAFFLES

A. The effluent weirs and scum baffles shall be per Miscellaneous Metals Specification.

2.23 GENERAL ITEMS

A. All anchor bolts shall be Type 304 stainless steel of ample size and strength for the purpose intended. All anchor bolts are to be set by the General Contractor in accordance with the Manufacturer's instructions. A radius screed for finishing of grout for the curved end ofthe tank shall be furnished by the Equipment Manufacturer.

2.24 PAINT

A. Equipment shall be shop primed as noted under the Painting Section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

3.2 INSTALLATION

A. Install clarifier equipment according to manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Dry Startup: Run equipment without liquid in basins and inspect for:

1. Alignment of sprockets, chain, flights, and wearing surfaces.
2. Binding and excessive heat buildup in drive units.

C. Wet Startup: Run equipment with wastewater in basins and verify proper operation.
D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two trips of two days each on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.
E. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

F. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
B. Check control module functions and adjust as necessary.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 43 21

SECTION 46 51 13 - FLOATING MECHANICAL AERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Floating mechanical aerators.
B. Related Requirements:

1. Section 09 96 00 - High Performance Coatings: Surface preparation and coating requirements.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data:

1. Submit manufacturer's product information for system materials and component equipment.
2. Submit electrical characteristics and connection requirements.
3. Submit installation requirements and other details.

C. Shop Drawings:

1. Indicate size and configuration of aerator assembly, mountings, weights, and accessory connections.
2. Indicate system materials and component equipment.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Certify that installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
G. Source Quality-Control Submittals: Provide certified wet & dry testing of the complete unit at the manufacturer’s facility.

1. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

H. Manufacturer Reports:

1. Certify that equipment has been installed according to manufacturer's instructions.
2. Indicate activities on Site, adverse findings, and recommendations.

1.4 COORDINATION

A. Coordinate Work of this Section with Work of other Sections.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record actual locations of installed aerators and components.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
C. Store materials according to manufacturer's instructions.
D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer's instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
B. The Manufacturer shall furnish a warranty extending twelve (12) months after substantial completion date of the project.

PART 2 - PRODUCTS

2.1 FLOATING MECHANICAL AERATORS (SA2110, SA2120)

A. Manufacturers:

1. Aqua-Aerobic® (Model FSS Endura® Series Aqua-Jet® Aerator)
2. Evoqua® (Aqua-Lator® Surface Aerator)
3. Or Approved Equal

B. Performance and Design Criteria:

1. Motor size: 15 hp

C. Diffusion Head

1. Material: 304 SS
2. The design of the diffusion head shall be such that the liquid spray shall discharge at an angle of 90 degrees to the motor shaft over a 360 pattern in the horizontal plane and shall be a monolithic casting.
3. The diffusion head casting shall act as a base for the aerator motor and alignment of the motor to this base shall be controlled by machined index fittings that engage the P-base of the motor. Diffusion head designs that employ studs and spacers or shoulder bolts are not allowed.
4. The diffusion head shall have load bearing flange-to-flange connections.
5. The diffusion head shall contain an anti-deflection journal insert to limit the radial deflection of the motor shaft. This anti-deflection journal insert shall be located in the lower extremity of the diffusion head approximately one-half the distance between the motor base and the lower end of the shaft. The journal insert shall be machined from Delrin or molded from moly-filled urethane and shall be a minimum of 0.060 inch diameter or larger through the bore than the diameter of the motor shaft. There shall be a fluid deflector located on the motor shaft immediately below the anti-deflection journal, which shall cover completely the anti-deflection journal insert and the lower portion of the diffusion head. This fluid deflector shall be molded from black neoprene or Delrin and shall be press fit onto the motor shaft.

D. Float:

1. Material: Fiberglass-reinforced polyester (FRP) skin, resistant to ultraviolet exposure.
2. The aerator shall have sufficient reserve buoyancy to ensure stability and to provide support flotation required during aerator servicing.
3. Fill:

    a. Material: Closed-cell polyurethane foam with minimum density of 2.0 lbs/ft^3.
    b. Injection applied.

4. Float shall be completely sealed to prevent the foam from being in contact with the external environment.
5. Float shall have three (3) mooring points, spaced at 120-degree locations around the outer circumference. All mooring connections shall be stainless steel.

E. Propeller:

1. Two-blade, left handed, self-cleaning, marine type
2. Material: 316 or 15/5 SS
3. Dynamically- and hydraulically-balanced.
4. Self-cleaning
5. Propeller shall be keyed to mate to the keyed shaft for ease of maintenance and assembly. The propeller shall be secured to the shaft by a locking nut.

F. Volute

1. Material: 304 stainless steel
2. Minimum diameter: 14 inches
3. The volute shall have a minimum of 3/16-inch wall thickness and a minimum of four full-length stainless steel gussets shall be welded on 90° spacing around the circumference of the volute between the top and bottom flanges.
4. Volute shall be round and true so that propeller blade tip clearance is uniform within the volute as it rotates.

G. Intake Cone

1. Material: 304 stainless steel
2. The intake cone shall be fabricated having a gradually expanding opening outward to the intake end. The length and inlet diameter shall be sufficient to provide uniform inlet hydraulics so that no increase in vibration is caused due to its shape or size.
3. The intake cone shall be designed so that the suction lift from the aerator propeller is vertical from the liquid depth below the aerator
4. Anti-vortex cross vanes: 304 stainless steel

H. Balancing

1. The entire rotating assembly including the motor rotor, shaft, shaft accessories, and impeller shall be dynamically balanced within 2.0 mils peak-to-peak horizontal displacement measured at the upper and lower motor bearing. Measurements shall be taken at a frequency equivalent to the motor RPM. Measurements shall be taken with the motor in a vertical, shaft down position with the entire power section mounted on resilient pads.

I. Electrical Service Cable

1. Electrical service cable shall be provided and shall be a continuous length (non-spliced). The cable shall have three power conductors and a ground conductor.
2. Conductors shall be flexible type annealed copper stranded. Each conductor, including the ground conductor, shall be insulated. Cables containing an uninsulated ground conductor will not be acceptable.
3. The insulated conductors shall be assembled together with a non-hygroscopic filler material.
4. Outer jacket shall be high quality CPE, PVC, TPE or equal, and shall be rated at a conductor operating temperature of not less than 90°C.
5. The cable shall be rated for hard usage outdoor service and shall be resistant to oil, sunlight, ozone, grease, acids, water, abrasion and impact.
6. The electrical service cable shall be factory assembled to the motor conduit box with cord grip and strain relief grip. The cord grip shall include a Neoprene bushing providing a liquid tight seal. The strain relief grip shall be a 304 stainless steel wire mesh strain relief grip for the electrical cable at the motor to prevent the cable from pulling out of the conduit box.
7. Spiral Wrap Electrical Cable Protection: A polyethylene expandable spiral wrap abrasion protection sleeve shall be provided for wrapping around the electrical cable at the unit. The spiral wrap shall be weather resistant for a temperature range from -40 ºF to 122 ºF, and protect the electrical cable from rubbing on the edge of the float.

J. Operation:

1. Electrical Characteristics:

   a. 460 V, 3 phase, 60 Hz.

2. Motor:

   a. Type: Totally enclosed, fan cooled (TEFC).
   b. Motor windings shall be nonhygroscopic, and insulation shall equal or exceed NEMA Class "F".
   c. Base: Vertical
   d. Shaft: 17-4 PH stainless steel
   e. Bearings shall be regreasable and be of the radial and axial thrust type.
   f. Hardware, Condensate Drains, and Grease Fittings shall be Cadmium-plated.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that facilities are ready to receive floating mechanical aerators.

3.2 INSTALLATION

A. Install according to manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Wet Startup: Run equipment with wastewater and verify proper alignment and operation.
C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one day (8 hrs) on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.
D. Equipment Acceptance:

    1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
    2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 51 13

SECTION 46 51 15 – VERTICEL AERATION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. Description of Work:

1. Provide all labor, material and equipment to furnish and install one (1) VertiCel® Aeration System as specified herein
2. (b) This specification covers the general requirements for the design, fabrication and installation of one (1) fine bubble aeration basin divided into one (1) cell

B. Work and Components Included (But Not Limited To)

1. The Equipment Manufacturer shall furnish the items listed below:
   a. Stainless steel drop legs
   b. PVC manifolds and air distributors
   c. PVC diffuser holders, subplates and retainer rings
   d. Stainless steel supports and anchors
   e. Bolts, nuts and gaskets for aeration system flange connections
   f. Liquid purge systems
   g. Membrane disc diffusers with integral O-ring gaskets
2. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts and manufacturer's service

C. Work Not Included
1. The following items are specified under other sections of these specifications:
   a. Concrete and Grout – Section 03 60 00
   b. Metal Fabrication – Section 05 50 00
   c. Paint – Section 09 96 00
   d. Electrical – Division 26

1.2 ACCEPTABLE MANUFACTURERS:

A. The Contractor shall use one of the following Engineer approved manufacturers:
1. Evoqua Water Technologies LLC, of Waukesha, WI
2. Or pre-qualified equal which meet or exceed the following requirements

B. Experience
1. The equipment Manufacturer shall have at least ten (10) successful installations of the specified type equipment at different locations in the United States
2. The Engineer may require evidence, in the form of operating records, from these installations to substantiate any claims concerning the ability of the equipment to perform as required

C. Pre-qualification or equal consideration
   1. Manufacturer not already pre-qualified and approved by Engineer meet the following criteria along with the submittal requirements specified in Section 1.03
   2. Manufacturer not already pre-qualified and approved by Engineer shall submit to Engineer an installation list, including facility contact information, demonstrating compliance with 1.02 (B) of this Specification no later than fifteen (15) days prior to the published bid opening date
   3. Manufacturer not already pre-qualified and approved by Engineer shall submit to Engineer written correspondence no later than (15) days prior to the published bid opening date, indicating intent to comply with an extended warranty valid for five (5) years from the start-up of equipment and the performance bond as described herein equal to 100% of the equipment price
      a. Performance Bond
         1) Manufacturer shall furnish a performance bond in an amount equal to 100% of the purchase price to be paid to the Manufacturer for the equipment specified herein. The performance bond furnished by the Manufacturer shall name the Installation Contractor with whom the manufacturer enters an agreement for the purchase of the equipment as an obligee and identify the Owner as a dual obligee. The obligees named in the bond are required to return original copies of the bond to the Manufacturer's surety company upon completion of the Manufacturer's obligations under the equipment purchase agreement executed between the Manufacturer and Installation Contractor. If the original copies of the bond are unavailable for any reason, the obligees will complete a release letter addressed to the manufacturer's surety company stating that the manufacturer's obligations under the above referenced purchase agreement have been satisfied and the surety company is released of any further obligations under the performance bond
         2) The performance bond shall be issued on the Manufacturer's standard form and shall be executed by a surety named in the current list of "Companies Holding Certificates of Authority as Acceptable Reinsuring Companies" as published in Circular 570 by the Financial Management Service, Surety Bond Branch, US Department of the Treasury. Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act."
         3) Manufacturer not already pre-qualified and approved by Engineer shall submit to Contractor a Performance Bond within fifteen (15) days of the executed agreement between Manufacturer and Contractor. The Performance Bond must adhere to the requirements stated in 1.02 (C) (2) (a) of this Specification
         4) Manufacturer not already pre-qualified and approved by Engineer shall submit manufacturing certificate to Engineer no later than (15) days prior to the published bid opening date that indicates discs are fabricated in the United States. Manufacturer shall also provide sample of discs to Engineer or Contractor to verify the disc specification stated in 2.02 (C) (3)
         5) Manufacturer not already pre-qualified and approved by Engineer shall submit disc aerator oxygen performance test data stated in Section 1.03, A, (4) to Engineer no later than (15) days prior to the published bid opening date that shows the proposed disc aeration equipment meets or exceeds the stated requirements
            a) If test data from an existing facility cannot be provided to meet Section 1.03 (4), of this specification, a field test shall be performed

by the Equipment Manufacturer in accordance with the Section 3.01 of this specification

6) Manufacturer not already pre-qualified and approved by Engineer shall submit diffuser test data stated in Section 1.03 (5,6,7,8,9,10,11) to Engineer no later than (15) days prior to the published bid opening date that shows that the proposed diffuser aeration equipment meets or exceeds the stated requirements
   a) If test data from an existing facility cannot be provided to meet any requirement of Section 1.03 (5,6,7,8,9,10,11) of this specification, a field test shall be performed by the Equipment Manufacturer on the installed equipment to verify the specified oxygen transfer efficiency. The field test shall be performed in accordance with ASCE's July, 1984 publication, Measurement of Oxygen Transfer in Clean Water

1.3 SUBMITTALS

A. Operating instructions, manuals and shop drawings shall be submitted in accordance with Section 013300.
B. Shop drawings shall be submitted to the Engineer for approval. Shop drawings shall include dimensional layouts, materials, details of appurtenances, anchoring, and installation and operation instructions. Fabrication and installation shall be in accordance with approved drawings
C. SOTE calculations to verify the clean water oxygen transfer efficiency of the fine bubble diffusers at both design and maximum airflow
D. Headloss Calculations for the fine bubble aeration system shall start from the top of the drop leg and continue to the furthest diffuser. Calculations shall include the total headloss across the membrane, balancing orifice, piping system and static head at both design and maximum airflow
E. Certified calculations, stamped by a registered professional engineer, shall be submitted with shop drawings to verify pipe supports shall be designed to provide a pipe flexural stress less than 750 psi at the maximum operating diffuser air rate
F. Data shall be submitted to show the types of chemicals the fine bubble diffuser membrane is resistant to
G. Six (6) copies of the manufacturer’s operation, installation and maintenance manual shall be submitted for approval prior to shipment of the equipment
H. Definitions:
   1. SCFM: Standard cubic feet per minute is understood to be air at 68° F, 14.7 PSIA and 36% relative humidity flowing at a rate of 1 cubic foot per minute
   2. SOTR: Standard oxygen transfer rate is understood to be the rate of oxygen transferred to tap water (pounds of oxygen per hour) at standard conditions of 20° C, 0.0 mg/l residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air)

3. SOTE: Standard oxygen transfer efficiency is understood to be the percentage of oxygen transferred under standard conditions of 20°C, 0.0 mg/l residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air)
4. SWD: Side water depth is understood to be the overall dimension from the high point of the basin floor to the water surface

1.4 EQUIPEMENT MANUFACTURER'S SERVICE REPRESENTATIVE

A. Manufacturer's Field Service for Equipment Installation.
1. The Manufacturer's field service technician shall check the installation of the equipment, assist in the start-up, and provide training on the maintenance of the equipment. A minimum of one (1) trip and a total of two (2) days at site shall be provided

1.5 SYSTEM DESIGN AND PERFORMANCE

A. Tank Design
1. Rectangular Tank
a. Number of Tanks: 1
b. Dimensions/Pass: Length 43 ft. – Width 23 ft. – SWD 21 ft.

B. Design aeration system to transfer not less than the following pounds of standard condition oxygen per day per tank in clean water at the specified submergence, air rate and pressure

	Average	Peak
Std. O_2 Transfer Rate (SOTR) (Total-lbs-O_2/day/tank)	1,500	3,000
Volumetric Air Rate (SCFM Total/Tank)	160	344
Oper. Press. At top of Drop Leg (psig)	9.32	9.73
Diffuser Submergence (ft.)	20.2	20.2
Total Diffusers	126	

C. Design air distributors with centerline spacing not to exceed 4 feet to maximize oxygen transfer efficiency and mixing efficiency and to minimize solids deposition between air distributors.

PART 2 - PRODUCTS

2.1 GENERAL

A. There shall be provided, as shown on the plans, one (1) complete VertiCel® aeration wastewater treatment systems

B. Each VertiCel® system shall consist of two (2) VLR basins operating in series, followed by one (1) diffused aeration basin. In this project, two (2) VLR basins are existing.

