

REFERENCE DOCUMENTS
FIGURE 1
100% DESIGN AND TECHNICAL SPECIFICATIONS
FOR
AQUIFER RECHARGE AT FLATFORD SWAMP IN MANATEE COUNTY, FLORIDA
BID NUMBER RFB 2001

**AQUIFER RECHARGE AT FLATFORD SWAMP
(H089)**

**BIDDING AND CONSTRUCTION
TECHNICAL SPECIFICATIONS**

Project No. 19850-041-01

Owner:

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
2379 Broad Street
Brooksville, Florida 34604-6899

Engineer:

JONES EDMUNDS & ASSOCIATES, INC.
730 NE Waldo Road
Gainesville, Florida 32641

Professional Engineering Certificate of Authorization #1841
Geology Business #GB133

October 2019

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DIVISION 1

GENERAL REQUIREMENTS

SECTION 01000
PROJECT REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Work to be done consists of the furnishing of all labor, materials, and equipment and the performance of all Work included in this Contract. The summary of the Work is presented in Section 01100, Summary of Work.
- B. Work Included
 - 1. The Contractor shall furnish all labor, superintendence, materials, power, light, heat, fuel, water, tools, appliances, equipment, supplies, and means of construction necessary for proper performance and completion of the Work. The Contractor shall obtain and pay for all necessary local building permits. The Contractor shall perform and complete the Work in the manner best calculated to promote rapid construction consistent with safety of life and property and to the satisfaction of the Engineer and in strict accordance with the Contract Documents. The Contractor shall clean up the Work and maintain it during and after construction, until accepted, and shall do all Work and pay all costs incidental thereto. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the Work.
 - 2. The cost of incidental work described in these Project Requirements for which there are no specific Contract Items shall be considered as part of the general cost of doing the Work and shall be included in the prices for the various Contract Items. No additional payment will be made therefore.
 - 3. The Contractor shall provide and maintain such modern tools and equipment as may be necessary, in the opinion of the Engineer, to perform in a satisfactory and acceptable manner all the Work required by this Contract. Only equipment of established reputation and proven efficiency shall be used. The Contractor shall be solely responsible for the adequacy of his workmanship, materials, and equipment, prior approval of the Engineer notwithstanding.
- C. Public Utility Installations and Structures
 - 1. Public utility installations and structures shall be understood to include all poles, tracks, pipes, wires, conduits, vaults, manholes, and all other appurtenances and facilities pertaining thereto whether owned or controlled by the Owner, other governmental bodies, or privately owned

by individuals, firms, or corporations used to serve the public with transportation, traffic control, gas, electricity, telephone, sewerage, drainage, water, or other public or private property which may be affected by the Work shall be deemed included hereunder.

- a. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. These data are not guaranteed as to their completeness or accuracy and it is the responsibility of the Contractor to make his own investigations to inform himself fully of the character, condition, and extent of all such installations and structures as may be encountered and as may affect the construction operations.
- b. The Contractor shall protect all public utility installations and structures from damage during the Work. Access across any buried public utility installation or structure shall be made to avoid any damage to these facilities. All required protective devices and construction shall be provided by the Contractor at his expense. All existing public utilities damaged by the Contractor shall be repaired by the Contractor, at his expense. No separate payment shall be made for such protection or repairs to public utility installations or structures.
- c. Public utility installations or structures owned or controlled by the Owner or other governmental body which are shown on the Drawings to be removed, relocated, replaced, or rebuilt by the Contractor shall be considered as a part of the general cost of doing the Work and shall be included in the prices bid for the various Contract Items. No separate payment shall be made therefor.
- d. Where public utility installations or structures owned or controlled by the Owner or other governmental body are encountered during the Work and are not indicated on the Drawings or in the Specifications, and when, in the opinion of the Engineer, removal, relocation, replacement, or rebuilding is necessary to complete the Work under this Contract, such Work shall be accomplished by the utility having jurisdiction, or such Work may be ordered, in writing by the Engineer, for the Contractor to accomplish. If such work is accomplished by the utility having jurisdiction it will be carried out expeditiously, and the Contractor shall give full cooperation to permit the utility to complete the removal, relocation, replacement, or rebuilding as required. If such work is accomplished by the Contractor, it will be paid for as extra work as provided in the Agreement.
- e. At all times in performance of the Work the Contractor shall employ acceptable methods and exercise reasonable care and skill so as to avoid unnecessary delay, injury, damage, or destruction of

public utility installations and structures and shall at all times in the performance of the Work avoid unnecessary interference with or interruption of public utility services and cooperate fully with the owners thereof to that end.

- f. The Contractor shall give written notice to the Owner and other governmental utility departments and other owners of public utilities of the location of his proposed construction operations at least 48 hours in advance of breaking ground in any area or on any unit of the Work.
- g. The maintenance, repair, removal, relocation, or rebuilding of public utility installations and structures, when accomplished by the Contractor as herein provided, shall be done by methods approved by the owners of such utilities.

1.02 DRAWINGS AND PROJECT MANUAL

- A. Drawings: When obtaining data and information from the Drawings, figures shall be used in preference to scaled dimensions and large-scale drawings in preference to small-scale drawings.
- B. Supplementary Drawings
 - 1. When, in the opinion of the Engineer, it becomes necessary to explain more fully the Work to be done or to illustrate the Work further or to show any changes that may be required, the Engineer will prepare drawings known as Supplementary Drawings, with specifications pertaining to such Drawings, and the Contractor will be furnished one complete set of reproducible black-line prints (24 inches by 36 inches) and one reproducible copy of the specifications.
 - 2. The Supplementary Drawings shall be binding upon the Contractor with the same force as the Contract Drawings. Where such Supplementary Drawings require either less or more than the estimated quantities of Work, credit to the Owner or compensation therefor to the Contractor shall be subject to the terms of the Agreement.
- C. Contractor to Check Drawings and Data
 - 1. The Contractor shall verify all dimensions, quantities, and details shown on the Drawings, Supplementary Drawings, Schedules, Specifications, or other data received from the Engineer, and shall notify the Engineer of all errors, omissions, conflicts, and discrepancies found therein. Failure to discover or correct errors, conflicts, or discrepancies shall not relieve the Contractor of full responsibility for unsatisfactory work, faulty construction, or improper operation resulting therefrom, nor from

rectifying such conditions at his own expense. He will not be allowed to take advantage of any errors or omissions, as full instructions will be furnished by the Engineer should such errors or omissions be discovered.

2. All schedules are given for the convenience of the Engineer and the Contractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for making estimates of the size, kind, and quantity of materials and equipment included in the Work to be done under the Contract.

D. Specifications: The Technical Specifications each consist of three parts: General, Products, and Execution. The General part of a Specification contains General Requirements that govern the Work. The Products and Execution parts modify and supplement the General Requirements by detailed requirements for the Work and shall always govern whenever there appears to be a conflict.

E. Intent

1. All Work called for in the Specifications applicable to this Contract, but not shown on the Drawings in their present form, or vice versa, shall be of like effect as if shown or mentioned in both. Work not specified in either the Drawings or in the Specifications but involved in carrying out their intent or in the complete and proper execution of the Work is required and shall be performed by the Contractor as though it were specifically delineated or described.
2. The apparent silence of the Specifications as to any detail or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the best quality is to be used. The interpretation of these Specifications shall be made upon that basis.

1.03 MATERIALS AND EQUIPMENT

A. Manufacturer

1. All transactions with the manufacturers or subcontractors shall be through the Contractor, unless the Contractor shall request and at the Engineer's option that the manufacturer or subcontractor deal directly with the Engineer. Any such transactions shall not in any way release the Contractor from his full responsibility under this Contract.
2. Any two or more pieces of material or equipment of the same kind, type, or classification, and being used for identical types of service, shall be made by the same manufacturer.

B. Delivery

1. The Contractor shall deliver materials in ample quantities to ensure the most speedy and uninterrupted progress of the Work to complete the Work within the allotted time.
2. The Contractor shall also coordinate deliveries to avoid delay in or impediment of the progress of the work of any related Contractor.

C. Tools and Accessories

1. Unless otherwise stated in the Contract Documents, the Contractor shall furnish each type, kind, or size of equipment one complete set of suitably marked high-grade special tools and appliances that may be needed to adjust, operate, maintain, or repair the equipment. Such tools and appliances shall be furnished in approved painted-steel cases, properly labeled and equipped with good-grade cylinder locks and duplicate keys.
2. Spare parts shall be furnished as specified herein and as recommended by the manufacturer necessary for the operation of the equipment, not including materials required for routine maintenance.
3. Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, weight, and principal rate data.

D. Service of Manufacturer's Engineer

1. The Contract Prices for equipment shall include the cost of furnishing a competent and experienced engineer or superintendent who shall represent the manufacturer and shall help the Contractor, when required, install, adjust, test, and place in operation the equipment in conformity with the Contract Documents.
2. After the equipment is placed in permanent operation by the Owner, the engineer or superintendent shall make all adjustments and tests required by the Engineer to prove that the equipment is in proper and satisfactory operating condition and shall instruct such personnel as may be designated by the Owner in the proper operation and maintenance of such equipment.

1.04 INSPECTION AND TESTING

A. General

1. For tests specified to be made by the Contractor, the testing personnel shall make the necessary inspections and tests, and the reports thereof shall be in such form as will facilitate checking to determine compliance with the Contract Documents. Five copies of the reports shall be submitted

and authoritative certification thereof must be furnished to the Engineer as a prerequisite for the acceptance of any material or equipment.

2. If, in the making of any test of any material or equipment, the Engineer ascertains that the material or equipment does not comply with the Contract Documents, the Contractor will be notified thereof and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the site or from the Work and replace it with acceptable material without cost to the Owner.
3. Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with the recognized test codes of the ANSI, ASME, or the IEEE, except as may otherwise be stated herein.
4. The Contractor shall be fully responsible for the proper operation of equipment during testing and instruction periods and shall neither have nor make any claim for damage that may occur to the equipment before the time when the Owner formally takes over the operation thereof.

B. Costs

1. The Contractor shall provide all inspection and testing of materials furnished under this Contract, unless otherwise expressly specified.
2. The Contractor shall bear the cost of shop and field tests of equipment and of certain other tests specifically called for in the Contract Documents, and such costs shall be deemed to be included in the Contract Price.
3. The Owner may test materials and equipment submitted by the Contractor as the equivalent to those specifically named in the Contract for compliance. The Contractor shall reimburse the Owner for the expenditures incurred in making such tests of materials and equipment that are rejected for non-compliance.

C. Certificate of Manufacture

1. The Contractor shall furnish the Engineer with authoritative evidence in the form of a certificate of manufacture that the materials to be used in the Work have been manufactured and tested in conformity with the Contract Documents.
2. These certificates shall be notarized and shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

D. Shop Tests

1. Each piece of equipment for which pressure, duty, capacity, rating, efficiency, performance, function, or special requirements are specified shall be tested in the shop of the maker in a manner that shall conclusively

prove that its characteristics comply fully with the requirements of the Contract Documents.

2. Five copies of the manufacturer's actual test data and interpreted results thereof, accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company and/or independent laboratory, shall be submitted to the Engineer for approval.
3. The Contractor shall bear the cost of shop tests and of furnishing manufacturer's preliminary and shop test data of operating equipment.

E. Start-up Tests

1. As soon as conditions permit, the Contractor shall furnish all labor, materials, and instruments and shall make start-up tests of equipment.
2. If the start-up tests disclose any equipment furnished under this Contract that does not comply with the requirements of the Contract Documents, the Contractor shall, before demonstration tests, make all changes, adjustments, and replacements required. The furnishing Contractor shall assist in the start-up tests as applicable.

F. Demonstration Tests

1. Before the Contractor's request for a Substantial Completion inspection, all equipment and piping installed under this Contract shall be subjected to demonstration tests as specified or required to prove compliance with the Contract Documents.
2. The Contractor shall furnish labor, fuel, energy, water, and all other materials, equipment, and instruments necessary for all demonstration tests at no additional cost to the Owner. The Contractor shall assist in the demonstration tests as applicable.

1.05 LINES AND GRADES

A. Grade

1. All Work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings or as given by the Engineer. The full responsibility for keeping alignment and grade shall rest upon the Contractor.
2. The Engineer will establish benchmarks and provide coordination points. Reference marks for lines and grades as the Work progresses will be located by the Contractor to cause as little inconvenience to the prosecution of the Work as possible. The Contractor shall place excavation and other materials so as to cause no inconvenience in the use

of the reference marks provided. He shall remove any obstructions he places contrary to this provision.

B. Surveys

1. At his own expense, the Contractor shall furnish and maintain stakes and other such materials.
2. The Contractor shall check such reference marks by such means as he may deem necessary and, before using them, shall call the Engineer's attention to any inaccuracies.
3. At his own expense, the Contractor shall establish all working or construction lines and grades as required from the reference marks set by the Engineer and shall be solely responsible for the accuracy of these lines and grades. He shall, however, be subject to check and review by the Engineer.

C. Safeguarding Marks

1. The Contractor shall safeguard all points, stakes, grade marks, monuments, and benchmarks made or established on the Work; bear the cost of re-establishing them if disturbed; and bear the entire expense of rectifying Work improperly installed due to not maintaining or protecting or removing without authorization such established points, stakes, and marks.
2. The Contractor shall safeguard all existing and known property corners, monuments, and marks adjacent to but not related to the Work and shall bear the cost of re-establishing them if they are disturbed or destroyed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01100 SUMMARY OF WORK

PART 1 GENERAL

1.01 SCOPE OF WORK

Unless otherwise expressly provided in the Contract Documents, the Work must be performed in accordance with best modern practice, with materials and workmanship of the highest quality to the satisfaction of the Owner.

- A. The Project title is Aquifer Recharge at Flatford Swamp.
- B. The Work of this Project is defined in the Agreement.
- C. The Specification divisions and Drawings are an integrated part of the Contract Documents and, as such, will not stand alone if used independently as individual sections, divisions, or drawing sheets. The Drawings and Specifications establish minimum standards of quality for this project. They do not purport to cover all details entering into the design and construction of materials and equipment.

1.02 REFERENCE STANDARDS

Reference standards and recommended practices referred to herein shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Association of State Highway and Transportation Officials (AASHTO)
Formerly (AASHO)
- B. American Concrete Institute (ACI)
- C. American Institute of Steel Construction (AISC)
- D. American Iron and Steel Institute (AISI)
- E. American National Standards Institute (ANSI)
- F. American Standards Association (ASA)
- G. American Society of Mechanical Engineers (ASME)
- H. American Society of Testing and Material (ASTM)
- I. American Water Works Association (AWWA)
- J. American Welding Society (AWS)
- K. Anti-Friction Bearing Manufacturer's Association (AFBMA)
- L. Building Officials and Code Administrators International, Inc. (BOCA)
- M. Construction Specifications Institute (CSI)
- N. Federal Specification (FS)

- O. Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction, Latest English Edition (Standard Specifications)
- P. FDOT Roadway and Traffic Design Standards Latest English Edition (FDOT Index)
- Q. Geosynthetics Institute (GSI)
- R. National Bureau of Standards (NBS)
- S. National Electrical Manufacturer's Association (NEMA)
- T. National Fire Protection Association (NFPA)
- U. Portland Cement Association (PCA)
- V. Occupational Safety and Health Act (Public Law 91-596), US Department of Labor (OSHA)
- W. Steel Structures Painting Council (SSPC)
- X. Southern Standard Building Code (SSBC)
- Y. Underwriters' Laboratories, Inc. (UL)
- Z. United States of America Standards Institute (USASI)
- AA. Regulations of Florida Industrial Commission Regarding Safety
- BB. All local, state, county, or municipal building codes requirements of the Owner's Insurance

1.03 GENERAL REQUIREMENTS

- A. Unless otherwise specified on the Construction Drawings or Specifications, all work and the quality of materials shall conform to the referenced sections of the FDOT *Standard Specifications for Road and Bridge Construction, Supplementary Specifications*, and *Roadway and Traffic Design Standards*. The Contractor shall retain on the job site copies of these standard FDOT documents. The basis of payment shall conform to Section 01200, Measurement and Payment, of the General Requirements.

1.04 WORKING HOURS

- A. Work under this contract shall not be prosecuted on Saturdays, Sundays, or on State and/or National holidays, except in time of emergency, and then only under written permission from the Owner who shall be the sole judge as to the urgency of that situation. On weekdays, the workday shall be limited to daylight hours.
- B. If the Contractor deems it necessary to work on Sundays, holidays, or beyond daylight hours to comply with his construction schedule or because of an emergency, the Contractor shall request permission of the Owner to do so. If, in the opinion of the Owner, the need is bona fide, the Owner will authorize the Contractor to work such hours as may be necessary.

1.05 REIMBURSEMENT FEES

- A. The following rates shall be applied as the Owner's reimbursement of the Engineer's fee to be paid by the Contractor for expenses such as overtime work or multiple submittal reviews. These rates cover the Engineer costs on the project.

1.	Senior Field Representative (Construction):	\$	105
2.	Senior Construction Administrator:	\$	155
3.	Engineering Consultant (Senior Project Manager):	\$	225
4.	Project Engineer	\$	170
5.	Administrative Assistant:	\$	85

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01200
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers methods of measurement and payment for items of work under this Contract.
- B. The total Contract Price shall cover all work required by the Contract Documents. All cost in connection with the proper and successful completion of the work including furnishing all materials, equipment, and tools and performing all necessary labor and supervision to fully complete the work, shall be included in the unit price and lump-sum Bid prices. All work not specifically set forth as a pay item in the Bid Form or Bid Schedule shall be considered a subsidiary/ancillary obligation of the Contractor and all costs in connection with these subsidiary/ancillary obligations shall be included in the Bid(s) to provide a complete and functional Project.

1.02 EXCAVATION, TRENCHING, AND CLEARING

- A. Except where otherwise specified, the unit price or lump-sum price bid for each item of work which involves excavation, trenching, clearing, grubbing, or disposal of cleared and grubbed materials shall include all costs for such work. No direct payment shall be made for clearing, grubbing, disposal of cleared or grubbed materials, excavation, trenching, disposal of surplus excavated material, handling water (and groundwater), and purchasing and hauling of required fill material. All excavation and trenching shall be unclassified as to materials which may be encountered; in addition, trenches shall be unclassified as to depth, unless otherwise stated.

1.03 LUMP SUM

- A. For lump-sum items, payments shall be made to the Contractor in accordance with an accepted Progress Schedule of Values on the basis of actual work completed and accepted by the Owner at the final completion of the Project.

1.04 UNIT PRICE

- A. For unit price items, payment shall be made based on the actual amount of work accepted by the Owner and for the actual amount of materials in place at the final completion of the Project, as confirmed by the final measurements.

- B. After the work is completed and before final payment is made, the Engineer will make final measurements, with all required assistance from the Contractor, to determine the quantities of various items of work accepted as the basis for the final unit price payment.

1.05 PAYMENT FOR INCREASED OR DECREASED QUANTITIES

- A. When alterations in the quantities of unit price work not requiring a Change Order(s), as herein provided for, are ordered and performed, the Contractor shall accept payment in full at the Contract unit price multiplied by the actual quantities of work constructed and accepted by the Owner at the completion of the project.
- B. The actual percentage of each lump-sum bid item completed by the Contractor and accepted by the Owner at the final completion of the Project will be paid to the Contractor.

1.06 DELETED ITEMS

- A. Should any items contained in the Bid Schedule(s) be found unnecessary for the proper completion of the work contracted, the Owner or Owner's Representative may eliminate such items from the Contract. This action shall in no way invalidate the Contract and no financial allowance or compensating payment for expected profit, overhead, etc., will be made for items so eliminated in making final payment to the Contractor.

1.07 PARTIAL PAYMENTS

- A. Partial payments shall be made monthly as the work progresses. Partial payment shall be made subject to the provisions of the Contract Documents.

1.08 PAYMENT FOR STORED MATERIAL DELIVERED TO THE PROJECT

- A. When requested by the Contractor and at the discretion of the Owner, payment may be made for all or part of the value of acceptable materials and equipment to be incorporated into bid items, which have not been used, and which have been delivered to the construction site or placed in storage places acceptable to the Owner. The Contractor shall provide receipts for all stored material items requested for reimbursement which clearly identify the stored material item, where it is to be constructed, the unit cost of the item, as well as the total cost of the delivered item(s), the quantity of the item, the brand name of the item, and the supplier. Note that there are additional documentation requirements and storage

requirements within the Contract Documents that must also be met before the Contractor can be reimbursed for these stored materials.

- B. No payment shall be made for fuels, supplies, installation or connection hardware, lumber, false work, or other similar materials or on temporary structures or other work (items) of any kind which are not a permanent part of the Contract. Items having a value of less than \$2,500 shall not be compensated for as a stored material item.

1.09 FINAL PAYMENT

- A. If requested by the Owner or Owner's Representative, the Contractor shall field verify all quantities in dispute by using visual observation, taped measurements, or other methods designated by the Owner. The field verification shall be made in the presence of the Owner or Owner's Representative and agreed to by both the Owner and the Contractor. The Owner or Owner's Representative will prepare a final adjusting Change Order that will adjust the final quantities of the project Bid Schedule to reflect the actual work accepted by the Owner and for which the Contractor will be compensated.