C. Raw wastewater, after entering the system, shall pass progressively through the VLR basins and diffused aeration basin then to the final clarifiers. Wastewater may be introduced into any one, or split between both VLR basins, depending on the operating conditions. Recycled sludge shall be returned to first basin under normal operating conditions. The flow from one aeration basin to another shall be by displacement of the mixed liquor circulating in each basin through slide gate and/or submerged ports interconnecting each adjacent aeration basin. The displaced flow shall be equal to the volume of raw waste and recycled sludge introduced into the aeration system

D. The effluent from each basin shall be controlled by means of a submerged slide gate and/or adjustable overflow weir. The effluent controls shall be designed to allow a liquid level variation of approximately 6" in each VLR basin with variations in the flow of wastewater and recycled sludge. Flow controls shall be arranged so that any basin in the system may be taken out of service and the remaining basin(s) still operated. All piping, valves, slide and stop gates, operators, and weirs shall be provided by the Contractor

E. The design and layout shown on the drawings are based on the Manufacturer listed in Section 1.02.A.1. If equipment other than that of the Manufacturer shown is submitted to the Engineer for consideration as an equal, it shall be the responsibility of the Bidder wishing to make the substitution to submit with the request a revised drawing of the mechanical equipment and basin layouts acceptable to the Engineer. This revised drawing shall show the proposed location of the substitute unit, and area required for withdrawal space of replacement or serviceable components. This drawing shall also show clearances of adjacent equipment and service area required by that equipment

F. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the substitution shall be the responsibility of the Bidder wishing to make the substitution. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the Bidder and not the Owner

2.2 EQUIPMENT

A. Stainless Steel – Pipe, Fittings and Supports
   1. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless steel with a 2D finish conforming to ASTM A240, 554, 774, 778
   2. Fabricate non-welded parts and flanges from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276
   3. Welds & Welding Procedure
      a. Weld in the factory with ER 316L filler wire using MIG, TIG or plasma-arc inert gas welding processes. Provide a cross section equal to or greater than the parent metal
      b. Provide full penetration butt welds to the interior surface with gas shielding of interior and exterior of joint
      c. Continuously weld both sides of face rings and flanges to eliminate potential for crevice corrosion
   4. Corrosion Protection and Finishing - Clean all welded stainless steel surfaces and welds after fabrication by using the following procedure:

a. Pre-clean all outside weld areas to remove weld splatter with stainless steel brushes and/or deburring and finish grinding wheels
b. Finish and clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3
c. Corrosion protection techniques not utilizing full immersion methods are unacceptable and will be cause for rejection of the equipment

B. Natural Rubber – Furnish all fixed and expansion joint O-ring gaskets of natural rubber/SBR with a Shore A durometer of 45 ± 5

C. Polyvinyl Chloride (PVC) – Pipe and Fittings
1. Produce all PVC pipe and fittings from PVC compound with a minimum tensile strength of 7000 psi
2. Provide lower drop pipe, manifold and air distributors as follows:

Diameter	Wall Thickness	ASTM
4-Inch	SDR 33.5	D3915, 3034
6-inch & larger	Schedule 40	D1784, 1785, 2466

3. Design air distributors and manifolds to withstand 125° F mean wall temperature
4. Add two parts by weight of titanium dioxide per 100 parts of resin to PVC compounds for air distributors, joints and PVC diffuser assembly components to minimize ultraviolet light degradation
5. Factory solvent weld all PVC joints and diffuser holders. Field solvent welding is NOT permitted

D. EPDM – Membrane Diffusers and Gaskets
1. Manufacture circular membrane diffuser discs with integral O-ring of EPDM synthetic rubber compound with precision die formed slits. Thermoplastic materials (i.e. plasticized PVC or polyurethane) are not acceptable
2. Add carbon black to the material for resistance to ultraviolet light
3. Design diffuser as one piece injection molded part with a minimum thickness of 0.080 inches for 9-inch diameter unit
4. Limit the maximum tensile strength of the diffuser to 10 psi when operating at 2.4 SCFM/sq. ft. of material. Furnish proportionately thicker material for larger diameter disc diffusers to limit the maximum tensile stress and to resist stretching
5. Produce diffusers free of tears, voids, bubbles, creases or other structural defects
6. Furnish diffuser material to meet the following:

Item	**Value/Units**	**ASTM**
Base Polymer	EPDM	D573
UV Resistance	Carbon Black	
Specific Gravity	1.25 or less	
Durometer – Minimum	58% ± 5%	D2240
Modulus of Elasticity	500 psi	D412
Ozone Resistance (72 hrs: 40°C pphm)	No cracks @ 2X magnification	D1171 Test A
Tensile Strength	1200 psi	D412
Elongation - % - Retained 70 hrs @ 100°C	75% Max	D573

- minimum at break	350%	D412

7. Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E
8. MEMBRANE LONGEVITY - Longevity of the proposed membrane diffusers shall have been demonstrated in at least three full-scale municipal installations operating continuously for a minimum of three years. Test reports, prepared by an independent testing agency, shall confirm membrane longevity through compliance with the following maximum allowed percent (+/-) change in each membrane property. Tests conducted in-house by the Supplier shall not be acceptable

Data for a minimum of three diffusers from each installation shall be provided.

Property	Maximum Percent Change
Durometer	5.0%
Weight	5.0%
Permanent Set	0.5%

2.3 FINE BUBBLE AERATION SYSTEM COMPONENTS

A. Drop Legs – Provide a stainless steel drop leg from the air main connection to the drop leg connection on the manifold
   1. Provide a stainless steel Van Stone style flange with a 150-pound drill pattern for the top connection
   2. Provide a stainless steel band clamp coupling with gasket for the lower dropleg to manifold connection

B. Manifolds - Provide PVC manifolds for connection to the air distribution headers
   1. Fabricate manifolds with 4-inch diameter fixed threaded union or flanged joints for connection to the air distributors
   2. Design manifold, distributor connections and supports to resist thrust generated by expansion/contraction of the air distributors over a temperature range of 125° F
   3. Support manifold with a minimum of two supports
   4. Connect manifolds with fixed threaded union or flanged joints to prevent rotation or blow apart

C. Air Distributors and Diffuser Holders – Provide 4-inch diameter air distributors perpendicular to the air manifold
   1. Fabricate distributors with single diffuser holders solvent welded to the crown of the air distributor for complete air seal and strength
   2. Provide minimum solvent weld area of 15 square inches
   3. Design distributors and holders to resist a dead load of 200 lbs applied vertically to the outer edge of the diffuser holder
   4. Provide 4-inch diameter threaded removable end caps complete with gasket, threaded coupling and end plate for clean out at the end of each distributor

D. Air Distributor and Manifold Connection Joints

1. Join air distributor sections with positive locking fixed threaded union or flange type joints for all submerged header joints to prevent blow apart and rotation
2. Bell and spigot, slip on or expansion type joints are not acceptable for submerged joints
3. Design threaded union joints that prevent rotation by directly locking spigot section connected to one end of the distribution header, and a threaded socket section connected to the mating distribution header. "O" ring gasket and a threaded screw on retainer ring to provide complete seal. Factory solvent weld all joints. Joints that rely on friction alone or use the "O" ring to prevent rotation shall not be acceptable
4. Design flange joints with an angle face ring, follower flange with a 125-pound drill pattern and stainless steel hardware

E. Supports – Provide each section of manifold and air distributor with a minimum of two (2) supports
1. Limit maximum support spacing to 8 feet
2. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125° F and to minimize stress build up in the piping system
3. Design supports to be adjustable without removing the air distributor from the support
4. Design supports to allow for complete removal from the tank to facilitate installation of additional headers and in-tank maintenance
5. Manifold Support – 6-inch diameter and larger
    a. Design supports to include hold down guide straps, support structure and anchor bolts
    b. Design guide straps with a 2-inch minimum width to eliminate point load on manifold and minimize binding
    c. Design support for 2-inches plus or minus vertical adjustment for leveling of manifold
    d. Attach supports to tank floor with two stainless steel anchor bolts
6. Air Distributor and Manifold Supports – 4-inch diameter
    a. Provide guide and fixed type supports to allow expansion/contraction
    b. Design supports with hold down straps, support structure and anchor bolt
    c. Design support for 1 1/2-inch (plus or minus) vertical adjustment for leveling air distributor to plus or minus 1/4-inch
    d. Guide support
        1) Guide straps to have 1 1/2-inch wide top and bottom contoured bearing surface with chamfered edges to minimize binding and resistance to movement of air distributor under full buoyant uplift load
        2) Design strap with 1/8-inch clearance around distributor so strap is self-limiting and cannot be over tightened
    e. Fixed Supports
        1) Fixed straps to have 1 1/2-inch wide top and bottom contoured bearing surface with punched burrs to positively grip the air distributor when tightened
        2) Design strap to be self-limiting to prevent stressing the distributor if the clamp is over tightened
    f. Attach supports to tank floor with one stainless steel anchor bolt

F. Diffuser Assemblies – Furnish diffuser assemblies including diffuser, diffuser gasket, holder, retaining ring and air flow control orifice
1. Membrane Diffuser
    a. Incorporate an integral check valve into the membrane diffuser

b. Design and test diffusers for a dynamic wet pressure (DWP) of 12 inches ± 20% water column @ 1.0 SCFM/diffuser and 2 inches submergence
c. Visual Uniformity – Observe diffusers for uniform air distribution across the active surface of the diffuser at 1.0 SCFM/diffuser and 2 inches submergence. Active surface is defined as the perforated horizontal projected area of the diffuser
d. Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E

2. Diffuser Holders, Support Plate and Retainer Rings
   a. Design holder with air flow control orifice and plenum chamber below the diffuser. Holder to provide peripheral support for the diffuser
   b. Diffuser Support Plate – Provide a PVC support plate to form an air plenum under the diffuser and support for the membrane when the air is off
   c. Design retainer ring to seal the diffuser and O-ring in the holder to prevent air leakage around gasket
   d. Design retainer ring threads with minimum cross section of 1/8 inch and allow for one complete turn to engage threads

G. Anchor Bolts
   1. Design anchor bolts for embedment in 4000 psi concrete with a pullout safety factor of 4
   2. Provide a mechanical stainless steel expansion type anchor bolt system

H. Liquid Purge System - Provide a liquid purge system to drain the entire submerged aeration piping system for each aeration grid including airlift purge eductor line and control valve

I. Instruments
   1. Manufacture shall supply one (1) ORP probes and mounting kit. The probe handrail mounting kit shall be constructed of aluminum (as shown in general arrangement drawings). One analytical transmitter shall be supplied. The transmitter shall have a 4-20 mA output for transmission of the signal to the PLC

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install the VertiCel® Aeration System as shown on the drawings.
B. Equipment shall be installed in accordance with GENERAL MECHANICAL REQUIREMENTS, and in accordance with the Manufacturer's recommendations to provide a complete installation.

3.2 ELECTRICAL CONNECTIONS AND WIRING

A. Wiring and conduits for electrical power, control and instrumentation shall be provided by the Electrical Contractor under DIVISION 16 - ELECTRICAL.

END OF SECTION 46 51 15

SECTION 46 51 23 – FIXED HEADER COARSE-BUBBLE AERATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes all materials and equipment for the fixed header aeration systems in the aerobic digester tanks.

1.2 REFERENCE STANDARDS

A. American Society of Civil Engineers:

1. ASCE 2 - Measurement of Oxygen Transfer in Clean Water.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's information for system materials and component equipment.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Indicate connections and other installation details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

I. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and final orientation of equipment.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's packaging; include application instructions.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store diffusers according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.7 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one year manufacturer's warranty for coarse bubble diffusers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Xylem Sanitaire – Brown Deer, Wisconsin

B. Approved equal

1. Experience in design, manufacture, supply, and commissioning of coarse bubble fixed header aeration equipment of the type specified is required for this project. Submit references for a minimum of five installations of similar size and design as specified, having been in successful operation for a period of not less than five years.

2.2 SYSTEM DESIGN AND PERFORMANCE

A. Tank Configuration:
1. Number of Tanks: 2
2. Dimensions: 39’ x 20”
3. Side Water Depth: 20’

B. Diffuser Design Requirements:
1. Volumetric Air Rate (SCFM/tank): 533
2. Available Operating pressure at drop leg (psig): 10.5
3. Diffuser submergence (ft): 19

2.3 MATERIALS, FABRICATION and FINISHING

A. Stainless Steel

1. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless steel with a 2D finish conforming to ASTM A240.

2. Fabricate non-welded parts and pieces from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276.

3. Provide drop legs, manifolds and headers of the diameter shown on the drawings with dimensional tolerances conforming to ASTM A554 and fabrication procedures in accordance to ASTM A774 & A778.

4. Furnish air distribution headers with the following minimum nominal wall thicknesses.

a. For gusset-reinforced diffuser connectors and header systems as specified in Section 2.3E.

Header Diameter (Inches)	**Wall Thickness (Inches)**
4 Thru 18	0.109

b. For diffuser connectors and headers that are not gusset reinforced as specified in Section 2.03E, the minimum allowable header wall thickness is 0.25 inches to minimize potential for connector failure.

5. Furnish diffuser connector from cast 316L Stainless Steel.

6. Furnish all flanges from stainless steel per paragraph 2.02 A2.

7. Furnish all nuts, bolts and washers including anchor bolts in 18-8 series stainless steel.

8. Furnish 304L stainless steel diffusers conforming to the material as listed in paragraph 2.02 A 1,2, and 3 with a cast 304L Schedule 80 threaded inlet nozzle.

9. Welds & Welding Procedure

   a. Weld in the factory with ER 316L filler wire using MIG, TIG or plasma-arc welding inert gas processes. Provide a cross section equal to or greater than the parent metal.
   b. Provide full penetration butt welds to the interior surface with gas shielding to interior and exterior of joint.
   c. Provide smooth, even distribution interior weld beads with an interior projection not exceeding 1/16 inch beyond the I.D. of the air header or fittings.
   d. Continuously weld both sides of face rings and flanges to eliminate potential for crevice corrosion.
   e. Field welding is NOT permitted.

10. Corrosion Protection and Finishing
    Clean all welded stainless steel surfaces and welds after fabrication by using the following procedure:

    a. Pre-clean all outside weld areas to remove weld splatter with the use of stainless steel brushes and/or deburring and finish grinding wheels.
    b. Finish clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits, oxide film and contaminants to regenerate a uniform, corrosion resistant chromium oxide film.

       1) Completely immerse all stainless steel assemblies and components in an acid solution as described in Section 6.2.11 of ASTM A380. Use nitric-hydrofluoric acid solution as defined in Table A.2.1 of Annex A2 of ASTM A380.
       2) Provide a final thorough rinse using ordinary industrial or potable water and dry in conformance per Section 8.3 of ASTM A380.

    c. Corrosion protection techniques not utilizing full immersion methods are unacceptable and will be cause for rejection of the equipment.
    d. Engineer/Owner at their option may choose to observe the equipment cleaning procedure by notifying the manufacturer of their intent to visit thirty (30) day prior to the date. Cost of the travel and expenses are by the owner.

B. Neoprene – furnish all gaskets of fiber reinforced neoprene – 45 to 50 durometer (Shore A).

2.4 FIXED AERATION HEADERS, MANIFOLD AND DROPLEGS

A. Provide a drop leg from the air main connection or air control valve to the aeration system as shown on the drawings.

   1. Provide a Van Stone style flange design with a 150 pound drill pattern for the top connection.

   2. Provide a band clamp coupling with gasket for the lower dropleg to header connection for ease of installation and alignment.

B. Fabricate manifold and air distribution headers in sections up to 41feet in length.

1. Provide eccentric reducers for changes in diameter for constant invert elevation.

2. Provide 8 inch diameter and smaller headers with removable end caps and 10 inch diameter and larger headers with welded end caps.

C. Join sections of manifold or air distribution headers with flanged joints or expansion joints. Design individual header sections for rotation independent of adjacent sections for alignment purposes during installation.

1. Provide flanged joints consisting of face rings, rotating ring flanges, bolts and gaskets.

2. Provide expansion joints consisting of a welded flanged expansion barrel, "O" ring gasket, "O" ring locking flange and hardware to accommodate + 2 inch of movement.

D. Furnish expansion/contraction system for all headers designed for temperature range of 125° F consisting of simple and fixed supports and expansion joints.

1. Lengths of header can extend up to 80 feet from restraining point without an expansion joint.

2. Limit maximum distance between restraining points on a continuous length of header to 120 feet maximum.

3. Provide an expansion joint on continuous lengths of header between two restraining points.

4. Provide simple supports to restrain header from buoyant uplift forces in compliance with Section 2.04.

5. Provide fixed supports in compliance with Section 2.04.
   a. Limit movement to prevent expansion joint blow apart and transmit expansion forces from the header to the fixed support stand.
      1) Provide a mechanical link to connect the header and fixed support stand.
      2) Reinforce the header at the attachment point of the mechanical link.

E. Duplex Diffuser Connectors

1. Factory weld to the invert centerline of the air header.

2. Design diffuser connectors for two diffusers.

3. Furnish PVC plugs for all unused diffuser connectors.

4. Provide connectors of length appropriate to the header diameter and positioned so that air exiting the diffusers clears the header.

5. Design header and diffuser connectors as follows:
   a. Reinforce the connector header weld joint by providing gussets continuously welded between the vertical side wall of the header and the connector ends to limit long term flexure failure. Minimum gusset thickness is 0.125 inch.

b. Weld connector to the header with a full penetration butt weld to minimize potential for crevice corrosion between header and connector. Use of fillet welds at the connection between the diffuser connector and header is NOT permitted.
c. Resist a vertical dead load applied to the threaded end of the connector that results in a bending moment of 1000 inch-lbs without exceeding 24,000 psi design stress in any part of the header wall or connector.
d. Header wall thickness for unreinforced connectors must comply with Section 2.2, A.4.b.

2.5 SUPPORTS AND ANCHOR BOLTS

1. Provide each section of air header with a minimum of two supports with the maximum spacing between supports not to exceed 17 ft. 6 inch.

2. Limit header or manifold cantilever to no more than 4 ft.

3. Provide header supports with a vertically adjustable header hold down locking mechanism mounted on a stainless steel support structure.

2.6 AIR DIFFUSERS

1. Provide diffusers fabricated of stainless steel material – refer to Section 2.02 Materials, Fabrication and Finishing.

2. Design diffuser for operating range of 8 to 40 SCFM.

3. Design diffusers with cast schedule 80 – 3/4 inch NPT threaded nozzle and acetyl orifice insert if required, an inverted air reservoir, air exit ports and a full length deflector.

   a. Design diffusers to provide full wide band aeration with a minimum air release perimeter of 48 inches per diffuser. Release air uniformly along a minimum two foot band beyond each side of the header.
   b. Locate exit ports discharging air into liquid on horizontal planes at two levels.

4. Diffuser Deflector

   a. Provide deflector below each diffuser for its full length and width.
   b. Design deflector to direct the liquid being aerated along the diffuser reservoir walls so that the air exits through the ports and is sheared into small bubbles and distributed into the liquid.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. According to manufacturer instructions.

3.3 INSTALLATION/START UP SERVICES

A. Provide services of a factory representative for 1 day(s) to verify the proper installation of the equipment.

B. Provide services of a factory representative for 1 day(s) to instruct owner's personnel on operation and maintenance.

3.4 WARRANTY

A. Warrant all parts to be free from defects in materials and workmanship for a period of one year after substantial completion or 18 months after delivery, whichever occurs first.

B. Furnish replacement parts to the Owner for any items found to be defective within the one year warranty period.

3.5 SOURCE QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements for testing, inspections, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Certificate of Compliance:

1. Submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

3.6 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Testing:

1. Test for proper operation.
2. Energize system equipment and test operation under supervision of manufacturer's representative and in presence of Engineer.

C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.7 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 51 22

SECTION 46 61 23 - DISC CLOTH TERTIARY FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Scope of Work:

1. Two (2) existing Disc cloth filters. Add additional 4 Disc in each existing Disc cloth filter, modify the backwash cleaning system and control panel.

B. Related Requirements:

1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to equipment specified by this Section.
2. Section 26 29 23 - Variable-Frequency Motor Controllers: Drive unit for filter shaft.

1.2 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with Work of other Sections.

1.3 SCHEDULING

A. Section 01 31 00 – Project Management and Coordination: Requirements for scheduling.

1.4 SUBMITTALS

A. Manufacturer shall provide, at a minimum, the following information in accordance with Section 01 33 00 Submittals.

1. Product Data/Information
2. Calculations verifying the effective filtration surface area.
3. Hydraulic profile through the filter showing influent and effluent weir lengths, elevations, and nappe at design and peak flow.
4. Shop Drawings
5. Maintenance Instructions
6. Installation Instructions
7. Wiring Diagrams
8. Parts List
9. Qualification Data
10. Sample Warranty

B. Manufacturer shall provide Operations and Maintenance Data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Tools: Furnish special tools and other devices required for Owner to maintain equipment.

1.6 QUALITY ASSURANCE

A. Applicable Standards:

1. ASTM -American Society for Testing and Materials
2. AISI -American Iron and Steel Institute
3. AGMA -American Gear Manufacturer's Association
4. NEMA- National Electrical Manufacturer’s Association
5. NEC -National Electric Code

B. To assure unity of responsibility, center drum, discs with filter media panels, support frame with cover over the entire filter, backwash spray assembly with pump, backwash trough, drive mechanism, automatic control system and components as specified shall be furnished and or coordinated by a single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store and protect materials according to manufacturer instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer shall provide a written warranty against defects in materials and workmanship. Manufacturer shall warrant the goods provided by the Manufacturer to be free from defects in materials and workmanship under normal conditions and use for a period of one (1) year from the date the goods are put into service, or eighteen (18) months from shipment of equipment, whichever first shall occur. This warranty shall not apply to any goods or parts which have been altered, applied, operated or installed contrary to the Manufacturer’s instructions or subject to misuse, chemical attack/degradation, negligence or accident.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Veolia Water Technologies, Inc (Kruger)

2.2 PERFORMANCE REQUIREMENTS:

Design Average Flow per unit, MGD	1.0
Peak Hour Flow per unit, MGD	2.0
Maximum Influent TSS, mg/L	20 mg/L
Effluent TSS, mg/L	<5
Filter Opening, µ	10
Filter Cloth Material	Polyester (woven)
Number of Filter Elements (Existing)	4 Disc / 2×64 panels
Number of Filter Elements (Additional added)	4 Disc / 2×64 panels
Filter Disc Diameter, m	2.1
Total Filter Area, ft^2	194×2
Filter Submergence, %	60
Filter Rotational Speed, RPM	2.8
Material of Construction (Disc)	AISI 304 stainless
Drive Motor (Existing)	1.5 hp, 460v, 3 phase
Drive Motor Service Factor	1.3
Drive Assembly (Existing)	Helical wormgear with riveted chain and sprocket
Number of Backwash Nozzles (per Disc)	12
Backwash Pressure, psi	110
Backwash Flowrate, GPM	60
Backwash Pump	7.5 hp, 460v, 3 phase

2.3 Filter System General Design Information:

A. The automatic backwash filter system shall be suitable for filtering domestic wastewater after secondary treatment and clarification. Each filter shall be designed to operate on a continuous basis and shall be designed to operate while receiving varying flows.

B. The proposed disc filtration system shall not exceed a hydraulic loading rate of 5.96 gpm/sf at peak flow.

2.4 MATERIALS AND EQUIPMENT

A. All fabricated metal shall be minimum grade AISI 304 stainless steel unless otherwise stated in this specification. Filter panels shall be polyester filter cloth mounted on AISI 304 stainless steel frames with integrated rubber seals. Filter disc segments shall be 304 stainless steel.

B. The valves, equipment, materials of construction and controls specified under this section supersede valves, equipment, materials of construction and controls specified elsewhere in the contract documents. Purchased components such as gear reducers, pumps, motors, valves, and actuators shall be provided as per filter manufacturer's standard designs and with standard recommended manufacturer's paint.

2.5 DISC ASSEMBLY

A. The filter shall be composed of modular and removable discs. Each disc shall consist of disc segments that can be easily mounted or dismounted as required. The segments of one disc will be bolted to each other, and the completed disc assembly will be secured to the center drum with stainless steel F clips and hardware.

B. Filter panels (filter media) shall be mounted on the sides of the disc segments. The filter panels shall consist of stainless steel frames with PET monofilament filter fabric attached to the frames. Each panel shall be equipped with a gasket that is fitted to and provided integral to the media frame to provide a watertight seal between the filter panels and disc segments. The panels will be held in place by a locking frame and one bolt per panel for easy exchange.

C. Nominal media pore size shall not exceed 10 microns.

2.6 BACKWASH CLEANING SYSTEM

A. The Discfilter shall be equipped with a single oscillating back-washing system with non-motorized moving spray headers for efficient cleaning of the filter cloth and for reduction of the consumption of backwash water. All panels shall receive 110 psi pressure backwash spray.

B. The backwash system shall be comprised of stainless steel backwash spray headers installed between the discs. The spray headers shall oscillate in an upward and downward motion during drum rotation. The spray header oscillation shall be operated by a cam system that is connected to the drum drive. Each header shall have flat pattern spray nozzles for each disc side. The spray nozzles shall consist of nozzle tips, mounting cap for quick removal, nozzle body and seals. The replacement of spray nozzles must be possible from outside the filter tank. A swivel joint shall allow the spray header manifold to rotate out for nozzle access without disassembly of the manifold or headers.

C. Each filter shall have one externally mounted low-pressure Grundfos centrifugal pump for the backwash system. The backwash pump shall be of the vertical multi-stage design with the motor mounted directly to the top of the pump. The motor shall be supplied by Grundfos integral with the pump. The motor shall be standard efficiency rated for 460V, 3 phase, 60 HZ operation. Filtered water shall be discharged from the pump to the backwash header piping constructed of stainless steel.

2.7 CONTROL PANEL MODIFICATION

A. The existing motor starter located in the Disc Filter Control Panel to manage the start/stop of the Backwash Pump motor will be replaced with a new motor starter as per this specification. The motor starter will be sized appropriately to match the requirements of the Backwash Pump

motor. The motor starter will be an IEC starter rated between 0.1 and 50 Amps @ 460VAC 3 phase, with rotary handle operator, visible trip indication, protection by overload, short circuit, undervoltage and shunt. The motor starter will be equipped with auxiliary contacts for monitoring and control. The IEC motor starter shall be Square D TeSys or approved equal.

2.8 DISCFILTER SPARE PARTS

A. The following spare parts will be supplied: 5 Backwash Spray Nozzles, 2 Filter Panels. Parts inventory shall be based in the United States.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall install the disc filter system per the Equipment Manufacturer's directions and the drawings. The Contractor will provide all required supports and anchoring required to install the disc filter unit. The plumbing and electrical connections shall be provided as detailed on the drawings and specifications. The Equipment Manufacturer will provide adequate crating and protection of the disc filter panel screen for shipment to the project site. Installation instructions will be provided that specifically outline installation of this drum screen. Lifting instructions will be provided to assist the Contractor in placing the unit into the concrete scree n sump.

3.2 FIELD SERVICES

A. The Equipment Manufacturer shall furnish the services of a factory-trained representative based in the United States and employed by the manufacturer, for a minimum of two (2) working days and one (1) trip. This trip shall consist of inspection and check-out (dry/wet/electrical) and for start-up.. The Contractor will provide to the Equipment Manufacturer a minimum prior notice of three (3) weeks in order to schedule these services.

END OF SECTION 46 61 23

SECTION 46 73 22 – DECANTER ASSEMBLY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install two (2) decant lines for drawing off fluid from two (2) sludge digester tanks at any point between the maximum tank water level and the invert of the draw-off pipe as specified herein and shown in the Drawings
B. The decant line shall be provided complete with all accessories, anchor bolts and other appurtenances as specified and as may be required for a complete and operating installation

1.2 REFERENCES

A. American Gear Manufacturers Association (AGMA)
B. National Electrical Manufacturers Association (NEMA)
C. American Federation of Bearing Manufacturers Association (AFBMA)
D. American Society for Testing and Materials (ASTM)
E. American Welding Society (AWS)
F. Steel Structures Painting Council, American National Standards Institute (SSPC)
G. Underwriters Laboratory (UL)

1.3 SUBMITTALS

A. Shop Drawing Submittals shall be submitted in accordance with Section 013300, and contain the following minimum content:

1. Shop Drawings and erection drawings showing details of construction, dimensions, anchor bolt locations, and field connections
2. Descriptive literature, bulletins, and catalogs of the equipment, including details of the hand winch and any lubrication points
3. Installation, operation, and maintenance procedures
4. Total weight of the equipment

1.4 OPERATION AND MAINTENANCE MANUALS

A. Submit operations and maintenance manuals for the equipment in compliance with Section 013300. Manuals shall include:
   1. Contact name, address, and telephone number of the equipment manufacturer's Service Department and Parts Department
   2. Descriptive literature, including illustrations, covering the operational features of the equipment, specific for the particular installation, with all inapplicable information omitted or marked out
   3. Operation and maintenance information
   4. Complete maintenance parts list
   5. Complete connection, interconnecting and assembly diagrams
   6. Approved Shop Drawings

1.5 QUALITY ASSURANCE

A. The materials covered by these specifications are intended to be standard equipment of proven reliability and as manufactured by a reputable manufacturer having experience in the production of fluid decanting equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per the manufacturer's recommendations

B. The design is based on a model as produced by Vulcan Industries, Inc. of Missouri Valley, Iowa. Acceptable manufacturers include Jim Myers & Sons, Waste-Tech, Inc., and Online Engineering. Substitute, alternate, and "or-equal" manufacturers are not acceptable

1.6 DESIGN REQUIREMENTS

Number of Units:	Two (2)
Maximum Water Surface Elev:	528.16
Decanter Intake Elev:	528.25
Invert Elev. Of Draw-off Pipe (Swivel Joint):	519.00
Decant Pipe Size:	6-inch

1.7 STORAGE AND HANDLING OF EQUIPMENT

A. The CONTRACTOR shall store and temporarily support equipment prior to installation in strict accordance with the Manufacturer's recommendations and instructions. Protect all exposed surfaces. The CONTRACTOR shall be responsible for work, equipment and materials until inspected, tested and finally accepted.

B. Protect the equipment from being contaminated by dust, dirt, vibration and moisture.

PART 2 - PRODUCTS

2.1 GENERAL

A. The decant line furnished shall be capable of decanting fluid from a storage tank at any point between the maximum fluid level and the invert of the draw-off pipe. The decant line shall be installed as shown on the Contract Drawings

2.2 DECANT TUBE

A. The decant tube(s) shall be fabricated of a minimum 12-gauge, 304 stainless steel. The unit shall be of single swivel joint design and shall be of proper length as shown on the Contract Drawings
B. The decant tube shall have a flanged elbow that shall be bolted to the contractor supplied draw-off piping. Contractor shall coordinate actual laying lengths with installation of piping
C. A swivel joint shall be furnished to allow the decant tube to travel between the high water level and the invert of the draw-off pipe as shown on the Contract Drawings. Swivel joint shall have replaceable seal gaskets
D. The decant tube shall be weighted with a properly sized weld-on weight to prevent flotation of the pipe

2.3 WINCH

A. A 1000-pound capacity, 304 stainless steel spur gear hand operated ratchet winch shall be furnished for each decant assembly. Winches shall have a suitable length of 3/16-inch diameter stainless steel cable and a hook with safety latch to attach the cable to the decant tube

2.4 FASTENERS

A. All fasteners and anchor bolts shall be 304 stainless steel unless otherwise indicated in this specification. Anchor bolts shall be provided for mounting the hand winch. All threaded fasteners shall be coated with a nickel based anti-seize thread lubricant prior to assembly

2.5 PROTECTIVE COATINGS

A. Stainless steel and plastic components shall not be painted. The stainless steel structural components and enclosure panels shall be passivated after fabrication to remove embedded iron, surface rust and weld burn. All other surfaces shall be blast cleaned to an SSPC-SP6 finish, removing all dirt, rust, scale and foreign materials
B. Cleaned surfaces shall be shop primed with one (1) coat of Tnemec 69-1212 primer, or equal, to attain a minimum dry film thickness of 2.5 mils

PART 3 - EXECUTION

3.1 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, F.O.B. its factory, any part or parts returned to it which examination shall show to have failed under normal use and service by the user within one (1) year from date of Substantial Completion on the project

3.2 START-UP

A. Manufacturer shall provide the services of manufacturer's technician to checkout the equipment with ½ day and certify the installation before the start-up

END OF SECTION 46 73 22

Appendix A

Geotechnical Report

CAREY STATION WATER REUSE FACILITY

GREENSBORO, GREENE COUNTY, GEORGIA

May 6, 2024

REPORT OF GEOTECHNICAL EXPLORATION

Prepared By

Goodwyn Mills Cawood LLC
801 Broad St # 900
Augusta, GA 30901
T (706) 303-3272
www.gmcnetwork.com

GMC PROJECT NUMBER: GAUG230004

Goodwyn Mills Cawood

801 Broad Street
Suite 900
Augusta, GA 30901

T (706) 251-9099
F (770) 955-1064

www.gmcnetwork.com

May 9, 2024

Mr. Graham Sizemore
GMC
801 Broad St # 900
Augusta, GA 30901

RE: REPORT OF GEOTECHNICAL EXPLORATION
CAREY STATION WATER REUSE FACILITY
GREENSBORO, GEORGIA
GMC PROJECT NO. GAUG230004

Dear Mr. Sizemore,

Goodwyn Mills Cawood, LLC (Geotechnical & Construction Services Division) is pleased to provide this report of geotechnical exploration performed for the above referenced project. This report includes the results of field and laboratory testing, general site preparation recommendations based on specific site conditions, and recommendations for foundation design.