1.10 SCHEDULE OF VALUES

- A. The schedule of values will be submitted in accordance with the General Conditions and is required to be approved by the Owner or Owner's Representative before the first pay request is approved. The schedule of values shall be based on the prices bid in the Bid Schedule(s). Prices bid in the Bid Schedule(s) cannot be changed in the schedule of values; they can only be broken down into more detail so that the Owner or Owner's Representative can more accurately review and approve the Contractor's pay application for the completed work.

1.11 MISCELLANEOUS CONSTRUCTION ITEMS

- A. The Contractor shall take all precautions necessary to protect existing utilities, roads, and miscellaneous items from damage during construction.
- B. The Contractor shall repair, relocate, or replace existing utilities, roadways, and miscellaneous items to pre-construction conditions.
- C. All repairs, relocations, and replacements necessary are considered incidental to the work and will be at the Contractor's cost, with no cost to the Owner.
- D. The unit-price bid items and lump-sum bid items for all pipe items shall constitute full compensation for furnishing, laying, jointing, and testing of pipe; dewatering;

excavation and backfill; and cleanup. All pipe lines, which are to be paid for per the Bid Schedule, will be measured for payment as described in the Bid Items below.

- E. Payment for the isolation valve bid items shall not be made until the associated Isolation Valve Cards have been properly filled out, signed by the Contractor, and accepted by the Owner or Owner's Representative as completed installations. Samples of the Isolation Valve Card are located at the end of Section 15110, Manual, Check, and Process Valves. The Contractor shall make all required copies of the cards for use in the work.
- F. The Contractor shall have the Owner /Engineer observe and document the installation of each underground fitting on the project. If the installation of any fitting is not confirmed and documented by the Engineer, it shall not be paid for by the Owner.

PART 2 PAY ITEM DESCRIPTIONS

2.01 BID

The descriptions provided in the following Paragraphs are to be used by the Bidder in preparing the Bid Schedule(s). They generally indicate how the major workscope items and their respective costs are to be separated into the line items listed in the Bid Schedule(s). These descriptions are not fully representative nor all-inclusive of the work required to complete the project in accordance with the Contract Documents. It is the Bidder's responsibility to include all required costs within the most appropriate line item(s).

Item 1. Mobilization/Demobilization/General Conditions (not to exceed 10% of Base Bid)—General—The work specified under this Section shall consist of the preparatory work and operations necessary to mobilize and begin work on the project. This shall include but is not limited to the following: those operations necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; the establishment of temporary offices, buildings, safety equipment and first-aid supplies, sanitary and other facilities required by these Contract Documents; construction survey and layout; compliance with all applicable federal, state, and local regulations; preparation and implementation of a Stormwater Pollution Prevention Plan; prepare and implement a Maintenance of Traffic Plan and provide all necessary labor, materials, and equipment to meet the requirement to maintain adequate warning signs, lights, barriers, barricades, cones, flaggers, etc., for the protection of traffic along the public roadways adjacent to the project site, in the project areas; and provide and maintain all project documentation including but not necessarily limited to video/ground photography and aerial photography specified by these Contract Documents. This item also includes installation of project signage and fees for permits and permit inspections as required by Owner and Contract Documents.

The cost of Bonds and any other required insurance, consideration for indemnification to the Owner and the Engineer, and any other pre-construction expenses necessary for the start of the work, excluding the cost of construction materials, shall also be included in this Section.

Payment: The work specified under this Section shall be paid for at the Contract lump-sum price for mobilization and shall be in accordance with the following schedule:

PERCENT OF ORIGINAL CONTRACT AMOUNT EARNED	ALLOWABLE PERCENT OF THE LUMP SUM PRICE FOR MOBILIZATION
5	25
10	50
25	75
50	100

Partial payment shall be limited to 10% of the original Contract amount for the project. Any remaining amount will be paid upon completion of all work on the project, including final punchlist work items. The applicable work specified under this Section shall be paid for under the following Pay Item (and/or other similar project specific phasing):

- Mobilization/Demobilization/General Conditions

Item 2. Allowance for Record Drawings — The Contractor shall furnish all labor, materials, equipment, and services for composing and providing Record Drawings for the entire project in accordance with the Contract Documents, including but not limited to updating the electronic copy of the Drawings, identifying items that were revised during the project or addenda, having all Drawings signed and sealed by a Florida-certified Professional Land Surveyor, and providing signed-and-sealed paper copies of the Record Drawings. Once the Record Drawings have been determined by the Engineer to be complete according to the Specification requirements, the entire allowance will be paid to the Contractor.

Item 3. Allowance for Quality Control Testing — The Contractor shall employ an independent testing laboratory to perform testing on soils, concrete, roadway and other related tests required by the Engineer for quality control during construction. The Contractor shall establish a Bid item account in the amount established in the Bid Form from which payments for these approved tests shall be made. The Contractor shall order the tests as required by the Engineer, and the invoices shall be submitted to the Contractor for payment. The Contractor shall be reimbursed for the approved payments in each appropriate monthly estimate. No Contractor markup shall be allowed for this Bid item. Tests not meeting the requirements shall be repeated at the Contractor's expense until satisfactory results are obtained. Costs for laboratory waiting time shall not be allowed. If the actual costs in this Bid item account be more or less than the specified allowance, the Bid item amount shall be adjusted in the final payment for the actual approved costs for testing.

Item 4a. 12-Inch FPVC Piping Horizontal Directional Drill—The Contractor shall furnish all labor, materials, equipment, and services for constructing and placing into operation the horizontal directional drill (HDD) for a 12-inch fusible polyvinyl chloride (FPVC) line, installed as shown on the Drawings or as otherwise specified in accordance with the Contract Documents, including but not limited to bore pits, pipe, bore, reaming, back-reaming, slurry, slurry relief holes, installing the pipe in the bore, connections and transition couplings, FPVC reducers, FPVC fittings, removing or avoiding obstructions in the path of the FPVC pipe, excavation, backfill, compaction, sodding/seeding, dirt drive restoration, testing, and all associated appurtenances. The Contractor will be paid for each linear foot of FPVC horizontal directional drilled line installed and tested completed and Contractor's approved Schedule of Values and upon Engineer verification.

Item 4b. 24-inch FPVC Piping Horizontal Directional Drill— The Contractor shall furnish all labor, materials, equipment, and services for constructing and placing into operation the horizontal directional drill (HDD) for a 24-inch fusible polyvinyl chloride (FPVC) line, installed as shown on the Drawings or as otherwise specified in accordance with the Contract Documents, including but not limited to bore pits, pipe, bore, reaming, back-reaming, slurry, slurry relief holes, installing the pipe in the bore, connections and transition couplings, FPVC reducers, FPVC fittings, removing or avoiding obstructions in the path of the FPVC pipe, excavation, backfill, compaction, sodding/seeding, dirt drive restoration, testing, and all associated appurtenances. The Contractor will be paid for each linear foot of FPVC horizontal directional drilled line installed and tested completed and Contractor's approved Schedule of Values and upon Engineer verification.

Item 5a. 12-inch FPVC Piping Open Cut — The Contractor shall furnish all labor, materials, equipment, and services for constructing by open-cut and placing into operation the a 12-inch fusible polyvinyl chloride (FPVC) line transmission lines shown on the Drawings in accordance with the Contract Documents, including but not limited to all piping, pipe restraint, end plugs, tracing wire, flushing of all lines, connections, excavation, removal of unsuitable materials and replacement with suitable materials, backfill, compaction, sodding/seeding, dirt drive restoration, testing, and all associated appurtenances. The Contractor will be paid for each linear foot of pipe installed as measured along the horizontal projection of the center line of the pipe. No deduction in length will be made for the space occupied by valves or fittings. The Contractor will be paid 90% upon installation and restoration and 10% upon passing the pressure test.

Item 6. Surface Facilities Construction and Startup — Payment of the lump-sum bid item in the Bid Form shall be full compensation for furnishing all labor, materials, and equipment to construct the surface facilities and related construction not identified in Bid Items 1 through 5. Work shall include but not limited to the following: bypass pumping and dewatering (portable coffer dams, flumes, well points, temporary pumps, temporary piping, etc.), all equipment and installation related to the gravity intake structure (concrete, coarse bar screen, baffle, grating, staff gauge, etc.) all remaining pipe, fittings, restraints, nuts, bolts, and pressure gauges not covered in the above Bid Items, all valves (air release, ball, borehole injection control with

hydraulic power unit, check, gate, stems, pads, etc.) all equipment and services related to the Recharge Pump Building (building, roof access hatches, foundation, recharge pump, trash pump, guide rails, safety cable, grouting, access hatch, air compressor, air conditioner, fine screen, etc.), all equipment and services related to the Recharge Well Building (building, roof access hatches, foundation, purge pump, monitoring equipment, etc.), all equipment and services related to the chemical injection (chemical containers, injection quill, fencing, pads, metering pumps, etc.) all monitoring well equipment (pumps, safety cables, piping, SWFWMD enclosure, etc.), all painting, coating, concrete (bollards, precast buildings, grouting, equipment pads, etc.), electrical/instrumentation (electrical tie-in, wiring, lighting, circuits, grounding, motor starters, level controls, transducers, flow meters, variable frequency drives, remote telemetry units, etc.), civil (rip rap, geotextile fabric, elliptical culvert crossings, outlet structures, clearing, grubbing, excavation, roads, etc.), warranties, and any other materials, equipment, or labor that are detailed in the Contract Documents, but not incorporated into Bid Items 1-5 above. Payment for this item shall be based on percent complete in accordance with the Contractor's approved Schedule of Values and upon Engineer Verification.

END OF SECTION

SECTION 01290 SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. To the Engineer, a proposed Schedule of Values allocated to the various portions of the Work, in accordance with Section 01000, Project Requirements, and Section 01200, Measurement and Payment.
- B. Upon request of the Engineer, supporting data that will substantiate the values' correctness.
- C. The accepted Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.
- D. An update and resubmittal of the Schedule of Values when Change Orders affect the listing or when the actual performance of the Work involves necessary changes of substance to values previously listed and approved.
- E. Schedule of Values
 - 1. Submit typed schedule on EJCDC 1910-8-E forms provided by the Engineer. The Contractor's standard form or electronic media printout will be considered.
 - 2. Submit Schedule of Values in duplicate within 10 days after the date of Owner-Contractor Agreement.
 - 3. Format – Use the schedule of prices in the Bid Proposal. Show the cost breakdown for each lump-sum item. The lump-sum breakdown shall, at a minimum, use the Table of Contents of this manual outline. Identify each line item with the number and title of the major Specification Section. Identify site mobilization and demobilization, bonds and insurance, Record Drawings, photographs, and operations and maintenance manuals, etc.
 - 4. For unit cost allowances, identify quantities taken from the Contract Documents multiplied by the unit cost to achieve the total for the item.
 - 5. Include within each line item a direct proportional amount of the Contractor's overhead and profit.