We appreciate the opportunity to perform this study on this phase of the project for you and look forward to continued participation during the construction phase of this project. If you have any questions pertaining to this report, or if we may be of further service, please do not hesitate to contact us.

Sincerely,
GOODWYN MILLS CAWOOD, LLC

Kevin W. Wales, PE
Executive Vice President
Licensed Georgia PE046948

Michael J. McNeill, PE
Vice President
Licensed Georgia PE045033

GMC

TABLE OF CONTENTS

APPENDIX:

1.0 EXECUTIVE SUMMARY

This summary report presents the results of our geotechnical investigation performed for the proposed Carey Station Water Reuse Facility improvements. The proposed project is located at 4610 Carey Station Road in Greensboro, Greene County, Georgia. Our geotechnical scope of work for this project included conducting geotechnical fieldwork, associated engineering analysis, and providing a geotechnical engineering report. The project is early in the design phase, and therefore there are no detailed structural information at the time of this report. Preliminary site grading plans were provided.

This report provides recommendations for site preparation, foundations, and other geotechnical related conditions that might affect the proposed construction. The following geotechnical considerations were identified during our investigation:

- The subsurface conditions were explored by drilling a total of ten (10) soil test borings across the site to the planned depth of 25 to 45 feet below existing grade.
- The surficial soils consisted of 1 to 4 inches of organic laden material (OLM). The subsurface conditions encountered generally consisted of medium to hard sandy to clayey SILT (ML). Standard Penetration Test (SPT) N-values ranged in these materials from 2 to 60 blows per foot (bpf). Partially Weathered Rock (PWR) was encountered at a depth of 28.5 feet below existing grade and in boring B-7 and 18.5 feet below existing grade in boring B-9.
- Laboratory testing included grain size, Atterberg limits, and permeability.
- Groundwater was not encountered in the borings at the time of drilling.
- Based on the limited laboratory testing performed, most of the on-site material can be reused as compacted fill. Silty soils are very moisture sensitive and require the moisture content to be at or near the optimum moisture content to achieve the required compaction. This may require moisture conditioning (wetting/drying) of the material, depending on the time of year site construction is occurring.
- Seismic Site Class is “D” based on N-values from the borings.
- Conventional shallow foundations may be utilized with a net allowable bearing capacity of 2,000 psf. If mat foundations are utilized, a modulus of subgrade reaction of 125 pci may be utilized. A sliding coefficient of 0.30 may be used for soil and concrete.

The recommendations presented herein have been developed based on the subsurface conditions encountered during field investigation and our understanding of the proposed construction. Should changes in the project criteria occur, a review must be carried out by GMC to determine if modifications to our recommendations will be required.

2.0 PROJECT INFORMATION AND SCOPE OF WORK

2.1 Project Information

A geotechnical exploration has been conducted for the proposed Carey Station Water Reuse Facility improvements. The proposed project is located at 4610 Carey Station Road in Greensboro, Greene County, Georgia.

The proposed facility will include a 1.5 MG reject pond, EQ basin, sludge aerobic digester, clarifier, headworks, and influent pump station. At the time this report was prepared, we had not been provided with structural information for the proposed structures.

2.2 Scope of Work

The purpose of this exploration was to characterize the subsurface soil conditions at the site, and to provide the following:

- A brief summary of our test procedures and the results of all field and laboratory testing.
- A review of the site conditions and geologic setting.
- A review of subsurface soil stratigraphy including the individual Boring Records, Subsurface Diagrams, and a Boring Location Plan.
- Information regarding groundwater conditions.
- General recommendations for site preparation, excavation considerations, preparation of existing soils for proposed construction activities, construction of compacted fills, foundation recommendations, and pavement recommendations.

The scope of services for the geotechnical exploration did not include any environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements, if any, in this report or on the boring records regarding odors, colors, or unusual or suspicious items or conditions are strictly for the information of the client.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 Existing Site Conditions

At the time of our exploration, the site topography consisted of a hilly terrain. The existing elevation of the lowest boring is 490 feet and the highest boring is 516 feet. The facility is currently comprised of an existing 0.5 MGD vertical loop reactor facility, a 1.5 MG reject pond, and a 1.5 MG reuse pond. The proposed construction areas consisted of woodlands surrounding the existing facility and grassed areas adjacent to existing structures at the facility.

3.2 Site Geology

Published geologic information indicates that the site is in the Piedmont physiographic unit. The Piedmont is typically characterized by gently rolling topography and deeply weathered bedrock. The subsurface conditions can consist of up to 70 feet of weathered residual soils (saprolites) underlain by metamorphic and igneous rocks consisting of granite, schist, and gneiss.

The subsurface bedrock in this region has undergone differing rates of weathering, which often produces a considerable variation in depth to competent rock over short horizontal distances. It is also not unusual for lenses and large boulders of hard rock and zones of partially weathered rock to be present within the soil mantle above the general bedrock level. The typical residual soil profile consists of clayey soils near the surface, where soil weathering is more advanced, underlain by sandy silts and silty sands, which often consist of saprolites (native soils which maintain the original fabric of the parent rock).

Generally, the soil becomes harder with depth to the top of parent crystalline rock or "massive bedrock." This transitional zone is termed partially weathered rock (PWR). PWR is defined for engineering purposes as material with standard penetration N-values of more than 100 blows per foot. Weathering of the rock is influenced by joints, fractures, and less resistant rock types therefore, the profile of the PWR and hard rock is irregular. It is not unusual to find boulders, lenses of hard rock, and zones of PWR within the soil mantle, above the general bedrock level.

3.3 Field Exploration

The site subsurface conditions were explored by drilling a total of ten (10) soil test borings across the site to depths of 25 to 45 feet below existing grade. Boring locations were selected by GMC and were staked in the field by GMC geotechnical personnel using handheld GPS equipment. The approximate boring locations can be found on the Boring Location Plan located in the Appendix. The ground surface elevations shown on the boring records were approximated from the provided topographic survey provided and should be considered approximate. Field-testing employed by GMC was in general accordance with ASTM standards or generally accepted methods.

The borings were performed using a drill rig equipped with a rotary head and hollow stem augers (HSA). Soils were sampled using a two-inch outside diameter split barrel sampler driven with an automatic hammer. Soil sampling and drilling was performed in general accordance with the procedures for "Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM D1586). Shelby Tube samples were collected in selected borings. All samples were identified according to project number, boring number and depth, and were placed in polyethylene plastic wrapping to protect against moisture loss.

3.4 Subsurface Conditions

The descriptions given below are for materials that were encountered in the specific boring locations during the course of the fieldwork. The subsurface descriptions contained herein are of a generalized nature to highlight the major soil stratification features and soil characteristics. The boring records included in the Appendix should be reviewed for specific information as to specific boring locations. The stratification shown on the boring records and subsurface profiles represent conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. In addition, the stratifications represent the approximate boundary between subsurface materials, and the transition may be gradual. The results of laboratory tests, consisting of natural moisture contents, grain size, and Atterberg limits performed on selected soil samples, are contained in the Appendix.

The following table summarizes the borings drilled:

Structure	Boring	Proposed Bearing Elevation (feet)	Approximate Ground Surface Elevation (feet)	Auger Refusal Depth (feet below existing grade)	Groundwater Depth/Approximate Elevation (feet)
Reject Pond	B-6 to B-9	486	490 to 500	N/A	Not encountered
EQ Basin	B-1, B-2	492	510 to 513	N/A	Not encountered
Headworks/Pump Station	B-3	507 / 493	514	N/A	Not encountered
Clarifier	B-4	506	510	N/A	Not encountered
Sludge Aerobic Digester	B-5	505	504	N/A	Not encountered
Chemical Storage Tank & Chemical Pump Room	B-10	499	507	N/A	Not Encountered

Surficial Materials

The surficial soils consisted of 1 to 4 inches of organic laden material (OLM).

Residual Soils

The subsurface conditions encountered generally consisted of medium to hard sandy to clayey SILT (ML, ML-CL). Standard Penetration Test (SPT) N-values ranged in these materials from 2 to 60 blows per foot (bpf).

Partially Weathered Rock

Partially Weathered Rock (PWR) was encountered at a depth of 28.5 feet below existing grade and in boring B-7 and 18.5 feet below existing grade in boring B-9.

3.5 Groundwater Information

Groundwater was not encountered in the borings at the time of drilling. The borings were backfilled at the end of the drilling operations and 24-hour water level reading were not performed. Groundwater levels may vary due to seasonal conditions and recent rainfall.

3.6 Laboratory Analyses

The laboratory-testing program included visual classification of all soil samples and laboratory testing of selected samples, which consisted of Atterberg limits, grain size analyses, permeability testing, and clay content. The

laboratory-testing program was conducted in general accordance with applicable ASTM standards and the results are summarized in the Appendix. The following table summarizes the laboratory testing:

Structure	Boring	Sample Elevation (feet)	USCS Classification	Atterberg Limits	Permeability (cm/sec)	Fines Content (%)
EQ Basin	B-1	492-494	ML	LL=38, PL=27, PI=11	4.07×10^{-7}	61.8
Reject Pond	B-7	477-479	SM	LL=32, PL=27, PI=5	8.73×10^{-7}	44.8

4.0 RECOMMENDATIONS

4.1 General

At the time of this report, we had not been provided with structural or grading information about the planned structures. The following is a summary of our findings:

- All structures will bear in native sandy and clayey silt (ML, ML-CL); therefore, no rock removal is anticipated.
- Shelby tube samples were obtained at the proposed EQ basin and reject pond bottom elevations and were tested for permeability, clay content, and plasticity. The results of these tests, included in the Section 3.6 Laboratory Analyses and in the Appendix, are representative for the bottom of the proposed ponds.

4.2 Site Preparation

Stripping

Surface vegetation and deleterious materials in the planned construction area should be completely removed. Based on our observations, we recommend 2 inches of stripping be budgeted to remove organics and root zones. It should be noted that deeper depths of organics may be present in lower lying areas of the site or in drainage features.

Proofrolling

Once the subgrade elevation has been achieved, we recommend that the subgrade be proofrolled with a loaded dump truck to verify the existing subgrade soils are suitable for slab support. Proofrolling consists of repeated passes with a loaded dump truck to locate areas of soft soil. Areas that rut or pump excessively will indicate those soils that will need remediation. If the layer of soft/pumping soils is relatively thin, less than about 1 foot, an attempt can be made to scarify, moisture condition, and compact the materials. Whether or not these soils will be problematic will be a function of prevailing weather conditions. If the soils are wet and adequate drying conditions are not present, this may not be practical. Deeper areas of soft/pumping soils should be removed until the thickness is such that the remaining material can be moisture conditioned and properly compacted. We recommend a GMC geotechnical engineer or qualified soils' technician observe the proofrolling operations.

Due to the moisture-sensitive nature of possible silty soils at the subgrade level, additional undercutting and/or stabilization will likely be required if proper site maintenance, protection from surface water, and equipment traffic control are not implemented. At the end of each day, the grading contractor should "weatherproof" exposed soil

subgrades, and provide positive drainage for surface water flow if inclement weather is expected. The contractor should have water trucks available to wet subgrades exposed to prolonged dry periods. Twisting and turning of construction equipment over exposed soils, especially during and after rain events, should be avoided, or otherwise degradation of the prepared subgrade soils will occur.

4.3 Excavation Considerations

Site soils consists of silty sands and silts with very loose to very dense fine-grained materials. It is our opinion that conventional earthmoving equipment in proper working condition should be capable of making necessary excavations for the project. Some excavation of the materials onsite may require the use of a large dozer (D8 or larger) equipped with a single-shank ripper or a hydraulic ram. Utility installations that require deeper excavation may encounter more resistant material that will likely require blasting or other means to efficiently remove the rock.

4.4 Time of Year Site Preparation Considerations

During periods of heavy rain, the near surface soils can become saturated and conditions of standing or ponding water at the ground surface can occur. The near-surface soils are deemed to be moisture sensitive and may lose their strength properties if exposed to excessive moisture. The time of the year that the sitework begins can affect the project considerably. In this area, the "wet season" is generally between the months of May and August, and the "dry season" from September to April. There are many considerations that need to be addressed prior to bidding a project that could affect the budget based on the time of year a project starts earthwork activities. The time of the year that the geotechnical borings were performed can provide a false sense of actual near surface conditions depending on the time of year and weather conditions. Below are considerations that should be addressed based on the time of the year earthwork is started.

"Wet" Season

During the wet season, the amount of undercutting may be greater, therefore resulting in greater excavation costs. The soils are typically proofrolled to determine their suitability for the placement of new fill or subgrade support. During the wet season, the surface soils have a higher moisture content and will tend to pump, therefore, hindering the placement of new fill. In addition, the drying time, time period between rain events, and temperature is not conducive to scarify soils, allow drying, and recompacting. At this time, the decision should be made to try either scarify/dry/compact the in-place soils, which could take time, or undercut and replace with suitable material, which could increase the sitework costs. Based on our experience, the amount of undercut could be 2 to 3 feet more (or greater in localized areas), whereas in drier weather, lesser amounts of undercutting may be necessary, if recompaction or stabilization of soils left in place can be achieved. Some undercut soils are not always "unsuitable" soil and can be moisture conditioned and reused as fill, if drying conditions are favorable.

The site contractor shall be responsible for maintaining a firm, unyielding and stable subgrade condition. Should the near surface soils become wet, the contractor should be prepared to mitigate these conditions by repeated aeration and exposure to sunlight or by admixture treatment.

"Dry" Season

During the dry season, the surface soils have a lower moisture content and will tend to "bridge" or "crust" softer underlying soils. They will generally allow the placement of new fill, but the crust can break down if repeated passes

with heavily loaded equipment is persistent. In addition, new fill from cuts or other sources may need to be moisture conditioned prior to compaction. The soils can dry significantly, requiring the addition of water for proper compaction. Water trucks should be used, as required, by the contractor to condition the soils within the required specifications.

4.5 Fill Placement

Fill material beneath buildings/structures and pavements should meet the following characteristics:

Property	Requirement
Liquid Limit (LL) and Plasticity Index (PI)	LL < 50 and PI ≤ 25
Maximum Dry Density (ASTM D-698)	≥ 95 pcf
Maximum Particle Size	3 inches or less
Organic Matter	≤ 5%
Fill Loose Lift Thickness	8 inches or less (4 inches of less for walk-behind compaction equipment)

The following table summarizes the compacted fill requirements:

Location	Test Method	Compaction Required (minimum)	Moisture Content
Upper 18 inches below pavements	ASTM D698	98%	-3% to +3% of optimum moisture
Building Areas and 5 feet beyond perimeter	ASTM D698	98%	-3% to +3% of optimum moisture
All other areas	ASTM D698	95%	-3% to +3% of optimum moisture

On site soils classified as ML and ML-CL should be suitable for use as compacted fill. Any zones of debris or highly organic material should be segregated and not utilized as structural fill. Samples of the proposed fill materials should be provided to the geotechnical engineer for testing and evaluation prior to placement. Density tests should be performed to document compaction and moisture content of any earthwork involving soils and other applicable materials. Density tests should be performed frequently, with a recommended minimum of one test per 5,000 square feet per lift of fill.