6. Revise the schedule to list approved Change Orders with each Application for Payment.

1.02 CASH ALLOWANCES

- A. Costs Included in Allowances—The cost of the product to the Contractor or subcontractor, less applicable trade discounts and applicable taxes.
- B. Costs Not Included in the Allowance, But Included in the Contract Price—Product handling at the site, including unloading, uncrating, and storage; protection of products from elements and from damage; and labor for installation and finishing.
- C. Contractor Responsibilities
 1. Execute purchase agreement with designated supplier.
 2. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
 3. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.
- D. Differences between allowance amounts and actual costs will be adjusted by Change Order before final payment.
- E. Cash Allowances Schedule
 1. Soils.
 2. Concrete.
 3. Testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01310
CONSTRUCTION COORDINATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall coordinate Work with that of other construction projects as needed.
- B. Before starting Work and from time to time as the Work progresses, the Contractor and each subcontractor shall examine the work and materials installed by others as it applies to its own work and shall notify the Engineer immediately in writing if any conditions exist which will prevent satisfactory results in the installation of the system. Should the Contractor or subcontractor start work without such notification, it shall be construed as an acceptance of all claims or questions as to the suitability of the work of others to receive its Work. The Contractor shall remove and/or replace, at its own expense, all work under this Contract that may have to be removed on account of such defects or omissions.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. The Contractor shall ensure that all drawing, product data, and samples comply with Contract Documents and field dimensions and clearances.
- B. The Contractor shall submit requests for interpretation of Contract Documents in a timely fashion to ensure there are no disruptions with the Work as scheduled. Obtain instructions through the Engineer to resolve all queries.
- C. Process requests for substitutions and Change Orders through the Engineer.
- D. Deliver close-out submittals to the Engineer.

1.03 CONSTRUCTION MOBILIZATION

The Contractor shall do the following:

- A. Prior to mobilizing equipment to the site, the Contractor shall schedule an inspection with the Owner and Manatee County to document the condition of Taylor Road. The Contractor shall be responsible for restoring Taylor Road to its'

original condition at the completion of the project at no additional cost to the Owner.

- B. Cooperate with the Owner in allocating mobilization areas on site for field offices and sheds, access, traffic, and parking facilities. During construction, the Contractor shall coordinate the use of the site and facilities through the Engineer.
- C. The Contractor shall mark all trees over 8 inches diameter at breast height, that the Contractor plans to remove. The Contractor shall schedule a field review meeting with the Owner and receive the Owners permission prior to the removal of any tree over 8 inches in diameter at breast height.
- D. Comply with the Engineer's procedures for intra-project communications: submittals, reports and records, schedules, coordination drawings, recommendations, and resolution of ambiguities/conflicts.
- E. Comply with the Engineer's instructions for use of temporary utilities and construction facilities.
- F. Coordinate field engineering and layout work under instructions of the Engineer.
- G. Coordinate scheduling, submittals, and work of the various sections of Contract Documents to ensure the efficient and orderly sequence of installation of construction elements, with provisions for accommodating items to be installed later.
- H. Coordinate the sequence of Work to accommodate the Owner occupancy as specified in the Contract Documents.
- I. The Owner and Engineer will organize and conduct progress meeting at least once a month to discuss the progress of the Work. The Contractor and any subcontractors the Contractor deems necessary shall attend these meetings. At the Engineer's discretion, the frequency of the meetings may be increased if the progress of the Work is not satisfactory or if coordination problems should arise.
- J. In addition to Progress Meetings, hold pre-construction conferences with personnel and Subcontractors to ensure coordination of Work. The Engineer shall be informed of such meetings and shall be allowed to attend.
- K. Coordinate the Work of various sections having interdependent responsibilities for installing equipment, connecting equipment, and placing such equipment in service.

- L. Coordinate the use of project space and the sequence of installing civil, architectural, mechanical, structural, instrumentation, systems, and electrical work. Follow practicable routings for pipes, ducts, and conduits, with due allowance for available physical space; make runs parallel with lines of building. Use space efficiently to maximize accessibility for other installations, maintenance, and repairs.
- M. Coordinate Work at existing facilities to minimize disruption of the Owner's operations.
- N. Assemble and coordinate close-out submittals specified in Section 01770, Project Closeout.

1.04 COORDINATION DRAWINGS

- A. The Contractor shall provide information required by the Engineer for preparing coordination drawings.
- B. The Contractor shall review drawings before submitting them to the Engineer.

1.05 CLOSE-OUT PROCEDURES

The Contractor shall do the following:

- A. Notify the Owner when Work is considered ready for Substantial Completion.
- B. Comply with the Owner's instructions to correct items of Work listed in executed Certificates of Substantial Completion.
- C. Notify the Owner when Work has reached Final Completion.
- D. Comply with the Owner's instructions for completing items of Work found incomplete in the Engineer's final inspection.
- E. Comply with Section 01770, Project Closeout.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. All vehicles on the property or easement must be operational.

3.02 UTILITIES

- A. The Contractor shall coordinate the activities of all utility companies with equipment in the construction area with the Contractor's and Subcontractor's Work.

3.03 CUTTING AND PATCHING

- A. No cutting and patching of new Work will be accepted. All Work must be new and continuous in its final form.

END OF SECTION

SECTION 01320
PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. All work of this Contract shall be scheduled and monitored by the Contractor using the Critical Path Method (CPM) and shall use the Precedence Diagram Method (PDM) of scheduling. The Contractor shall prepare all schedules and all monthly updates described in this Section. The Contractor will prepare revisions of the schedule to reflect changes in the Contractor's plan of performance or changes in the Work and submit these revisions to the Owner or Owner's Representative for acceptance. The Owner or Owner Representative's acceptance of the scheduling documents is to ensure that all CPM Scheduling documents prepared by the Contractor are in conformance with the Contract Documents and Specifications described herein. This acceptance will not impose on the Engineer or Owner the responsibility for the schedule or for the sequencing, scheduling, or progress of the Work, nor will the acceptance interfere with or relieve the Contractor of full responsibility for the schedule and the means, methods, procedures, and sequence of construction.
- B. The Contractor shall use the latest version of a scheduling software similar to Primavera Software, or an Owner-approved equal, for all CPM Scheduling applications.
- C. The Engineer or Owner may retain the professional services of a CPM Scheduling Consultant to assist in the review and acceptance of the CPM Scheduling documents prepared by the Contractor. Therefore, any reference to the Engineer or Owner within this Section may also indicate the involvement of the Engineer's or Owner's CPM Scheduling Consultant.
- D. The Contractor shall prepare and maintain a detailed progress schedule throughout the construction of the Project. The schedule shall be the Contractor's working schedule and be used to plan, organize, and execute the Work, record and report actual performance and progress, and show how the Contractor plans to complete the Work. The schedule will be in the form of an activity-oriented network diagram (CPM).
- E. When the Contractor prepares the CPM Schedule and the schedule is accepted by the Engineer, it shall become part of the Contract Documents and will be used by Contractor and Engineer to monitor the progress of the Project. The CPM Schedule may be revised to show changes in the Contractor's method or manner

of performance; delays, or authorized changes in the Work. All changes to the schedule will be made in accordance with Article 1.08 of this Section.

- F. The Contractor acknowledges that free float belongs to the Owner.

1.02 QUALIFICATIONS

- A. To help prepare the detailed CPM Schedule, the Contractor shall engage at his own expense a Consultant who is skilled in the time-and-cost application of network techniques for construction projects. If the Contractor has qualified personnel on staff, the Contractor can perform the required scheduling within his own organization.
- B. Before engaging a Consultant or using in-house staff personnel and within 5 calendar days after Award of Contract, the Contractor shall submit the following to the Engineer:
 - 1. The name and address of the proposed Consultant or employee who will prepare the CPM schedule.
 - 2. Sufficient information to show that the proposed Consultant or employee has the above qualifications including a list of prior construction projects of similar size and complexity, along with selected network samples, which the proposed Consultant or employee has performed. These network samples must show complete project planning similar to that required under this Contract.
- C. The Engineer shall have the right to approve or disapprove employment of the proposed Consultant or the performance of the requirements herein by the Contractor's employee and will notify the Contractor of the decision within 7 calendar days from receipt of the information. If the proposed Consultant is rejected, the Contractor shall resubmit another name within 7 calendar days for renewed consideration. Such approval or disapproval does not release the Contractor from his obligations under this Contract.
- D. If the Owner or Engineer has reasonable objections to the qualifications of the Contractor's nominated scheduling personnel, the Contractor shall, at no additional cost to the Owner, employ a scheduler whose qualifications comply with the requirements of this Section or employ a qualified subcontractor, subject to review of his qualifications by the Engineer and the Owner.

1.03 PRELIMINARY 90-DAY CPM SCHEDULE

- A. The Contractor shall develop a 90-Day CPM Schedule within 10 days after the date indicated in the Notice to Proceed. This schedule shall be a computerized

CPM Schedule showing only the early start, early finish of each work activity. The 90-Day Schedule shall contain work activities over the first 90 days, and the estimated durations for each work activity shall be 15 workdays or less. The balance of the job shall be shown in summary log. The 90-Day Schedule shall include but not be limited to site work, hazardous material removal, demolition, key procurement activities (i.e. submissions, approvals, fabrication, and delivery), equipment, mechanical, electrical, and plumbing coordination and any other work that will occur during the first 90 days. This 90-Day Schedule shall become part of the Detailed CPM Schedule.

1.04 DEFINITIONS

The following terms used in this Section shall have the following meanings:

- A. *Activity.* A fundamental unit of work in a CPM Schedule establishing the time and resources required for performing or furnishing a part of the Work or a requisite step. Each Activity has defined geographical boundaries, time duration in days, and a detailed estimate of resources required to construct the task. Each activity is assigned a unique description, activity number, activity code, and a dollar value.
- B. *Record Schedule.* The Record Schedule will have actual start dates and actual finish dates for all work Activities and Milestones necessary to complete the Work.
- C. *Baseline Schedule.* The Engineer-accepted Proposed Baseline Schedule. The Baseline Schedule is the Contractor's plan which has been approved by the Engineer for completion of the Work in compliance with the Milestones listed in the Contract Documents and within the Contract Time. The Baseline Schedule may be revised only by the Engineer's approval of a Contractor-produced adjusted Baseline Schedule. The Baseline Schedule for the Work is the sole basis for (a) the monitoring of the Contractor's progress against Milestones and the Contract Time; (b) calculating Total Float or Contract Float; and (c) the evaluation and reconciliation of extensions in Contract Time, if any. The first Baseline Schedule shall be designated by all parties as the Baseline Schedule, Rev. 0. When Baseline Schedules are adjusted by the Contractor and approved by the Engineer, they shall be designated as Baseline Schedule, Rev. 1, 2, 3, etc. (as appropriate) and shall replace the previously approved Baseline Schedule.
- D. *Contract Float.* Workdays between the Contractor's expected date for early completion of the Work, or specified part, and the corresponding Contract Time.
- E. *CPM Network.* The structure of the computerized schedule. The CPM Network accounts for the entire Work and defines the construction logic in terms of all of the Activities with their logical dependencies.