5.0 FOUNDATIONS

5.1 Shallow Foundations

If the site preparation recommendations in Section 4 are followed, the proposed structures can be supported on shallow foundations. The foundations should:

- Structures may be sized using a net allowable soil bearing pressure of 2,000 pounds per square foot (psf). If mat foundations are utilized, a modulus of subgrade reaction of 125 pci may be utilized. A sliding coefficient of 0.30 may be used for soil and concrete.
- Total settlements of foundations due to loads are expected to be approximately 1-inch, with differential settlements of about ½-inch.
- Be founded a minimum of 24 inches below exterior adjacent grade in densified existing soils or newly placed fill (based on sitework recommendations).
- Even though computed footing dimensions may be less, column footings and continuous footings should have minimum dimensions of 24 inches and 18 inches, respectively. This allows for hand cleaning of materials disturbed during the excavation process and reduces the potential for punching shear failure.

The geotechnical engineer or his representative should observe all foundation excavations, prior to concrete placement. The engineer can provide geotechnical guidance to the owner's design team should any unforeseen foundation problems develop during construction. If any areas of foundation surfaces prove to be unsuitable, the foundation should be over-excavated.

The condition of the soils at the planned bearing elevations for each structure may vary, depending on the planned final subgrade elevation. If required by field conditions and directed by the geotechnical engineer, we recommend that an allowance be included in the budget to over-excavate footing excavations through existing loose soils where present. The over-excavated area can be backfilled with "lean" concrete, controlled low strength material (CLSM) with minimum 28-day strength of 1500 psi, or compacted well-graded crushed stone up to the planned foundation bearing depth.

Foundation concrete should be placed the same day they are excavated so that disturbance of the foundation bearing soils can be reduced. Foundation bearing surfaces should not be disturbed or left exposed during inclement weather. Saturation of the on-site soils can cause a loss of strength and increased compressibility. Excavations for footings should be hand cleaned to remove any loose soil or mud from the foundation bearing surface. If construction occurs during inclement weather and concreting is not possible immediately after excavation, we recommend that a thin layer (approximately 2 inches) of lean concrete or flowable fill be placed on the bearing surface for protection after we have observed and evaluated the exposed bearing surfaces.

5.2 Floor (Mat) Slabs

Provided that the recommendations above are followed, we recommend a modulus of subgrade reaction, k_s, of 125 pounds per cubic inch (pci) be utilized in the design. We recommend that an effective vapor barrier should be used to reduce slab dampness due to soil moisture. We note that penetrations of the vapor barrier by construction staking and traffic should be kept to a minimum as they will greatly reduce the barrier effectiveness. We recommend that

slabs (and mat foundations) be supported on a minimum of 4 inches of crushed aggregate or sand compacted to at least 98% of standard Proctor maximum dry density.

Slab subgrades are often disturbed between completion of grading and slab construction due to weather, footing, and utility line installation, and other construction activities. For this reason, we recommend that slab subgrades be evaluated by a Geotechnical Engineer prior to slab construction. This can be accomplished by proofrolling with heavy rubber-tired construction equipment. Areas determined by the Geotechnical Engineer to be unsatisfactory for slab support should be undercut to stable materials and replaced with properly compacted structural fill.
Care should be taken so that fines from the subgrade are not allowed to contaminate the granular layer. If fines do contaminate this layer, capillary rise and subsequent damage to moisture sensitive floor coverings could occur. On most projects, there is some time lag between initial grading and the time when the contractor is ready to place concrete for the slab-on-grade. Inclement weather just prior to placement of concrete for the slab-on-grade can result in trapped water in the granular layer.

5.3 Seismic Site Classification

Subsurface information (SPT and soil classification) from the borings, published geologic information, and our experience was used to estimate the seismic site classification according to methods in the 2021 International Building Code. Based upon this information, we recommend a Seismic Class of D (Stiff Soil) for this site. Based on our understanding of the project, we have assumed a Risk Category of III. If the Risk Category is different, the values below may need to be revised. According to the ASCE 7/SEI 7-16 hazard standard information, the site has mapped 0.2 second spectral response acceleration (S_S) of approximately 0.224g and a mapped 1.0 second spectral response acceleration (S_1) of approximately 0.085g.

Using this information, Site Class D and Risk Category IV, the site coefficients F_a and F_v have been determined to be 1.6 and 2.4, respectively. The design spectral response accelerations S_{DS} and S_{D1} were 0.239g and 0.136g, respectively.

5.4 Below Grade Walls

Below grade walls must be designed to resist the lateral earth pressures that will be induced by the weight of the backfill materials, hydrostatic pressures on the walls, and any adjacent slab or foundation surcharge loads exerted on the walls. It is recommended that the walls be supported as outlined above and backfilled with a free draining material such as crushed stone/gravel or clean sand (less than 10% passing a No. 200 sieve). **A drainage system should be provided near or at the base of the walls to collect and remove groundwater or seepage and to prevent buildup of hydrostatic pressures.**

Walls that support buildings or otherwise need to have little horizontal movement at the top should be designed for "at rest" earth pressure conditions. Walls that are free to deflect should be designed for "active" earth pressure conditions. The "passive" earth pressure state should be used for soils supporting the retaining structure, such as toe backfill.

Relatively free-draining crushed stone/gravel or sand should be used as backfill. Samples of all backfill material should be evaluated for use as backfill. The design values and recommendations presented above assume that the backfill

behind the wall will be horizontal with no surcharge loads and that a permanent drainage system will be installed behind the retaining wall to prevent the development of hydrostatic pressures.

Fine-grained soils (CL, CH, ML, and MH) will not be acceptable to be used as backfill directly behind the walls. Using a select material can significantly reduce the horizontal loads on the wall as well as improve the effectiveness of the wall drainage system. The noted backfill should extend from the wall and upward from the top of the footing on a line 30 degrees from the vertical.

The below requirements are for lift stations or structures that are not designed to withstand hydrostatic pressures up to the top of the structure. Structures that are designed to withstand hydrostatic pressures up to the ground surface should follow the requirements of Section 4.5 Fill Placement for material and compaction requirements. It is the responsibility of the Contractor to ensure safe excavations are maintained during construction.

The table below presents recommended values of earth pressure coefficients for the select backfill materials:

Soil Parameter	Backfill Type		
	SM, SC	SP, SW	GW, GP
Soil Unit Weight (pcf)	120	125	130
Buoyant unit Weight (pcf)	58	63	68
Angle of Internal Friction, Φ, deg	32	34	38
At rest Pressure Coefficient, K_o	0.47	0.44	0.38
Active Pressure Coefficient, K_a	0.31	0.28	0.24
Passive Pressure Coefficient, K_p	3.25	3.54	4.20
Coefficient of Friction, tan Φ	0.62	0.67	0.78
At-rest Equivalent Fluid Pressure, pcf (Above GWT, below GWT)	56	55	50
	89	90	88
Active Equivalent Fluid Pressure, pcf (Above GWT, below GWT)	37	35	31
	80	80	78
Passive Equivalent Fluid Pressure, pcf (Above GWT, below GWT)	391	442	546
	251	285	348

GWT - Ground Water Table

For analysis of sliding resistance of the base of the retaining walls, the ultimate coefficient of friction may be taken as 0.30 between concrete and firm soil.

Compaction of backfill behind walls should be performed by appropriate manual equipment. The wall should be properly braced and heavy equipment should not be allowed behind the wall. No equipment or construction loads should be allowed within 10 feet of retaining walls or half the distance of the freestanding wall-height. This will help

prevent any surcharge loads from adding lateral earth pressures above that previously recommended to the retaining wall.

Below grade walls should be braced during any backfilling operations and monitored for movement. If the footing construction precedes the subgrade preparation, then the footings should either be embedded below the subgrade a sufficient distance to achieve the required horizontal component or the footing should include a shear key to prevent movement.

5.5 Backfilling of Utility Trenches

Backfilling of storm drain and utility trenches must be performed in a controlled manner to reduce settlement of the fill and cracking of overlying floor slabs and pavements. We recommend that utility trenches be backfilled with acceptable borrow or dense-graded crushed stone in 4-inch loose lifts compacted with mechanical piston tampers to the project requirements. Should seepage occur in utility trenches, it may be necessary to "floor" the trench with dense-graded gravel. Open-graded crushed stone such as #57 can serve as a channel for seepage toward structures and therefore is not recommended for use as general utility trench backfill.

5.6 Slopes

We recommend that once the site grades have been established, any cut or fill slope should be evaluated for stability. Permanent cut and fill slopes should have a maximum slope orientation no steeper than 3(H):1(V). The recommended fill slope orientation is dependent on the fill being placed in accordance with the structural fill section of this report. If fill slopes will be placed above soft or loose soils, the slope stability should be evaluated to check whether geotextile reinforcement will be required to provide stable slopes. The slopes will experience erosion if runoff is not controlled. Runoff from above must be channeled to cross the slope in paved ditch sections or flumes and not allowed to flow down the face.

The foundation soils should be free of loose or compressive soils that can consolidate under the added load of the embankment. The Geotechnical Engineer or his designated representative should evaluate the suitability of exposed foundation soils.

Where a new embankment is placed against an existing steep slope (steeper than 5H:1V), the existing slope should be benched to provide good contact and prevent the formation of weak zones. The benching should commence at the toe of the proposed slopes and commence upwards as fill is placed. Inadequate benching could result in creep and perhaps slope failures. Benches should be at least 10 feet wide.

5.7 Subgrade Restoration

Typically, due to the movement of heavy equipment and weather conditions, the subgrade soil can become disturbed during construction. As a result, these soils have a tendency to lose shear strength and support capability. Therefore, additional effort on the Contractor's part will be required to reduce traffic and limit disturbance of soils. It is essential that the subgrade be restored to a properly compacted condition based on optimum moisture and density.

5.8 Drainage Considerations

Adequate drainage should be provided at the site to reduce possible increased moisture content of the foundation soils. We recommend that driveway areas, walkways, and the ground surface be sloped away from the structures on all sides. Roof drainage should be collected by gutters and downspouts and transmitted by pipe to the storm water drainage system or discharge a minimum of 5 feet away from the building.

6.0 REPORT LIMITATIONS

The recommendations submitted are based on the available soil information obtained by GMC and design details furnished by GMC for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, we should be notified immediately to determine if changes in the foundation, or other, recommendations are required. If GMC is not retained to perform these functions, GMC cannot be responsible for the impact of those conditions on the performance of the project.

The findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans are more complete, the geotechnical engineer should be provided the opportunity to review the design plans to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations.

We emphasize that this report was prepared for design and informational purposes only and may not be sufficient to prepare an accurate construction budget. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design and informational purposes only. A more comprehensive exploration and testing program would be required to assist the contractor in preparing the final building pad preparation, grading, and foundation construction budgets. In no case should this report be utilized as a substitute for development of earthwork specifications.

The information contained in this report is not intended, nor is sufficient, to aid in the design of segmental or mechanically stabilized earth (MSE) retaining walls. Segmental or MSE wall designers and builders should not rely on this report and should perform independent analysis to determine all necessary soil characteristics for use in their wall design, including but not limited to, soil shear strengths, bearing capacities, global stability, etc.

APPENDIX

Figure 1 – Site Location Plan

Figure 2 – USGS Site Map

Figure 3 – Boring Location Plan

Soil Classification Chart

Subsurface Diagrams

Boring Records

Laboratory Results

Field and Laboratory Procedures

Carey Station WRF
Greensboro, GA

USGS Topo Map 2020
Site Location Plan

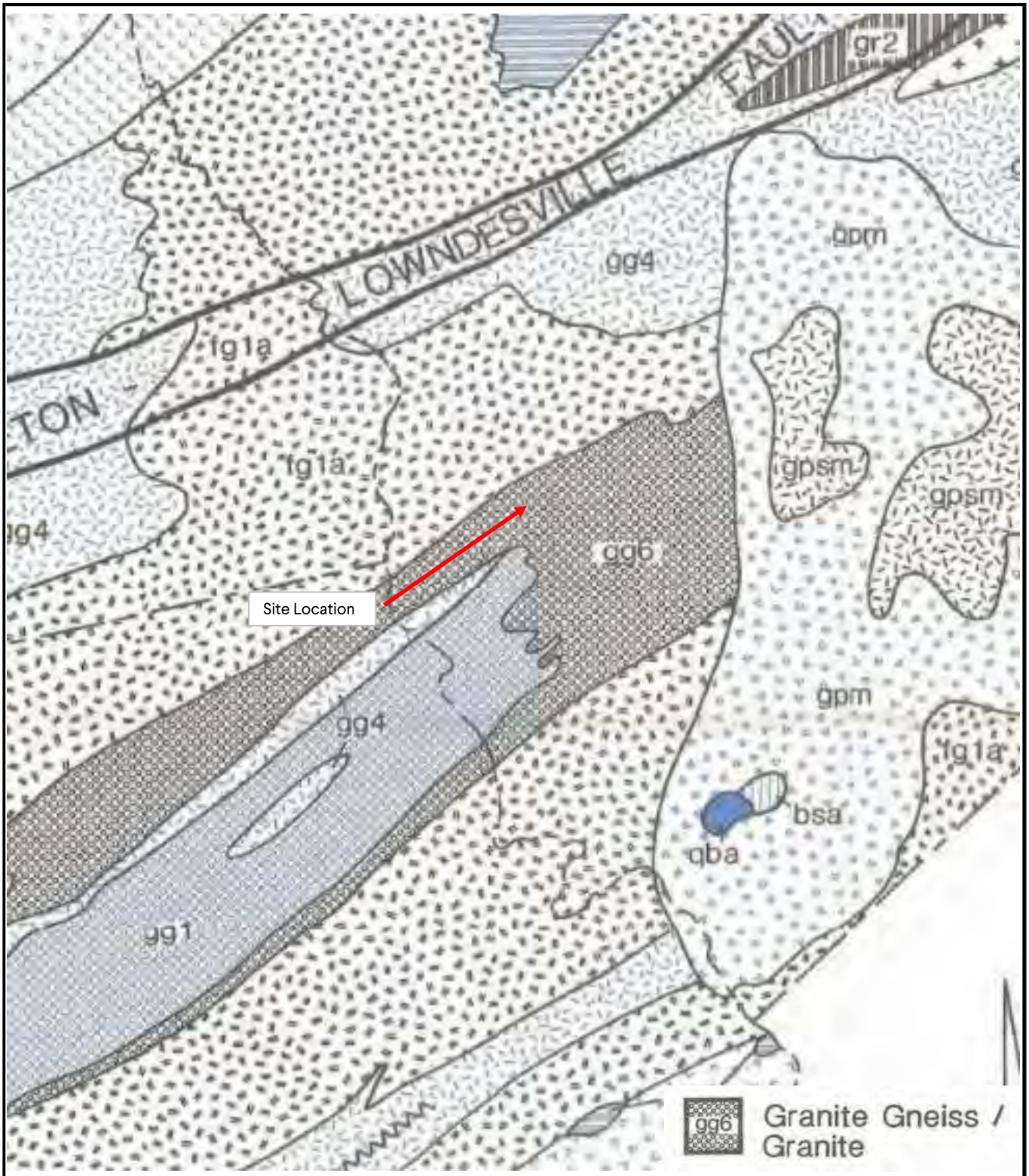
Figure 1

GMC# GAUG230004
4/2/2024
Drawn By: SWN

801 Broad St # 900
Augusta, GA 30901

Tel: (706) 303-3272
www.gmcnetwork.com

GMC



Carey Station WRF
Greensboro, GA

USGS Site Map

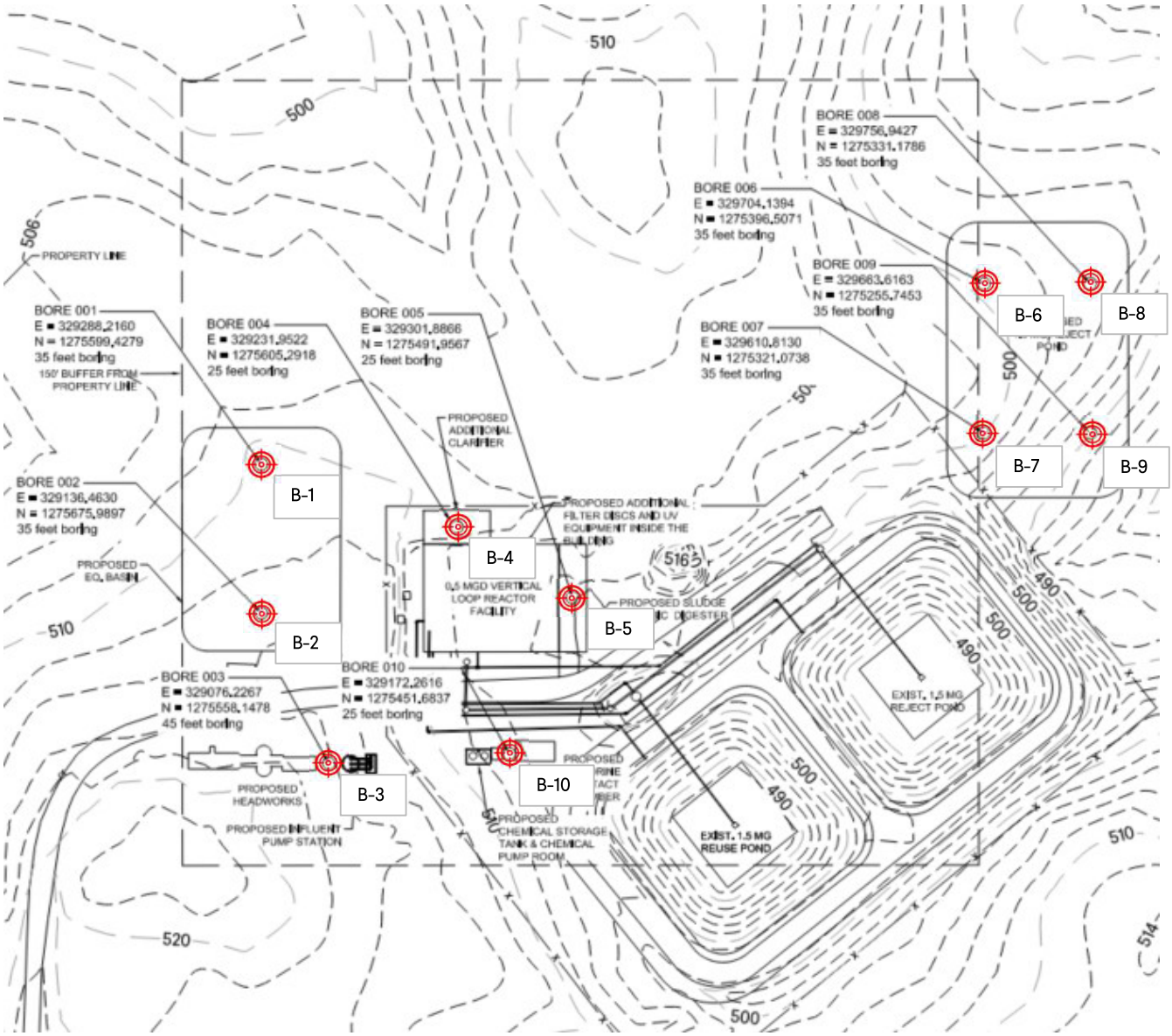
Figure 2

GMC# GAUG230004
4/2/2024
Drawn By: SWN

801 Broad St # 900
Augusta, GA 30901

Tel: (706) 303-3272
www.gmcnetwork.com

GMC



Carey Station WRF
Greensboro, GA

Boring Location Plan

Figure 3

GMC# GAUG230004
4/2/2024
Drawn By: SWN

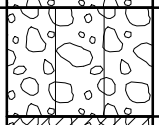
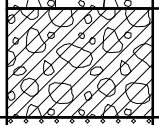
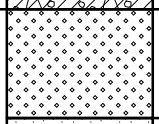
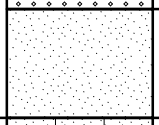
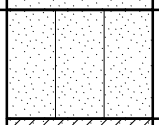
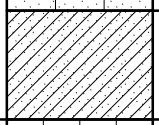
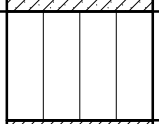
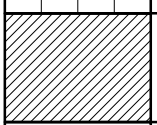
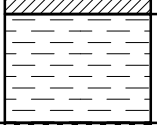
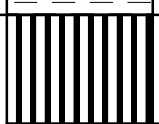
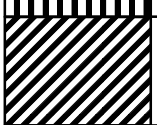
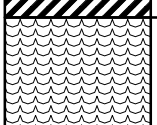
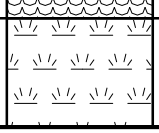
801 Broad St # 900
Augusta, GA 30901

Tel: (706) 303-3272
www.gmcnetwork.com

GMC

GMC

SOIL CLASSIFICATION CHART

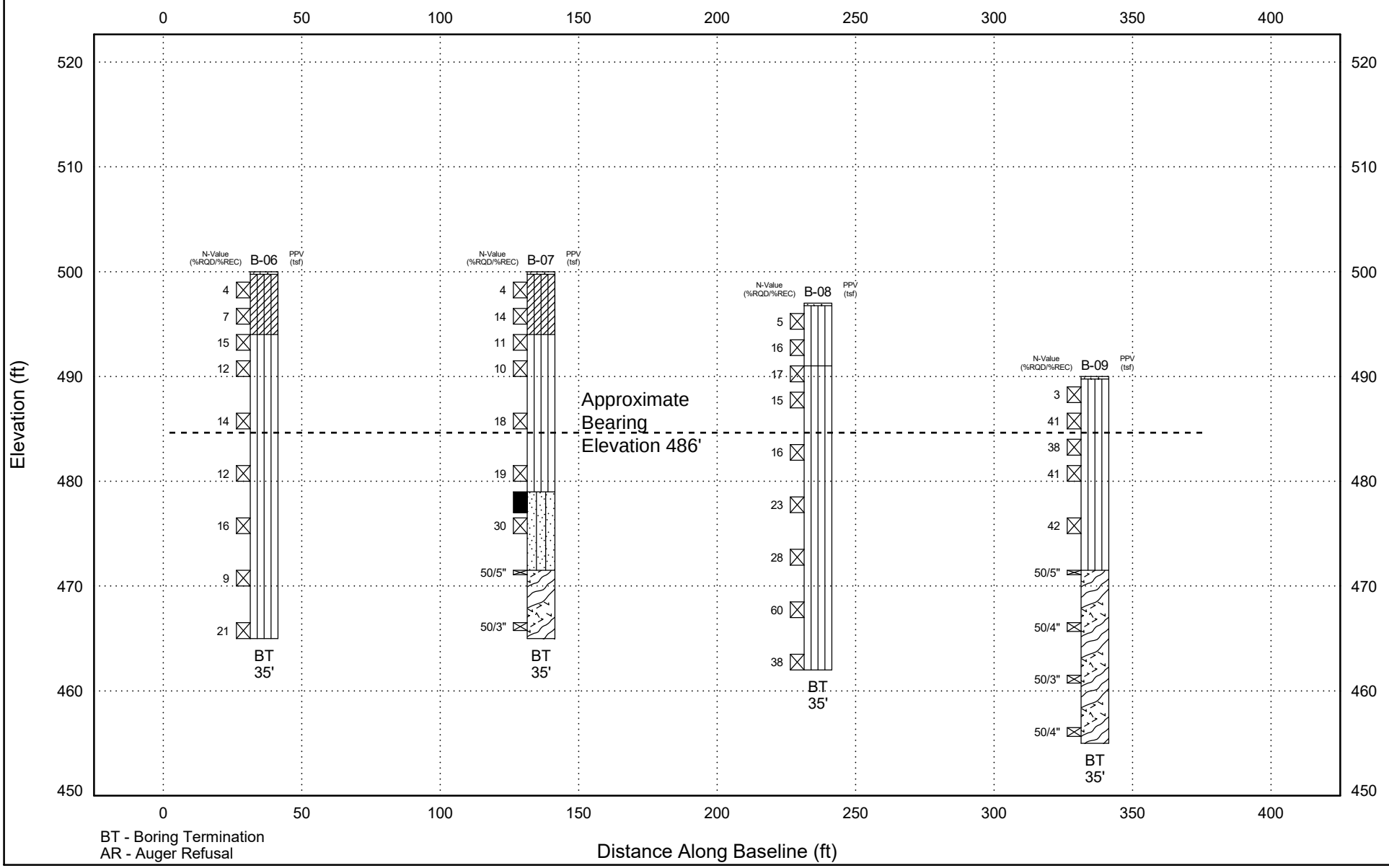
MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SUBSURFACE DIAGRAM A

TOPSOIL | ML-CL | ML | SM | GNEISS

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia



BT - Boring Termination
AR - Auger Refusal

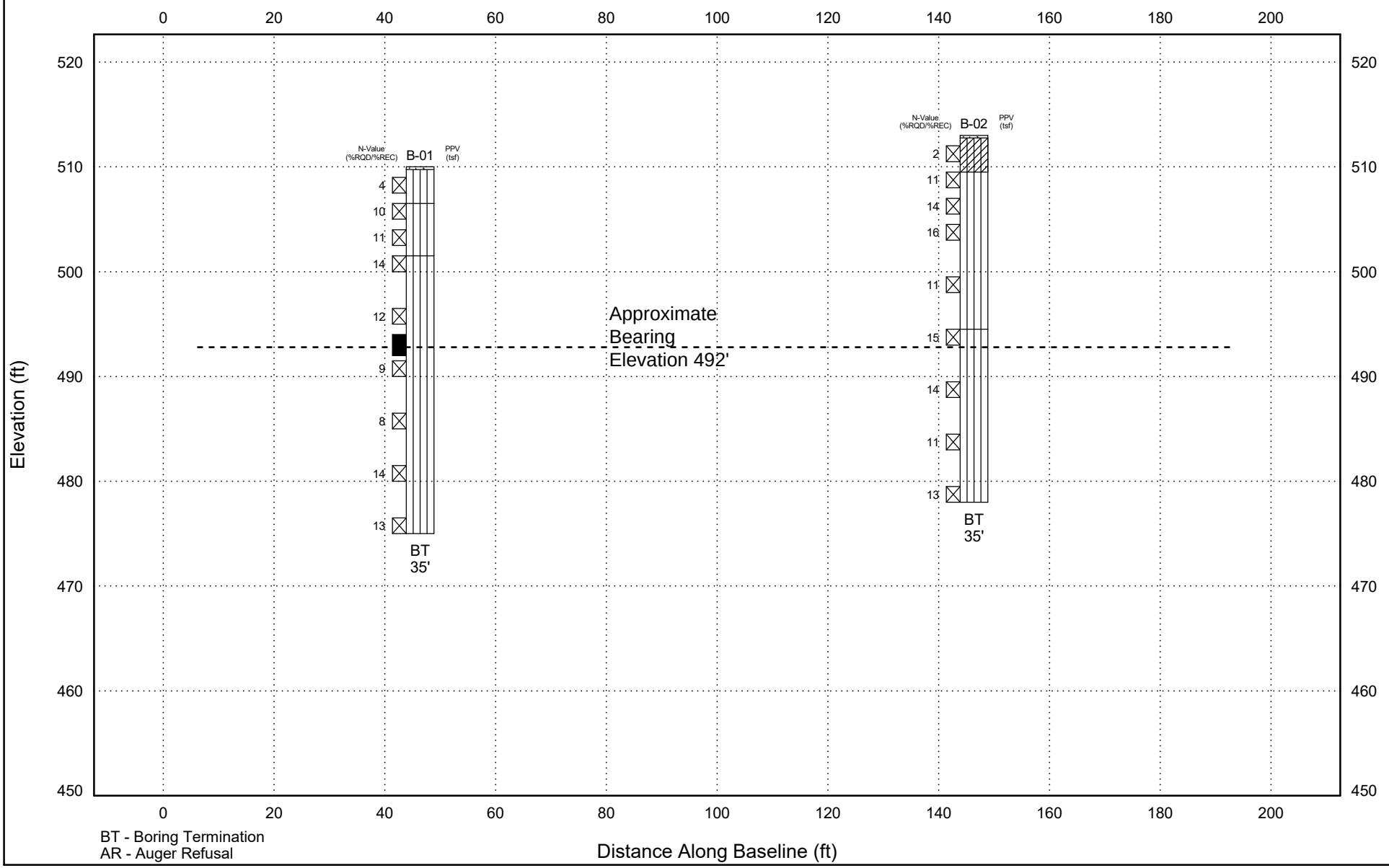
BT-AR DEPTH LOG CAREY STATION BORINGS.GPJ GMC DATA TEMPLATE.GDT 4/2/24

SUBSURFACE DIAGRAM B

TOPSOIL ML ML-CL

CLIENT Piedmont Water Company **PROJECT NAME** Carey Station Water Reuse Facility

PROJECT NUMBER GAUG230004 **PROJECT LOCATION** Greensboro, Georgia



BT - Boring Termination
AR - Auger Refusal

BT-AR DEPTH LOG CAREY STATION BORINGS.GPJ GMC DATA TEMPLATE.GDT 4/2/24

SUBSURFACE DIAGRAM C

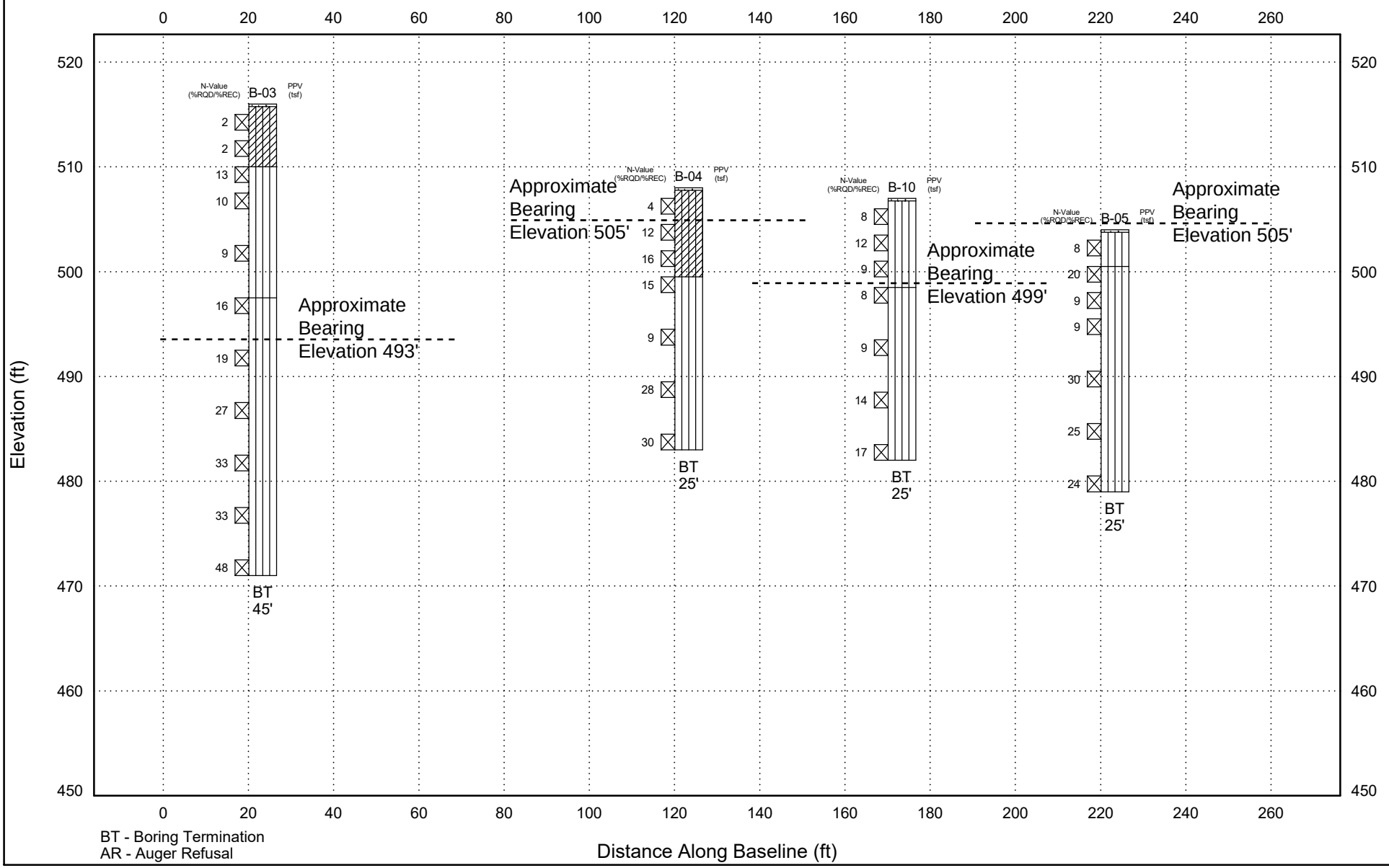
TOPSOIL | ML-CL | ML

CLIENT Piedmont Water Company

PROJECT NAME Carey Station Water Reuse Facility

PROJECT NUMBER GAUG230004

PROJECT LOCATION Greensboro, Georgia



BT - Boring Termination
AR - Auger Refusal

BT-AR DEPTH LOG CAREY STATION BORINGS.GPJ GMC DATA TEMPLATE.GDT 4/2/24

BORING NUMBER B-01

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 510 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
510	0		Organic Laden Material (OLM) - 3 inches										
			SILT (ML), brown, medium to very stiff	SS		1-2-2 (4)							
			, light brown and gray	SS		3-5-5 (10)							
				SS		6-5-6 (11)							
500	10		, brown and light brown	SS		6-7-7 (14)							
				SS		5-6-6 (12)							
				ST						38	27	11	62
490	20			SS		4-5-4 (9)							
				SS		3-4-4 (8)							
480	30			SS		6-7-7 (14)							
				SS		7-6-7 (13)							
			Boring was terminated at 35.0 feet.										
470	40												
460	50												