- F. *Critical Path.* A series of Activities linked by dependencies that determine the shortest possible time to complete the Work.
- G. *Early Dates.* The early start dates and early finish dates, i.e., the dates each Activity will start and finish if each is started at the earliest end of the range of dates that the CPM indicates the Activities can be performed.
- H. *Excusable Delay.* An unforeseeable delay, beyond the control of the Contractor, experienced due to no fault or negligence by the Contractor, its subcontractors, or suppliers.
- I. *Free Float.* The amount of time that any activity can be delayed without adversely affecting the early start of the following activity.
- J. *Fragnet.* A predefined or individual segment of a network which represents a specified sequence of the Work. Fragnets shall be submitted which include all Activities, required resources, and costs and shall be submitted to the Engineer for approval of all Change Orders before their incorporation into the Baseline Schedule by the Contractor. A Fragnet shall be submitted before approval of any proposed logic changes. Fragnets are banded Activities representing a revised portion of the Baseline Schedule and shall be logically connected and constrained by previously existing predecessor and successor Activities, as applicable.
- K. *Late Dates.* The late start dates and the late finish dates; i.e., the dates each Activity will start and finish if each is started at the latest end of the range of dates that the CPM Network indicates the Activities can be performed and still achieve the Milestones and Contract Time.
- L. *Milestone.* A point of progress designated for the purpose of establishing start or finish times for a key aspect of the Work.
- M. *Predecessor Activity.* An Activity which precedes another Activity (to which it is logically tied) in the CPM Network.
- N. *Preliminary Schedule.* The Contractor's Baseline Schedule for the first 180 days of the Contract.
- O. *Proposed Baseline Schedule.* The Proposed Baseline Schedule shall represent the Contractor's plan for completion of the Work in compliance with Milestones listed in the Contract Documents and within the Contract Time. It represents the Contractor's first complete planned schedule submitted for review and approval by the Engineer. The Proposed Baseline Schedule shall take into account all foreseeable activities to be accomplished by any separate contractors, utility

owners, or the Owner's operations. The Proposed Baseline Schedule shall anticipate all necessary manpower and resources to accomplish activities within the durations set forth in the Proposed Baseline Schedule. The Proposed Baseline Schedule shall address and indicate all submittals required by the Contract and indicate the times allowed for review, resubmittal, and approval of submittals. Upon approval by the Engineer, the first Proposed Baseline Schedule shall become the Baseline Schedule, Rev. 0.

- P. *Resource Loading.* The allocation of work force and equipment necessary for the completion of an Activity as scheduled.
- Q. *Six-Week Schedule.* A detailed progress schedule taken from the Working Schedule, which discloses the plan for the next 6 weeks' Work and the actual schedule for the previous 6 weeks' Work.
- R. *Successor Activity.* An Activity which follows another Activity (to which it is logically tied) in the CPM Network.
- S. *Total Float.* The number of workdays by which a part of the Work in the Baseline Schedule or Revised Baseline Schedule may be delayed from its Early Dates without necessarily extending the Contract Time.
- T. *Working Schedule.* When the Proposed Baseline Schedule (or a subsequent adjustment is made by the Contractor to the Baseline Schedule) is accepted by the Engineer and becomes the Baseline Schedule, Rev. 0, 1, 2, 3, etc., it shall be duplicated and become the Working Schedule. The Contractor shall update the Working Schedule monthly with a Data Date designated by the Engineer. The Working Schedule shall be updated monthly to reflect actual progress only and shall be the basis for determining monthly progress payments and the Contractor's performance in relation to the most recently approved Baseline Schedule. The Final Working Schedule shall be the Record Schedule.

1.05 DETAILED CPM SCHEDULE

- A. The Detailed Network Diagram shall provide sufficient detail and clarity of form and technique so that the Contractor can plan, schedule, and control his work properly and the Engineer can readily monitor and follow the progress for all portions of the Work. The Detailed Network Diagram shall comply with the Contract Times of the Agreement and various limits imposed by the Contract Documents, including required sequencing of portions of the Work described in Section 01100, Summary of Work. The degree of detail shall be to the satisfaction

of the Engineer, but the following factors shall have a bearing on the required depth of activity detail:

1. The structural breakdown of the Project.
 2. Project Phasing and/or Milestones.
 3. The type of work to be performed and the labor trades involved.
 4. All purchase, manufacture, and delivery activities for all major materials and equipment.
 5. Maintenance of Facilities in Operation.
 6. Submittal and approval of shop drawings and material samples.
 7. Plans for all subcontract work.
 8. Crew flows and sizes.
 9. Assignment of responsibility for performing all activities.
 10. Access and availability to work areas.
 11. Identification of interfaces and dependencies with preceding, concurrent, and follow-on subcontractors and contractors.
 12. Testing and start-up of systems.
 13. Planning for phased takeover by the Owner.
- B. Activities shown shall be in workdays and shall have a maximum duration of 5 days, except in the case of non-construction activities such as procurement of materials and delivery of equipment. All durations shall be the result of definitive manpower and resource planning by the Contractor.
- C. The Detailed Network Diagram shall be prepared using a computer plotter.

1.06 COMPUTERIZATION OF THE DETAILED CPM SCHEDULE

- A. The mathematical analysis of the Detailed Network Diagram shall be made by computer, and a tabulation for each activity shall include the following:
1. Unique event numbers.
 2. Activity descriptions.
 3. Durations in workdays for each activity.
 4. Earliest start date (by calendar date).
 5. Earliest finish date (by calendar date).
 6. Latest start day (by calendar date).
 7. Latest finish day (by calendar date).
 8. Slack or total float in workdays.
 9. Percentage of activity completed.

- B. The following computer outputs shall be prepared as part of the initial schedule submission and each update thereafter:

1. Activity file sort.
2. Eight-week "Look Ahead" detailed bar chart.
3. Summary bar chart.
4. Additional computer sorts as required by the Owner.
5. CDs of all computer files.
6. Items 1 through 4 above, submit seven copies of each.

1.07 COMPLETION REQUIREMENT

- A. The 90-Day Schedule shall be completed within 10 calendar days after the date indicated in the Notice to Proceed.
- B. The Detailed CPM Schedule shall be prepared within 30 calendar days after the date indicated in the Notice to Proceed.
- C. If the Contractor fails to provide the required CPM scheduling documents to the Engineer within the time prescribed and/or revisions of the scheduling documents within the required time, the Contractor shall be in default of the Contract requirements and the Engineer may withhold approval of progress payments until such time as the Contractor submits the required information.
- D. Notwithstanding the implementation of the Progress Schedule, it shall be the sole responsibility of the Contractor to complete the Work within the time of completion required by the Contract.

1.08 UPDATINGS

- A. The 90-Day CPM Schedule shall be updated monthly until the Engineer accepts the Detailed CPM Schedule.
- B. The first update of the Detailed CPM Schedule shall take place 60 calendar days after the Notice to Proceed with subsequent updates performed monthly at the jobsite for the duration of the contract.
- C. The Contractor shall update the Detailed CPM Schedule monthly, using a cutoff/data date agreeable to the Contractor and the Engineer. This cutoff/data date shall be consistent from month to month. The update information shall include but not be limited to the following:
1. Actual start dates.
 2. Actual completion dates.

3. Activity percent completion.
 4. Remaining duration of activities in progress.
- D. The Contractor shall update all the scheduling documents and submit these documents to the Engineer within 5 workdays of the cutoff/data date.
- E. The Contractor shall submit seven copies of the CPM schedule and one electronic copy of the CPM schedule on a CD.
- F. As part of the normal CPM update, the Contractor shall prepare a written narrative report highlighting the progress during the past update period. The written narrative report shall include but not be limited to the following information:
1. Summary of work accomplished during the past update period.
 2. Milestone Comparison Chart.
 3. Analysis of Critical Path(s).
 4. Analysis of Secondary Critical Path(s). Secondary Critical Path is defined as float within 10 workdays of Critical Path.
 5. Analysis of time lost/gained during the update period.
 6. Identification of problem areas.
 7. Identification of change orders and/or any delay that is impacting/delaying the project schedule.
 8. Solutions to current problems.
- G. The Contractor is required to attend and participate in a CPM update review meeting with the Engineer. Attendance is mandatory. This meeting will take place 7 workdays after the cutoff/data date, or during progress meetings as decided by the Owner and the Engineer. The purpose of this meeting is to review past progress, current status, problem areas, and future progress. The Contractor's narrative report will be reviewed at this meeting.
- H. All schedule update information outlined above will be reviewed and accepted by the Engineer.

1.09 RECOVERY SCHEDULE

- A. If the Contractor fails to achieve the planned progress, as indicated in the approved/updated detailed CPM Schedule, and the Contractor's lack of progress delays the Critical path and/or an intermediate milestone by more than 10 workdays (monthly or cumulatively), the Contractor shall submit to the Engineer for review and acceptance a proposed Recovery Schedule indicating how the Contractor will recover the time lost.

- B. If the Contractor fails to submit a Recovery Schedule and/or fails to cooperate with the Engineer in the Recovery Schedule process, the Owner can immediately order the Contractor to accelerate completion of the late activities which have been delayed by whatever means necessary without any additional costs to the Owner. The Owner can withhold future progress payments until the Contractor's progress is in compliance with the Contract Schedule or until the Owner has approved by Change Order proposed adjustments to the contract milestones, extension of contract time, or modification of the Contract Schedule.