BORING NUMBER B-02

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 513 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
	0		Organic Laden Material (OLM)- 3 inches										
510			SILTY CLAY (ML-CL), red, very soft	SS		1-1-1 (2)							
			SANDY SILT (ML), light brown, medium to stiff	SS		6-5-6 (11)							
				SS		6-7-7 (14)							
	10			SS		7-9-7 (16)							
500				SS		6-5-6 (11)							
	20		, light brown and gray	SS		6-7-8 (15)							
490				SS		8-7-7 (14)							
	30			SS		6-5-6 (11)							
480				SS		7-6-7 (13)							
			Boring was terminated at 35.0 feet.										
	40												
470													
	50												

BORING NUMBER B-03

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 516 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
	0		Organic Laden Material (OLM)- 3 inches										
			SILTY CLAY (ML-CL), red, very soft	SS		1-1-1 (2)							
				SS		1-1-1 (2)							
510			SANDY SILT (ML), brown, medium to hard	SS		4-6-7 (13)							
	10			SS		4-5-5 (10)							
				SS		4-4-5 (9)							
500													
	20		, light brown and gray	SS		5-7-9 (16)							
				SS		7-9-10 (19)							
490													
	30			SS		8-12-15 (27)							
				SS		5-14-19 (33)							
480													
	40			SS		13-18-15 (33)							
				SS		13-20-28 (48)							
470			Boring was terminated at 45.0 feet.										
	50												

BORING NUMBER B-04

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 508 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
	0		Organic Laden Material (OLM)- 2 inches										
			SILTY CLAY (ML-CL), red, medium to stiff	SS		3-2-2 (4)							
				SS		3-5-7 (12)							
500				SS		5-7-9 (16)							
	10		SANDY SILT (ML), brown, medium to hard	SS		7-7-8 (15)							
				SS		5-4-5 (9)							
490													
	20			SS		12-14-14 (28)							
				SS		10-15-15 (30)							
			Boring was terminated at 25.0 feet.										
480													
	30												
470													
	40												
460													
	50												

BORING NUMBER B-05

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 504 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
	0		Organic Laden Material (OLM)- 1 inch										
			SANDY SILT (ML), red, medium to hard	SS		6-4-4 (8)							
500			, brown and light brown	SS		6-9-11 (20)							
				SS		4-4-5 (9)							
	10			SS		4-5-4 (9)							
490				SS		11-15-15 (30)							
	20			SS		8-10-15 (25)							
480				SS		9-11-13 (24)							
			Boring was terminated at 25.0 feet.										
	30												
470													
	40												
460													
	50												

BORING NUMBER B-06

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 500 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
500	0		Organic Laden Material (OLM)- 3 inches										
			SILTY CLAY (ML-CL), red, medium to stiff	SS		2-2-2 (4)							
				SS		3-3-4 (7)							
			SANDY SILT (ML), light brown, stiff to very stiff	SS		7-7-8 (15)							
490	10			SS		6-6-6 (12)							
				SS		5-6-8 (14)							
480	20			SS		5-6-6 (12)							
				SS		7-7-9 (16)							
470	30			SS		5-4-5 (9)							
				SS		8-9-12 (21)							
			Boring was terminated at 35.0 feet.										
460	40												
450	50												

BORING NUMBER B-07

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 500 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
500	0		Organic Laden Material (OLM)- 4 inches										
			SILTY CLAY (ML-CL), red, medium to stiff	SS		2-2-2 (4)							
				SS		6-7-7 (14)							
			SANDY SILT (ML), light brown, stiff to very stiff	SS		5-6-5 (11)							
490	10			SS		5-5-5 (10)							
				SS		7-8-10 (18)							
480	20			SS		7-9-10 (19)							
			SILTY SAND (SM), gray, medium	ST						32	27	5	45
				SS		10-13-17 (30)							
470	30		PARTIALLY WEATHERED ROCK - Sampled as POORLY GRADED SAND with SILT (SP-SM), gray, very dense	SS		50/5"							
				SS		10-50/3"							
			Boring was terminated at 35.0 feet.										
460	40												
450	50												

BORING NUMBER B-08

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 497 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
	0		Organic Laden Material (OLM)- 3 inches										
			SANDY SILT (ML), brown, medium to very stiff	SS		3-3-2 (5)							
				SS		10-9-7 (16)							
490			, light brown, stiff to hard	SS		8-10-7 (17)							
	10			SS		7-7-8 (15)							
				SS		6-7-9 (16)							
480													
	20			SS		8-10-13 (23)							
				SS		10-13-15 (28)							
470													
	30			SS		14-28-32 (60)							
				SS		14-17-21 (38)							
460			Boring was terminated at 35.0 feet.										
	40												
450													
	50												

BORING NUMBER B-09

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 490 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
490	0		Organic Laden Material (OLM)- 4 inches										
			SANDY SILT (ML), light brown, soft to hard	SS		1-1-2 (3)							
				SS		12-23-18 (41)							
				SS		14-19-19 (38)							
480	10			SS		13-19-22 (41)							
				SS		10-19-23 (42)							
470	20		PARTIALLY WEATHERED ROCK - Sampled as POORLY GRADED SAND with SILT (SP-SM), light brown, very dense	SS		50/5"							
				SS		27-50/4"							
460	30			SS		25-50/3"							
				SS		30-50/4"							
			Boring was terminated at 35.0 feet.										
450	40												
440	50												

BORING NUMBER B-10

CLIENT Piedmont Water Company
PROJECT NAME Carey Station Water Reuse Facility
PROJECT NUMBER GAUG230004
PROJECT LOCATION Greensboro, Georgia
DATE STARTED 2/20/24 **COMPLETED** 2/20/24
GROUND ELEVATION 507 ft **HOLE SIZE** 3.25"
DRILLING CONTRACTOR Premier Drilling
GROUND WATER LEVELS:
DRILLING METHOD CME 550 ATV, Auto-Hammer, HSA w/ SPT
AT TIME OF DRILLING Not Encountered
LOGGED BY S. Nickerson **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
	0		Organic Laden Material (OLM)- 2 inches										
			SANDY SILT (ML), brown, medium to very stiff	SS		3-4-4 (8)							
				SS		6-6-6 (12)							
500				SS		3-4-5 (9)							
	10		, light brown	SS		4-4-4 (8)							
				SS		4-5-4 (9)							
490													
	20			SS		6-7-7 (14)							
				SS		9-8-9 (17)							
480			Boring was terminated at 25.0 feet.										
	30												
470													
	40												
460													
	50												

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project :	Goodwin Mills- Laboratory Testing							
Date:	3/28/2024			Panel Number :	P-1			
Project No. :	EN231257				Permometer Data			
Boring No.:	B-001	a_p =	0.031416 cm^2		Set Mercury to Pipet Rp at beginning	Equilibrium	1.6	cm^3
Sample:	N/A	a_a =	0.767120 cm^2			Pipet **Rp**	**18.2**	cm^3
Depth (ft):	16.0-18.0	M_1 =	0.030180	C =	0.0004653	Annulus **Ra**	0.9	cm^3
Other Location:	Tube	M_2 =	1.040953	T =	0.0602682			

Material Description : Sandy Silt

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			634.51	g	Tare No.:	TTYL	Tare No.:	X
Tare or ring Wt. :			0.0	g	Wet Wt.+tare:	113.61	Wet Wt.+tare:	303.66
Wet Wt: of Sample :			634.51	g	Dry Wt.+tare:	103.84	Dry Wt.+tare:	251.29
Diameter :	2.81	in	7.14	cm^2	Tare Wt:	52.51	Tare Wt:	0.00
Length :	3.06	in	7.77	cm	Dry Wt.:	51.33	Dry Wt.:	251.29
Area:	6.20	in^2	40.01	cm^2	Water Wt.:	9.77	Water Wt.:	52.37
Volume :	18.98	in^3	310.97	cm^3	% moist.:	**19.0**	% moist.:	**20.8**
Unit Wt.(wet):	**127.32**	pcf	**2.04**	g/cm^3				
Unit Wt.(dry):	**106.96**	pcf	**1.71**	g/cm^3				

Assumed Specific Gravity: **2.70** Max Dry Density(pcf) = OMC =
% of max = +/- OMC =
Calculated % saturation: 97.71 Void ratio (e) = **0.58** Porosity (n)= **0.37**

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 Back Pressure (psi) = 50.00 Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 17.3 cm Hydraulic Gradient = 28.00

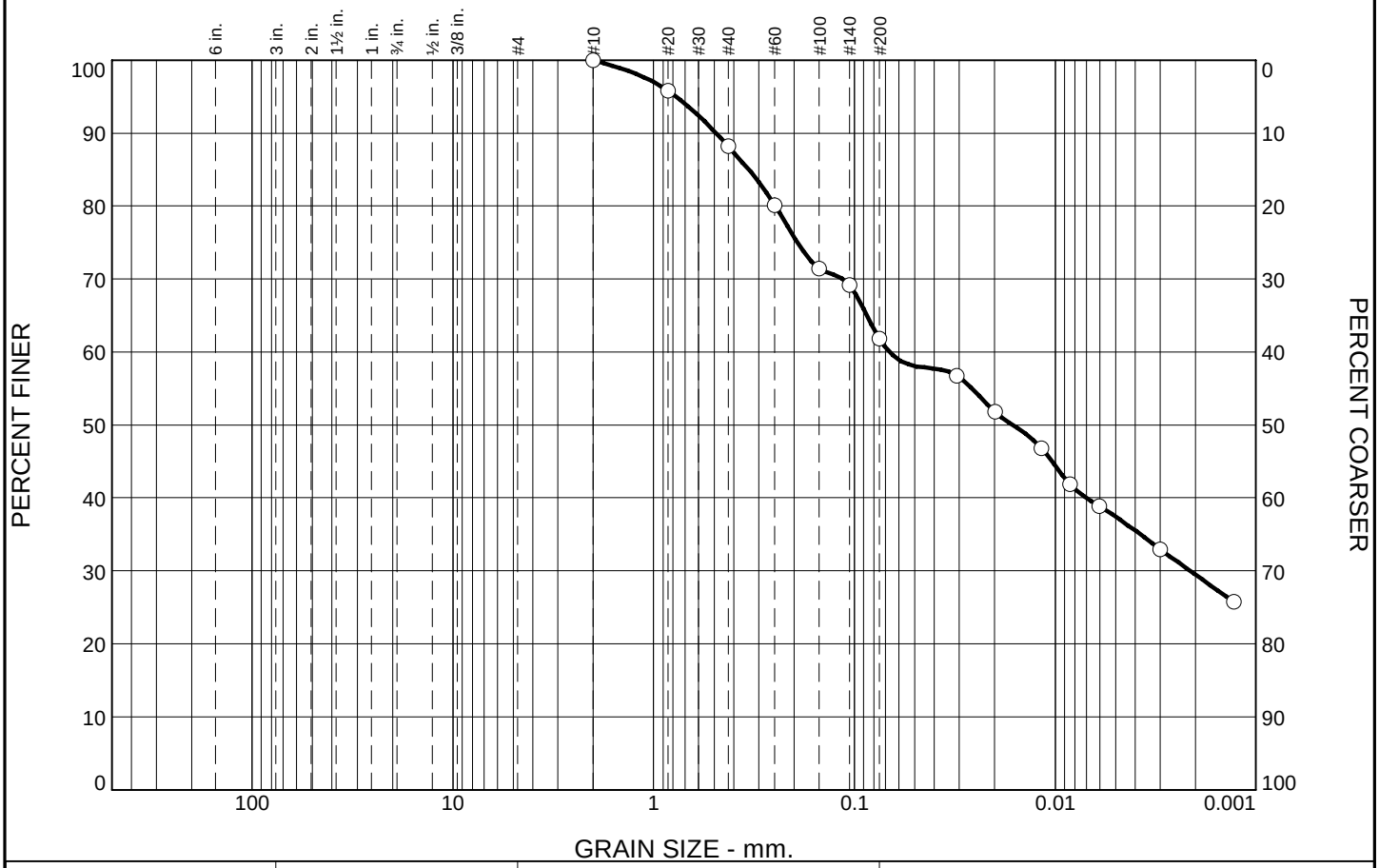
Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
3/4/2024	120	16.3	1.892485	21	0.977	4.59E-07	1.30E-03	
3/4/2024	240	15	3.192485	21	0.977	4.05E-07	1.15E-03	
3/4/2024	360	14	4.192485	21	0.977	3.68E-07	1.04E-03	
3/4/2024	480	12.5	5.692485	21	0.977	3.98E-07	1.13E-03	

SUMMARY

k_a =	4.07E-07 cm/sec			Acceptance criteria =	50 %
ki		Vm			
k1 =	4.59E-07 cm/sec	12.6	%	Vm =	$\frac{\lvert k_a - k_i \rvert}{k_a} \times 100$
k2 =	4.05E-07 cm/sec	0.6	%		
k3 =	3.68E-07 cm/sec	9.7	%		
k4 =	3.98E-07 cm/sec	2.3	%		

Hydraulic conductivity	k =	**4.07E-07**	cm/sec	**1.15E-03**	ft/day
Void Ratio	e =	**0.58**			
Porosity	n =	**0.37**			
Bulk Density	γ =	**2.04**	g/cm^3	**127.3**	pcf
Water Content	W =	**0.33**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**4.17E-12**	cm^2	(at 20 deg C)	

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	11.8	26.4	24.4	37.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	95.8		
#40	88.2		
#60	80.1		
#100	71.5		
#140	69.1		
#200	61.8		
0.0310 mm.	56.8		
0.0200 mm.	51.8		
0.0117 mm.	46.8		
0.0084 mm.	41.9		
0.0060 mm.	38.9		
0.0030 mm.	33.0		
0.0013 mm.	25.8		

* (no specification provided)

Soil Description

sandy silt

Atterberg Limits

PL= 27 LL= 38 PI= 11

Coefficients

D_{90}= 0.4902 D_{85}= 0.3365 D_{60}= 0.0669
D_{50}= 0.0163 D_{30}= 0.0021 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-6(6)

Remarks

F.M.=0.55

Source of Sample: Goodwyn Mills Testing **Depth:** 16.0-18.0 ft
Sample Number: B-001 **Date:** 3/28/24

Terracon Consultants, Inc.