1.10 CHANGE ORDERS, DELAYS AND EXTENSIONS OF TIME

- A. When proposed Change Orders, approved Change Orders, or any delays are experienced and the Contractor believes the Change Order/Delay is causing delay to an intermediate contract milestone or to the project completion, the Contractor shall submit to the Engineer a Time Impact Analysis, explaining the influence of each Change Order/Delay on the current updated Contract CPM Schedule. The Contractor shall prepare a "Fragnet" (network analysis) of each Change Order/Delay on the current updated Contract CPM Schedule. The analysis will demonstrate the time impact based on the date the change is given to the Contractor, the status of construction at that point in time, and the event time computation of all affected activities. The event times used in the analysis shall be those included in the latest updated copy of the detailed CPM Schedule closest to the time of delay or as accepted by the Engineer.
- B. For the Contractor to be entitled to an extension of Contract time to an intermediate contract milestone and/or to the project completion, the Time Impact Analysis must show that the Change Order/Delay impacts the intermediate contractual milestone date and/or the updated CPM Schedule's Critical Path, thereby directly impacting the project completion date. Change Orders/Delays that do not impact intermediate contractual milestones and/or the critical path and impact activities with float will not be considered as a delay to the project and no extension of time will be granted.
- C. The Contractor must submit a written analysis within 7 calendar days after a delay occurs or authorized change in work is given to the Contractor. If the Contractor does not submit a written analysis for specific Change Order(s) or Delay(s) within the specified period of time, then it is mutually agreed that the particular Change Order of Delay has no time impact on the Project CPM Schedule and no time extension is required.
- D. The Engineer will accept or reject each Time Impact Analysis within 14 calendar days after submission, unless subsequent meetings and negotiations are necessary. Upon the Engineer's acceptance, the Contractor will incorporate fragnets

illustrating the influence of the Change Orders and Delays into the Detailed CPM Schedule during the first update after agreement is reached.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01325
CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall have digital pictures, photographs, and DVDs made of the Work from views and at such times as requested by the Owner or Owner's Representative. These photographs shall represent a visual history of the Project, from Contract Award through Contract Completion.
- B. The Contractor shall take a preconstruction video of the entire site, including the areas of adjacent properties within 100 feet of the limit of Work. Special effort shall be made to show the existing paved roads, shoulders, signs, and other existing features.
- C. The Contractor shall also use electronic "snap-shot" photography as necessary to record and facilitate resolution of on-site issues through the transmission of electronic photographs by e-mail from the site to the Engineer's and Owner's offices.

PART 2 PRODUCTS

2.01 PRODUCTS

- A. Photographs shall be digital and in color. Provide one copy of each digital picture on each of three CDs.
- B. Provide photographs taken of each of the major items during construction.
- C. View and Quantities Required: A minimum of 30 photographs per month clearly showing project status and key elements of construction.
- D. Deliver electronic images to the Engineer with every pay request.
- E. Capture and provide digital, true-color, aerial photographs and videos of the complete project site before beginning construction, during construction, and at final completion. The aerials shall be captured digitally utilizing a drone with high-quality camera.

- F. Provide and update aerial photo monthly, providing two copies on disk. Each month provide aerial photos taken at the same elevation and orientation. Provide up to four views to show the complete site progress.

PART 3 EXECUTION

3.01 VIEWS REQUIRED

- A. Photographs shall be from locations to illustrate the condition of construction and the state of progress adequately.
- B. The Contractor shall provide before and after photographs of each portion of the site. The below-ground facilities shall include all equipment, walls, floor, piping, supports, and entrance. At major location photographs shall include before, during, and after prints and all prints shall be placed in binders in ascending date order to show the Work as it progresses.

3.02 DESCRIPTIVE INFORMATION

- A. Each photograph shall have a permanent title block on the back and shall contain the typed information and arrangement as follows:

COMPLETE PROJECT NAME

Contract No.

CONTRACTOR:	(Name of Contractor)
DATE:	(When photo was taken)
PHOTO NO.:	(Consecutive Numbers)
PHOTO BY:	(Firm Name of Photographer)
LOCATION:	(Description of Location and View)

- B. The Contractor shall provide the Engineer with a written description of each photograph. This description shall be included in the binders and a copy shall be submitted with the CDs. The Field Engineer or inspector shall approve the description.

3.03 VIDEOTAPE REQUIREMENTS

- A. Major Locations:
 - 1. The Contractor shall provide color digital video of each major facility and structures and facilities adjacent to the construction before construction starts, during construction, and when construction has been completed. Approximately every 2 weeks, 15 minutes of digital video shall be submitted to the Engineer showing Work completed, Work in progress, Work started,

and problems that occurred since the last taping. The Contractor shall maintain the master video CD ROM of each portion of the facility on the Work site. The master video shall be a running chronicle of construction progress. The Contractor shall combine the bi-weekly video onto the master video. The bi-weekly video shall be submitted to the Engineer within 10 working days after recording and the bi-weekly videos may include multiple locations.

2. All videos shall be recorded with character generator operating with date, time, and location on screen. During video recording, the Contractor shall narrate the video, explaining what is being shown, the problem that has occurred, and what is being done. All videos shall be delivered to the Engineer before Final Completion is submitted.

3.04 DIGITAL PHOTO DOCUMENTATION

- A. Catalog and manage Electronic “snap-shots” and images of photographs in a secure digital photo management system capable of being linked to the project schedule and document management database. Add captions, descriptions, and key words. Transfer a copy of all “snap-shots” and photos with their related notes, keywords, captions, and activity IDs to the Engineer weekly.
- B. All prints shall be clear, sharp, and free of distortion after enlargement from the negative. Each photograph shall have a permanent title block in the lower right-hand corner, which shall be 2 1/2 inches high by 6 inches wide and shall contain the information and arrangement as described in Paragraph 3.02A above.

END OF SECTION

SECTION 01330
SUBMITTALS AND ACCEPTANCE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall submit documentation that describes the Work to be performed under the Contract as required in this Section. This documentation will be for the Engineer and Owner's review and use. The documentation furnished by the Contractor must enable the Engineer and Owner to verify the Contractor's performance and compliance with Contract requirements. The documentation shall cover all services and deliverables required and secured by the Contract Documents.

1.02 SUBMITTALS

- A. General—The Contractor shall submit the following:
1. Project documentation: For the Engineer and Owner's internal use and shall include all information that will be essential for the facility's operations, maintenance, training, and repair of equipment and facilities supplied by the Contractor. The Contractor shall submit all documentation necessary to ascertain compliance with technical/contractual provisions.
 2. Shop drawings: Drawings, schedules, diagrams, warrant, and other data prepared specifically for this Contract by the Contractor or through the Contractor by way of subcontractor, manufacturer, supplier, distributor, or other lower-tier contractor to illustrate a portion of the Work.
 3. Product data: Preprinted materials such as illustrations, standard schedules, performance charts, instructions, brochures, diagrams, manufacturer's descriptive literature, catalog data, and other data to illustrate a portion of the Work, but not prepared exclusively for this Contract.
 4. Samples: Physical examples of products, materials, equipment, assemblies, or workmanship that are physically identical to portions of the Work, illustrating portions of work, or establishing standards for evaluating appearance of finished work or both.
 5. Administrative submittals: Data presented for reviews and acceptance to ensure that administrative requirements of the project are adequately met but

not to ensure directly that work is in accordance with the design concept and in compliance with Contract Documents.

6. Mockups: Before installing work requiring mockups, the Contractor shall build mockups for each form of construction and finish required using materials indicated for the completed Work, as follows:
 - a. Build mockups in the location and of the size approved by the Engineer.
 - b. Notify the Engineer 7 days in advance of dates and times when mockups will be constructed.
 - c. Demonstrate the proposed range of aesthetic effects and workmanship.
 - d. Obtain the Engineer's acceptance of mockups before starting work, fabrication, or construction.
 - e. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - f. Demolish and remove mockups when completed work is accepted by the Owner or Owner's Representative.

B. Coordination

1. Submittals and schedules shall be checked and coordinated with the Work of all trades involved before they are submitted and shall bear the Contractor's stamp of approval as evidence of such checking and coordination. Drawings or schedules submitted without this stamp of approval shall be returned to the Contractor for resubmission.

C. Start of Work

1. Within 30 calendar days after the notice to proceed for the project, the Contractor shall submit to the Engineer a Contract Data Requirements List that defines all data to be submitted under this Contract. Included in this list shall be the names of all proposed manufacturers furnishing specified items to the extent known. Review of this list by the Engineer shall in no way relieve the Contractor from providing materials, equipment, systems, and structures fully in accordance with the Specifications.

D. General Requirements

1. The Contractor shall prepare, assemble, and submit all documents as described herein. The Contractor shall submit certification that the documents prepared conform to the Contract requirements and will result in a complete and operable project. The Engineer and Owner shall review

the Contractor's documents for conformance to the Contract requirements and may comment on the documents.

2. The Contractor shall approve and certify all project documents. The Contractor's failure to certify the documents or failure to provide documents that demonstrate conformance to the Contract requirements are grounds for rejection. The Contractor shall be responsible for and bear all costs for proceeding with any part of the Work that fails to meet the Contract requirements.
3. Submittal of documents for the Engineer's review shall in no way relieve the Contractor of full responsibility for providing a complete, safe, reliable, operating, and coordinated Work (system/equipment/facilities) that is in compliance with these Contract documents.

E. Requests for Substitution

1. All requests for substitution shall clearly and specifically indicate any and all differences or omissions between the products specified as basis of design and the product proposed for substitution. Data shall include but not be limited to differences as follows for both the specified and substituted products:
 - a. Principle of operation.
 - b. Materials of construction or finishes.
 - c. Thickness or gauge of materials.
 - d. Weight of item.
 - e. Deleted features or items.
 - f. Added features or items.
 - g. Changes in other work caused by the substitution.
 - h. If the substitution contains differences or omissions not specifically called to the attention of the Engineer, the Engineer reserves the right to require equal or similar features to be added to the substituted product at the Contractor's expense.

F. Submittal Requirements and Procedures

1. Drawing Formats and Requirements
 - a. Drawings—All Drawings and Shop Drawings shall be prepared on 22-x-34-inch paper and shall have a blank area of 3 x 4 inches in the lower right-hand corner above the title block. Each Drawing shall indicate the following information in the title block:
 - (1) Title and Drawing Number.
 - (2) Date of Drawing or Revision.

- (3) Name of Building or Facility.
 - (4) Name of Contractor or subcontractor.
 - (5) Drawing contents and locations.
 - (6) Specification Section and Subsection Numbers.
- b. Required Copies—All drawings submitted shall have a minimum of eight copies distributed in the following way:
 - (1) 2—Owner.
 - (2) 4—Jones Edmunds.
 - (3) 2—Returned.

2. Product Data

- a. Requirements—Product data shall include all catalog cuts, performance surveys, test reports, equipment lists, material lists, diagrams, pictures, and descriptive material. All product data shall be submitted on either 8.5-x-11-inch or folded 11-x-17-inch size paper of 20-pound (9.072 kg) weight. The submittal information shall show the standard and optional product features, as well as all performance data and specifications. The manufacturer's recommendation for special tools shall be supplied.

3. Samples—The Contractor shall furnish samples required by the Contract Documents, for review by the Engineer. Samples shall be delivered to the Engineer as specified or directed.

- a. All samples shall be of sufficient size and quantity to illustrate clearly the functional characteristics of the product, with integrally related parts and attachment devices. The samples shall show the full range of color, texture, and pattern.
- b. The Contractor shall submit a minimum of four samples of items submitted. All samples shall be marked with required submittal information, as specified above.

4. Color, Texture, and Pattern Charts

- a. The Contractor shall submit color, texture, or pattern charts of all required finishes.
- b. A minimum of four charts of each item shall be submitted.

5. Submittal Information Requirements

- a. When used in the Contract Documents, the term "Submittal Information" shall be considered to mean the following information at a minimum:
 - (1) Contract Name.
 - (2) Contract Number.
 - (3) Location within the Facility.
 - (4) Date Submitted.
- b. Drawings—The Contractor shall mark submittal information on all Drawings in the left half of the 4-x-3-inch block as described above.
- c. Product Data and Manufacturer's Literature—The Contractor shall mark all product data and manufacturer's literature with submittal information and note which item is being furnished. The Contractor shall mark the option and supplies to be furnished with the item. At least one original manufacturer product data sheet must be submitted; the balance can be copied. Do not submit the manufacturer's general catalog; submit only items being installed or delivered. When manuals are being submitted, the Contractor shall mark submittal information on both the cover and title page. If manuals being submitted contain more than just one item, each item must be marked and only Contract name and number is to be marked on the cover and title page.

6. Training, Operation and Maintenance Manuals

- a. The Contractor shall submit to the Engineer for review and acceptance of manufacturer's installation, operations, lubrication, maintenance, and training manuals for all equipment installed or delivered under this Contract. All manuals shall have submittal information marked on the front cover, title page, and three places inside the manual. If the manual being submitted is for different components, mark the front cover and title page only. Each component section must be marked with the Specification Section and subsection numbers. Operations and Maintenance Manuals shall conform to requirements defined in Section 01830, Operations and Maintenance Manuals, and Section 01820, Training.

G. Required Submittals

1. Architectural and Structural Submittals

- a. This Section specifies general procedural requirements for contractual submittals for the following architectural and structural schedules, product data, samples, and manufacturer's certificates.
 - (1) Product Data—The Contractor shall provide product data for all architectural and structural items, options, and other data and provide supplemental manufacturer's standard data for information unique to the Work and installation. The submittals shall reflect all items delivered or installed under this Contract.
 - (2) Samples—The Contractor shall provide all samples required under this Specification including color charts and product samples.
 - (3) Material, equipment, and installation and demolition Specifications.

2. Mechanical and Electrical System Submittals

- a. This Section specifies general procedural requirements for mechanical schedules, performance data, control diagrams, and other submittal data.
- b. The Contractor shall submit the following:
 - (1) Performance Data.
 - (2) Power and Riser Diagrams—Single line riser, power diagrams, and all conduit runs shall be provided for all equipment and facilities.
 - (3) Wiring Diagrams—Elementary controls diagrams and separate wiring diagrams for mechanical and electrical unit/subsystem. Drawing for starting and shutdown of equipment including controls shall be provided, including a comprehensive description of operation.
 - (4) Finished Data—Complete surface preparation and finished data for all mechanical and electrical unit/subsystems shall be provided, including a complete list of cleaning instructions.

- (5) Factory Testing—Detailed description of factory testing procedures, reporting procedures and criteria for test passing or failing shall be provided for all mechanical and electrical units/subsystems. Testing shall comply with the General Requirements and Technical Requirements Sections.
- (6) Site (Field) Testing and Acceptance—Detailed description of site testing and acceptance tests including descriptions of procedures, testing equipment, reporting procedures, and criteria for passing or failing tests shall be provided for all mechanical and electrical units/subsystems. Testing shall comply with General Requirements and Technical Requirements.
- (7) Factory Test Report—After fabrication and testing, the Contractor shall submit the results of tests. No shipment of any mechanical and electrical unit/subsystem shall be allowed without the written certification from the Contractor that the equipment conforms to the Contract requirements.
- (8) Site Test and Acceptance Report—Site test and acceptance reports shall be submitted to the Owner and Engineer.
- (9) Operations and Maintenance Manuals—The Contractor shall furnish manuals for all mechanical and electrical equipment specified under this Contract. Each manual shall include the following at a minimum:
 - (a) Description of equipment.
 - (b) Record shop drawing.
 - (c) Operation and maintenance instructions.
 - (d) Part lists.
 - (e) Equipment ratings.
 - (f) Valve list.
 - (g) Lubrication instructions.

- c. Compliance with this Section does not relieve the Contractor from compliance with the requirements of Section 01830, Operations and Maintenance Manuals.

H. Submittal Review

1. The Engineer's review of the Contractor's documents shall not relieve the Contractor of the responsibility for meeting all of the requirements of the Contract nor of the responsibility for correcting the documents furnished. The Contractor shall have no claim for additional cost or extension in time because of delays due to revisions of the documents that may be necessary for ensuring compliance with the Contract.
2. The Engineer will review a submittal or re-submittal once, after which the cost of review shall be borne by the Contractor. The cost of Engineering shall be equal to the Engineer's full cost.
3. No partial submittals will be reviewed. A submittal or re-submittal not complete will be returned to the Contractor for completing and re-submittal.
4. Documents submitted by the Contractor for approval by the Engineer will be returned bearing a project-specific stamp bearing the dated signature of the reviewer and one of four boxes checked:
 - a. NO EXCEPTIONS NOTED—This indicates that the submittal appears to be in compliance with the requirements of the performance specifications and that the Work may proceed.
 - b. MAKE CORRECTIONS NOTED—This indicates that the reviewer has added a minor correction to the submission and that the Work (modified in accordance with the correction comment) may proceed. The Contractor shall accept the responsibility of the modified document and resulting Work with no additional compensation.
 - c. AMEND AND RESUBMIT—This indicates that the submittal will require Contractor modifications based on the reviewer's comments that accompanied the returned submittal. The Contractor will be cautioned that work may not proceed under this review status.
 - d. REJECTED—This indicates that the submittal is not in conformance with the requirements of the performance Specifications and cannot be modified to gain compliance. A new submittal will be required in the instance of a "reject" status and the Contractor will be cautioned that work may not proceed under this condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTAL PROCEDURES

- A. Before submitting documents for the Engineer's review, the Contractor shall review the documentation for conformance to the Contract requirements. Submittals shall be complete and comprise a logical division of the Contract Work.
- B. All documentation submitted by the Contractor to the Engineer shall be accompanied by a letter of transmittal and shall be submitted in a sequence that allows the Engineer to have all of the information necessary for checking and accepting a particular document at the time of submittal.
- C. Each document shall be identified by a document number, Contract number, Contract name, location, Specification Section, subsection numbers, and submittal date. Where a manual/drawing is revised to reflect a change in design or a change for any other reason, each such revision shall be shown by a revision number, date, and subject in a revision block. Indication of official approval by the Contractor's Project Manager shall also be included. To permit rapid location of the revision, additional notation shall be made in the manual opposite the line or area where the change was made and identified by the corresponding revision number.

3.02 DOCUMENTATION CONTROL AND SUBMITTAL SEQUENCING

- A. The Contract Data Requirements List shall be updated and resubmitted to the Engineer monthly throughout the duration of the Contract. This list shall identify the Contractor's submittal number, proposed and actual submittal date, Contract Specification Section Number, Paragraph, Item of the Work, and type of document.
- B. The Contractor shall work with the Engineer to provide a regulated flow of submittals that allows the Engineer to review the submittals in the defined timeframe without undue delays. Monthly the Contractor shall provide the Engineer a schedule of the approximate quantities and delivery dates for all submittals due for the next 120 days.

3.03 FINAL RECORD DRAWINGS

- A. The Contractor shall submit the Final Record Drawing Package to the Engineer for review 60 days before Final Completion. The Contractor shall be provided with CADD files, AutoCAD Version 2016. Final Record Drawings shall be printed on 22-x-34-inch sheets and on CDs, AutoCAD Version 2016. The Contractor may request to use a different version, but it must be approved by the Engineer.

3.04 REQUIREMENTS FOR SUBMITTAL

- A. Additional documents, drawings, interface data, and other pertinent project submittal data are listed in specific sections of this Contract.

3.05 RECORD PRINTS

- A. The Contractor shall submit one set of all record prints before final completion. The record print or project records shall include submittals, catalog cuts, drawings, calculations, test reports, manufacturer's data, maintenance manuals, installation instructions, and operating manuals. All "record prints" shall be delivered to the Engineer in three-ring binders with dividers and shall be placed in order by Specification Section.

END OF SECTION

SECTION 01350
ENVIRONMENTAL PROTECTION PROCEDURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Work covered by this Section consists of furnishing all labor, materials, and equipment and performing all work required for the prevention of environmental pollution in conformance with applicable laws and regulations during and as the result of construction operations under this Contract. In this Section *environmental pollution* is defined as the presence of chemical, physical, or biological elements or agents that adversely affect human health or welfare, unfavorably alter ecological balances of importance to human life, affect other species of importance to humans, or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires considering air, water, and land and involves managing noise and solid waste as well as other pollutants.
- C. The Contractor shall schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the Work. The Contractor shall provide erosion-control measures such as diversion channels, sedimentation or filtration systems, berms, staked hay bales, seeding, mulching or other special surface treatments that are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion-control measures shall be in place in an area before any construction activity in that area. Specific requirements for erosion and sedimentation controls are specified in Section 02370, Erosion and Sedimentation Control.
- D. This Section is intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- E. All phases of sedimentation and erosion control shall comply with and be subject to the laws of the State of Florida and the Project Environmental Resource Permit.

1.02 SUBMITTALS

- A. The Contractor shall prepare a sedimentation and erosion-control drawing meeting the requirements of the law and furnish two copies of the approved Drawing to the Engineer.

1.03 WORK SEQUENCE

- A. Before beginning the Work, the Contractor shall meet with the Engineer to establish agreed-upon compliance with these provisions and administration of the environmental pollution control program.
- B. The Contractor shall remove temporary environmental control features when approved by the Engineer and incorporate permanent control features into the project at the earliest practicable time.

1.04 REFERENCE STANDARDS

- A. Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.
 - 1. State of Florida Erosion and Sedimentation Control Designer and Reviewer Manual.
 - 2. State of Florida Erosion and Sedimentation Control Field Manual.
 - 3. Florida Department of Transportation (FDOT)
 - a. FDOT Section 103—Temporary Work Structures.
 - b. FDOT Section 104—Prevention, Control, and Abatement of Erosion and Water Pollution.
 - c. FDOT Section 530—Riprap.
 - d. FDOT Section 982—Fertilizer.
 - e. FDOT Section 985—Geotextile Fabrics.
- B. The Contractor shall comply with all applicable Federal, State, and local laws and regulations concerning environmental pollution control and abatement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EROSION CONTROL

- A. The Contractor shall control erosion by minimizing the flow of surface water runoff through areas with disturbed soils. Erosion-control measures, such as siltation basins, hay check dams, mulching, jute netting, and other equivalent

techniques shall be used as appropriate. Surface water shall be prevented from flowing into excavated areas. At the completion of the Work, temporary grading to control stormwater shall be removed and the ground surface restored to its original condition.