Client: Goodwyn Mills Cawood
Project: Goodwyn Mills-Laboratory Testing

Project No: EN231257

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project :	Goodwin Mills- Laboratory Testing							
Date:	3/28/2024			Panel Number :	P-1			
Project No. :	EN231257				Permometer Data			
Boring No.:	B-007	a_p =	0.031416 cm^2		**Set Mercury to Pipet Rp at beginning**	Equilibrium	1.6	cm^3
Sample:	N/A	a_a =	0.767120 cm^2			Pipet **Rp**	**10.4**	cm^3
Depth (ft):	21.0-23.0	M_1 =	0.030180	C =	0.0002343	Annulus **Ra**	1.2	cm^3
Other Location:	Tube	M_2 =	1.040953	T =	0.1131416			
Material Description :	Silty Sand							

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			351.30	g	Tare No.:	CH4	Tare No.:	X
Tare or ring Wt. :			0.0	g	Wet Wt.+tare:	268.45	Wet Wt.+tare:	199.87
Wet Wt: of Sample :			351.30	g	Dry Wt.+tare:	248.89	Dry Wt.+tare:	169.99
Diameter :	2.89	in	7.34	cm^2	Tare Wt:	52.70	Tare Wt:	0.00
Length :	1.63	in	4.14	cm	Dry Wt.:	196.19	Dry Wt.:	169.99
Area:	6.56	in^2	42.32	cm^2	Water Wt.:	19.56	Water Wt.:	29.88
Volume :	10.69	in^3	175.22	cm^3	% moist.:	**10.0**	% moist.:	**17.6**
Unit Wt.(wet):	**125.11**	pcf	**2.00**	g/cm^3				
Unit Wt.(dry):	**113.77**	pcf	**1.82**	g/cm^3				

Assumed Specific Gravity:	**2.70**	Max Dry Density(pcf) =		OMC =	
		% of max =		+/- OMC =	
Calculated % saturation:	98.54	Void ratio (e) =	**0.48**	Porosity (n)=	**0.33**

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 Back Pressure (psi) = 50.00 Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 9.2 cm Hydraulic Gradient = 28.00

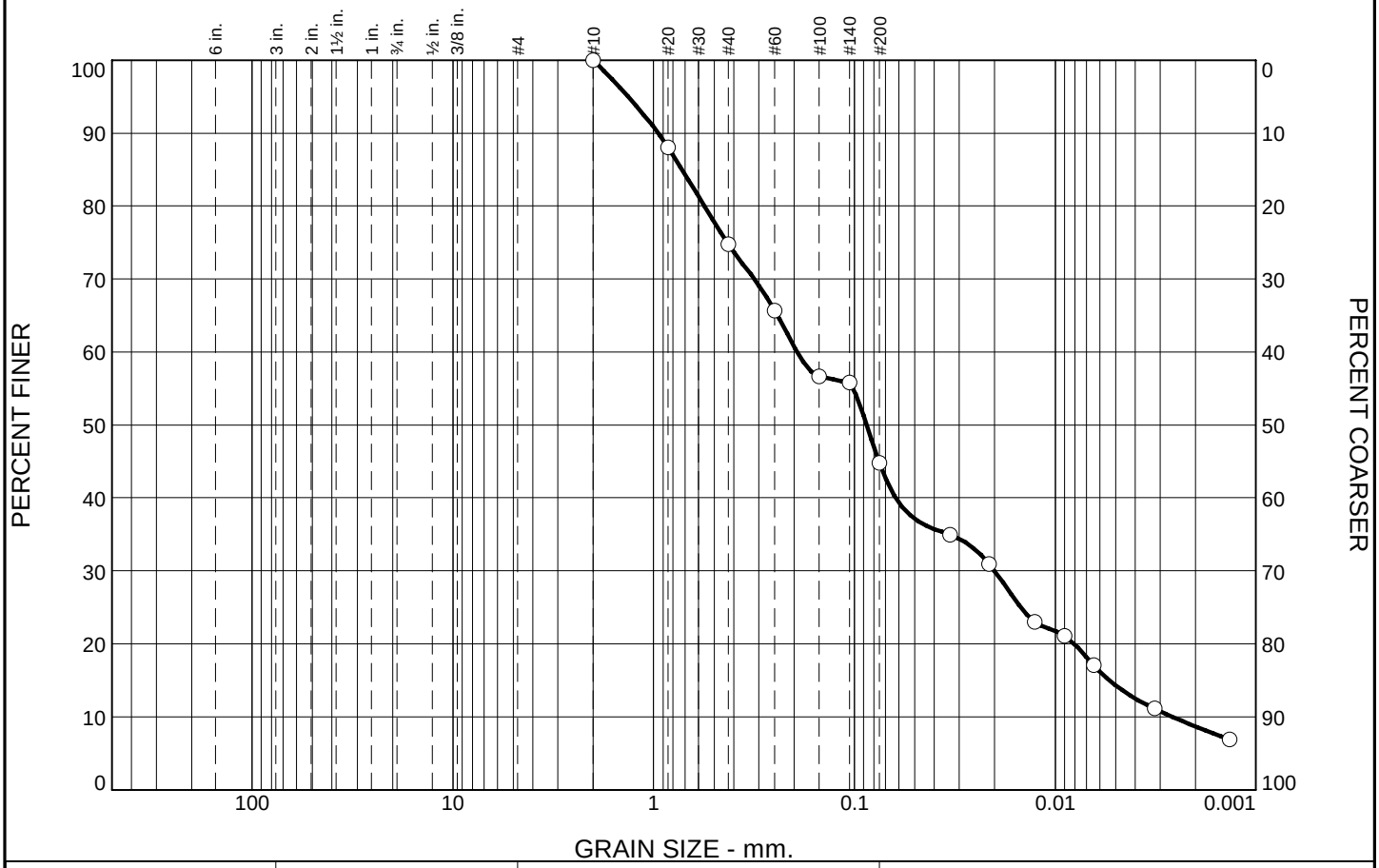
Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
3/4/2024	30	9.3	1.138481	21	0.977	1.05E-06	2.98E-03	
3/4/2024	60	8.8	1.638481	21	0.977	7.82E-07	2.22E-03	
3/4/2024	90	8	2.438481	21	0.977	8.21E-07	2.33E-03	
3/4/2024	120	7.3	3.138481	21	0.977	8.37E-07	2.37E-03	

SUMMARY

k_a =	8.73E-07	cm/sec		Acceptance criteria =	50 %
ki			Vm		
k1 =	1.05E-06	cm/sec	20.5	%	Vm = $\frac{\lvert k_a - k_i \rvert}{k_a} \times 100$
k2 =	7.82E-07	cm/sec	10.4	%	
k3 =	8.21E-07	cm/sec	6.0	%	
k4 =	8.37E-07	cm/sec	4.2	%	

Hydraulic conductivity	k =	**8.73E-07**	cm/sec	**2.47E-03**	ft/day
Void Ratio	e =	**0.48**			
Porosity	n =	**0.33**			
Bulk Density	γ =	**2.00**	g/cm^3	**125.1**	pcf
Water Content	W =	**0.18**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**8.94E-12**	cm^2	(at 20 deg C)	

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	25.2	30.0	30.5	14.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	88.1		
#40	74.8		
#60	65.7		
#100	56.6		
#140	55.8		
#200	44.8		
0.0334 mm.	35.0		
0.0214 mm.	31.0		
0.0127 mm.	23.0		
0.0090 mm.	21.1		
0.0064 mm.	17.0		
0.0032 mm.	11.1		
0.0014 mm.	6.9		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= 27 LL= 32 PI= 5

Coefficients

D_{90}= 0.9513 D_{85}= 0.7209 D_{60}= 0.1932
D_{50}= 0.0868 D_{30}= 0.0201 D_{15}= 0.0054
D_{10}= 0.0026 C_u= 73.85 C_c= 0.80

Classification

USCS= SM AASHTO= A-4(0)

Remarks

F.M.=1.00

Source of Sample: Goodwyn Mills Testing **Depth:** 21.0-23.0 ft
Sample Number: B-007 **Date:** 3/28/24

Terracon Consultants, Inc.

Client: Goodwyn Mills Cawood
Project: Goodwyn Mills-Laboratory Testing

Project No: EN231257

GMC

FIELD TEST PROCEDURES

General

The general field procedures employed by Goodwyn Mills Cawood, LLC (GMC), are summarized in the American Society for Testing and Materials (ASTM) Standard D420 which is entitled "Investigating and Sampling Soil and Rock". This recommended practice lists recognized methods for determining soil and rock distribution and groundwater conditions. These methods include geophysical and in-situ methods as well as borings.

The detailed collection methods used during this exploration are presented in the following paragraphs.

Standard Drilling Techniques

General: To obtain subsurface samples, borings are drilled using one of several alternate techniques depending upon the subsurface conditions. These techniques are as follows:

In Soils:

a) Continuous hollow stem augers.
b) Rotary borings using roller cone bits or drag bits, and water or drilling mud to flush the hole.
c) "Hand" augers.

In Rock:

a) Core drilling with diamond-faced, double or triple tube core barrels.
b) Core boring with roller cone bits.

Hollow Stem Auger: A hollow stem augers consists of a hollow steel tube with a continuous exterior spiral flange termed a flight. The auger is turned into the ground, returning the cuttings along the flights. The hollow center permits a variety of sampling and testing tools to be used without removing the auger.

Rotary Borings: Rotary drilling involves the use of roller cone or drag type drill bits attached to the end of drill rods. A flushing medium, normally water or bentonite slurry, is pumped through the rods to clear the cuttings from the bit face and flush them to the surface. Casing is sometimes set behind the advancing bit to prevent the hole from collapsing and to restrict the penetration of the drilling fluid into the surrounding soils. Cuttings returned to the surface by the drilling fluid are typically collected in a settling tank, to allow the fluid to be recirculated.

Hand Auger Boring: Hand auger borings are advanced by manually twisting a 4" diameter steel bucket auger into the ground and withdrawing it when filled to observe the sample collected. Posthole diggers are sometimes used in lieu of augers to obtain shallow soil samples. Occasionally these hand auger borings are used for driving 3-inch diameter steel tubes to obtain intact soil samples.

Core Drilling: Soil drilling methods are not normally capable of penetrating through hard cemeted soil, weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound, continuous rock. Material that cannot be penetrated by auger or rotary soil-drilling methods at a reasonable rate is designated as "refusal material". Core drilling procedures are required to penetrate and sample refusal materials.

Prior to coring, casing may be set in the drilled hole through the overburden soils, to keep the hole from caving and to prevent excessive water loss. The refusal materials are then cored according to ASTM D2113 using a diamond studded bit fastened to the end of a hollow, double or triple tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run,

the core barrel is brought to the surface, the core recovery is measured, and the core is placed, in sequence, in boxes for storage and transported to our laboratory.

Sampling and Testing in Boreholes

General: Several techniques are used to obtain samples and data in soils; however, the most common methods in this area are:

a) Standard Penetrating Testing
b) Water Level Readings

These procedures are presented below. Any additional testing techniques employed during this exploration are contained in other sections of the Appendix.

Standard Penetration Testing: At regular intervals, the drilling tools are removed and soil samples obtained with a standard 2-inch diameter split tube sampler connected to an A or N-size rod. The sampler is first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140-pound safety hammer falling 30 inches. Generally, the number of hammer blows required to drive the sampler the final 12 inches is designated the "penetration resistance" or "N" value, in blows per foot (bpf). The split barrel sampler is designed to retain the soil penetrated, so that it may be returned to the surface for observation. Representative portions of the soil samples obtained from each split barrel sample are placed in jars, sealed and transported to our laboratory.

The standard penetration test, when properly evaluated, provides an indication of the soil strength and compressibility. The tests are conducted according to ASTM Standard D1586. The depths and N-values of standard penetration tests are shown on the Boring Records. Split barrel samples are suitable for visual observation and classification tests but are not sufficiently intact for quantitative laboratory testing.

Water Level Readings: Water table readings are normally taken in the borings and are recorded on the Boring Records. In sandy soils, these readings indicate the approximate location of the hydrostatic water table at the time of our field exploration. In clayey soils, the rate of water seepage into the borings is low and it is generally not possible to establish the location of the hydrostatic water table through short-term water level readings. Also, fluctuation in the water table should be expected with variations in precipitation, surface run-off, evaporation, and other factors. For long-term monitoring of water levels, it is necessary to install piezometers.

The water levels reported on the Boring Records are determined by field crews immediately after the drilling tools are removed, and several hours after the borings are completed, if possible. The time lag is intended to permit stabilization of the groundwater table, which may have been disrupted by the drilling operation.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the cave-in zone. The cave-in depth is measured and recorded on the Boring Records.

Boring Records

The subsurface conditions encountered during drilling are reported on a field boring record prepared by the Driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of coarse gravel, cobbles, etc., and observations of ground water. It also contains the driller's interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are kept on file in our office.

After the drilling is completed, a geotechnical professional classifies the soil samples and prepares the final Boring Records, which are the basis for all evaluations and recommendations. The following terms are taken

from ASTM D2487 or Deere's Technical Description of Rock Cores for Engineering Purposes, Rock Mechanical Engineering Geology 1, pp. 18-22.

Relative Density of Cohesionless Soils From Standard Penetration Test	
Very Loose	‹ 4 bpf
Loose	5 - 10 bpf
Medium	11 – 30 bpf
Dense	31 - 50 bpf
Very Dense	› 50 bpf
(bpf = blows per foot, ASTM D 1586)	

Consistency of Cohesive Soils	
Very Soft	‹ 2 bpf
Soft	3 - 4 bpf
Medium	5 - 8 bpf
Stiff	9 - 15 bpf
Very Stiff	16 - 30 bpf
Hard	› 30 bpf

Relative Hardness of Rock
Very Soft Rock disintegrates or easily compresses to touch; can be hard to very hard soil.
Soft Rock may be broken with fingers.
Moderately Soft Rock may be scratched with a nail, corners and edges may be broken with fingers.
Moderately Hard Rock a light blow of hammer is required to break samples.
Hard Rock a hard blow of hammer is required to break sample.

Particle Size Identification	
Boulders	Larger than 12"
Cobbles	3" - 12"
Gravel	
Coarse	3/4" - 3"
Fine	4.76mm - 3/4"
Sand	
Coarse	2.0 - 4.76 mm
Medium	0.42 - 2.00 mm
Fine	0.42 - 0.074 mm
Fines (Silt or Clay)	Smaller than 0.074 mm

Rock Continuity

RECOVERY = $\frac{\text{Total Length of Core}}{\text{Length of Core Run}}$ x 100 %

Description	Core Recovery %
Incompetent	Less than 40
Competent	40 - 70
Fairly Continuous	71 - 90
Continuous	91 - 100

Relative Quality of Rocks

RQD = $\frac{\text{Total core, counting only pieces › 4" long}}{\text{Length of Core Run}}$ x 100 %

Description	RQD %
Very Poor	0 - 25 %
Poor	25 - 50 %
Fair	50 - 75 %
Good	75 - 90 %
Excellent	90 - 100 %

LABORATORY TESTING

GENERAL

The laboratory testing procedures employed by Goodwyn Mills Cawood, LLC (GMC) are in general accordance with ASTM standard methods and other applicable specifications.

Several test methods, described together with others in this Appendix, were used during the course of this exploration. The Laboratory Data Summary sheet indicates the specific tests performed.

SOIL CLASSIFICATION

Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Boring Records".

The classification system discussed above is primarily qualitative and for detailed soil classification, two laboratory tests are commonly performed: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D-2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

ATTERBERG LIMITS

Liquid Limit (LL), Plastic Limit (PL) and Shrinkage Limit (SL) tests are performed to aid in the classification of soils and to determine the plasticity and volume change characteristics of the materials. The Liquid Limit is the minimum moisture content at which a soil will flow as a heavy viscous fluid. The Plastic Limit is the minimum moisture content at which the soil behaves as a plastic material. The Shrinkage Limit is the moisture content below which no further volume change will take place with continued drying. The Plasticity Index (PI) is the numeric difference of Liquid Limit and Plastic Limit and indicates the range of moisture content over which a soil remains plastic. These tests are performed in accordance with ASTM D4318, D4943 and D427.

PARTICLE SIZE DISTRIBUTION

The distribution of soils coarser than the No. 200 (75-mm) sieve is determined by passing a representative specimen through a standard set of nested sieves. The weight of material retained on each sieve is determined and the percentage retained (or passing) is calculated.

A specimen may be washed through only the No. 200 sieve, if the full range of particle sizes is not required. The percentage of material passing the No. 200 sieve is reported.

The distribution of materials finer than the No. 200 sieve is determined by use of a hydrometer. The particle sizes and distribution are computed from the time rate of settlement of the different size particles while suspended in water. These tests are performed in accordance with ASTM D-421, D-422 and D-1140.

PERMEABILITY TEST

The permeability test is used to measure the ease with which water will flow through soils, such as seepage through liners or under dams, the squeezing out of water from the soil by the application of load and drainage of subgrades, dams and backfills.

The permeability test is conducted on undisturbed or remolded samples. Samples are trimmed to 1.4 or 2.85 inches in diameter and are variable heights. The samples are molded or trimmed and placed in a ring and placed between porous plates. Water is forced to flow through the sample and the rate of flow is determined.

Two methods of permeability are used, depending on the grain size of soils.

Constant head method is used for granular soil per ASTM D-2434.

Falling head method is used for fine grained soil per ASTM D-5084.