3.02 PROTECTION OF STREAMS AND SURFACE WATERS

- A. Care shall be taken to prevent or reduce to a minimum any damage to any stream or surface water from pollution by debris, sediment, or other material or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing or that contains oils or sediments that will reduce the quality of the water in the stream shall not be directly returned to the stream. Such waters shall be diverted through a settling basin or filter before being directed into streams or surface waters.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water, or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.
- C. All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with a contingency action plan approved by the Florida Department of Environmental Protection and the US Environmental Protection Agency. The Contractor shall submit two copies of approved contingency plans to the Engineer.
- D. Water being flushed from structures or pipelines after disinfection with Cl_2 shall be treated with a dechlorination solution approved by the Engineer before discharge.

3.03 PROTECTION OF LAND RESOURCES

- A. After completion of construction, the Contractor shall restore land resources within the project boundaries and outside the limits of permanent work to a condition that will appear to be natural and not detract from the appearance of the project. All construction activities shall be confined to areas shown on the Drawings.
- B. The Contractor shall mark all trees over 8 inches diameter at breast height, that the Contractor plans to remove. The Contractor shall schedule a field review meeting with the Owner and receive the Owners permission prior to the removal of any tree over 8 inches in diameter at breast height.

- C. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, the Contractor shall first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- D. The Contractor shall protect trees that may possibly be defaced, bruised, injured, or otherwise damaged by the construction equipment, dumping, or other operations by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly.
- E. Any trees or other landscape features scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to their original condition. The Owner will decide the method of restoration to be used and whether damaged trees shall be treated and healed or removed and disposed of.
 - 1. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 1 inch in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.
 - 2. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and, in the opinion of the Owner, are beyond saving shall be immediately removed and replaced.
- F. The Contractor's storage and other construction buildings required temporarily in the performance of the work shall be located in cleared portions of the job site or areas to be cleared as shown on the Drawings and approved by the Engineer and shall not be within wetlands or floodplains. Preserving the landscape shall be required in the selection of all sites and in the construction of buildings. Drawings showing storage facilities shall be submitted for the Engineer's approval.
- G. If the Contractor proposes to construct temporary roads or embankments and excavations for plant and/or work areas, the Contractor shall submit the following for approval at least 10 days before the scheduled start of such temporary work:
 - 1. A layout of all temporary roads, excavations, embankments, and drainage to be constructed within the work area.
 - 2. Details of temporary road construction.

3. Drawings and cross-sections of proposed embankments and their foundations, including a description of proposed materials.
 4. Landscaping drawings showing the proposed restoration of the area. The proposed removal of any trees and shrubs outside the limits of the existing clearing area must be indicated. Locations of guard posts or barriers required to control vehicular traffic and protect trees and shrubs to be maintained undamaged must also be indicated. The drawings shall provide for the obliteration of construction scars as such and shall provide for a natural appearing final condition of the area. Modification of the Contractor's approved drawings shall be made only with the written approval of the Engineer. No unauthorized road construction, excavation, or embankment construction including disposal areas will be permitted.
- H. The Contractor shall remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess waste materials, or any other vestiges of construction. It is expected that excavation, filling, and plowing of roadways will be required to restore the area to near natural conditions that will permit the growth of vegetation within the roadway areas. The disturbed areas shall be prepared and seeded as approved by the Engineer or Owner.
- I. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

3.04 PROTECTION OF AIR QUALITY

- A. Burning—Burning will not be permitted at the project site for the disposal of refuse and debris.
- B. Dust Control—The Contractor shall maintain all excavations, embankment, stockpiles, access roads, plant sites, waste areas, borrow areas, and all other work areas within or outside the project boundaries free from dust which could cause the standards for air pollution to be exceeded and which would cause a hazard or nuisance to others.
- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer.
- D. To be approved, sprinkling must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor shall have sufficient competent equipment on the job to accomplish this. Dust control shall

be performed as the Work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Owner.

3.05 NOISE CONTROL

- A. The Contractor shall make every effort to minimize noises caused by the construction operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with Federal and State regulations.

3.06 MAINTENANCE OF POLLUTION-CONTROL FACILITIES DURING CONSTRUCTION

- A. During the life of this Contract, the Contractor shall maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

END OF SECTION

SECTION 01355
SPECIAL PROVISIONS

PART 1 GENERAL

1.01 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.

1.02 WARRANTIES

- A. Warranties shall be in accordance with the Contract Documents.
- B. Unless specified otherwise in the Contract Documents, all equipment supplied under these Specifications shall be warranted by the Contractor and the equipment manufacturers for 1 year. The warranty period shall begin on the date of Owner acceptance.
- C. The equipment shall be warranted to be free from defects in workmanship, design, and materials. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s) and the unit(s) restored to service at no expense to the Owner.
- D. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining equipment warranties in accordance with Section 01780, Warranties and Bonds, from each of the respective suppliers or manufacturers for all the equipment specified under Divisions 11, Equipment, 13, Special Construction, 15, Mechanical, and 16, Electrical.
- E. If the manufacturer is unwilling to provide a 1-year warranty beginning at the time of Owner acceptance, the Contractor shall obtain from the manufacturer a 2-year warranty starting at the time of equipment delivery to the job site. This 2-year warranty shall not relieve the Contractor of the 1-year warranty starting at the time of Owner acceptance of the equipment.

1.03 INSTALLATION OF EQUIPMENT

- A. The Contractor shall take special care to ensure proper alignment of all equipment with particular reference to the pumps and electric drives. The units shall be carefully aligned on their foundations by qualified millwrights after the units' sole plates have been shimmed to true alignment at the anchor bolts. The anchor bolts

shall be set in place and the nuts tightened against the shims. After the Engineer has approved the foundation alignments, the bedplates or wing feet of the equipment shall be securely bolted in place. The Contractor shall further check the alignment of the equipment after it is secured to the foundations and, after all alignments are conformed, shall finally grout the sole plates in place. The Contractor shall be responsible for the exact alignment of equipment with associated piping and under no circumstances will "pipe springing" be allowed.

- B. The Contractor shall furnish all wedges, shims, filling pieces, keys, packing, grout, or other materials necessary to properly align, level, and secure apparatus in place. All parts intended to be plumb or level must be proven to be exactly so. The Contractor shall perform all grinding necessary to bring parts to proper bearing after erection.

1.04 SLEEVES AND OPENINGS

- A. The Contractor shall provide all openings, channels, chases, etc., in new construction and furnish and install anchor bolts and other items to be embedded in concrete, as required to complete the Work under this Contract. The Contractor shall perform all cutting, coring, and rough and finish patching required in existing construction for the work of all trades.
- B. Subcontractors shall furnish all sleeves, inserts, hangers, anchor bolts, etc., required for the execution of their work. Before the work of the Contractor begins, the subcontractors shall be responsible for furnishing the Contractor with the above items and with templates, drawings, or written information covering chases, openings, etc., which they require and to follow up the work of the Contractor as it progresses, making sure that their drawings and written instructions are carried out. If the subcontractors fail to do this, they shall be responsible for the cost of any corrective measures that may be required to provide necessary openings, etc. If the Contractor fails to carry out the directions given him, covering details and locations of openings, etc., he shall be responsible for any cutting and refinishing required to make the necessary corrections. In no case shall beams, lintels, or other structural members be cut without the approval of the Engineer.

1.05 GREASE, OIL, AND FUEL

- A. The Contractor shall furnish all grease, oil, and fuel required for testing equipment with the respective equipment. The Owner shall be furnished with a year's supply of required lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied under Divisions 11, Equipment, 13, Special Construction, 15, Mechanical, and 16, Electrical.

1.06 TOOLS

- A. The Contractor shall furnish any special tools (including grease guns or other lubricating devices) that may be necessary for the adjustment, operation, and maintenance of any equipment with the respective equipment.
- B. Tools shall be furnished in heavy steel tool boxes complete with lock and duplicate keys.

1.07 POWER SUPPLY (NOT USED)

1.08 POWER FACTOR CORRECTION CAPACITORS

- A. Capacitors shall be installed under Division 16, Electrical.

1.09 ARCHITECTURAL COATINGS (NOT USED)

1.10 PIPE MARKING

- A. Pipe marking is included in Division 9, Finishes, under Painting and Coating, but it shall be the Contractor's responsibility, as required by the Engineer, to help identify pipe contents, direction of flow, and all else required for proper marking of pipe.

1.11 VALVE IDENTIFICATION

- A. The Contractor shall prepare a valve schedule for all valves required for the Work showing a number, the location, type, function, and normal operating position for each valve. The schedule shall be submitted to the Engineer for approval not less than 120 days before start-up. The Contractor shall coordinate valve identification with Section 15110, Manual, Check, and Process Valves.
- B. The Contractor shall furnish tags for all valves required for the Work. Valve tags shall be 2-inch-diameter, 19-gauge, brass or plastic, with brass hooks suitable for attaching the tag to the valve operator. Tags shall be stamped or etched with the valve number and the information on the valve schedule coded in a system provided by the Owner. The Contractor shall submit two samples of the type of tag proposed and the manufacturer's standard color chart and letter styles to the Engineer for approval.
- C. The Contractor shall install valve tags on all valves required for the Work.

1.12 NOISE LIMITATIONS

- A. All equipment to be furnished under this Contract, unless specified otherwise in the Technical Specifications, shall be designed to ensure that the sound pressure level does not exceed 85 decibels (dB) over a frequency range of 37.8 to 9,600 cycles per second at a distance of 3 feet from any portion of the equipment, under any load condition, when tested using standard equipment and methods. Noise levels shall include the noise from the motor. Mufflers or external baffles shall not be acceptable for reducing noise. Data on noise levels shall be included with the shop drawing submittal.

1.13 SPARE PARTS

- A. Where spare parts are specified in the Specification Sections, the Contractor shall furnish all spare parts recommended by the manufacturer or system supplier for 1 year of service. In addition, the Contractor shall furnish all spare parts itemized in each section.
- B. The Contractor shall collect and store all spare parts in an area to be designated by the Engineer and shall furnish the Engineer with an inventory listing all spare parts, the equipment they are associated with, the name and address of the supplier, and the delivered cost of each item. Copies of actual invoices for each item shall be furnished with the inventory to substantiate the delivery cost.
- C. Spare parts shall be packed in cartons properly labeled with indelible markings with complete descriptive information, including manufacturer, part number, part name, and equipment for which the part is to be used and shall be properly treated for 1 year of storage.

1.14 HURRICANE PREPAREDNESS PLAN

- A. Within 30 calendar days of the date of Notice to Proceed, the Contractor shall submit a Hurricane Preparedness Plan to the Engineer and the Owner for approval. The Plan shall describe in detail the necessary measures that the Contractor will perform, at no additional costs to the Owner, in case of a hurricane warning. The Contractor shall revise the Plan as required by the Engineer and Owner.

1.15 WEATHER PROTECTION

- A. In the event of inclement weather, the Contractor shall protect the Work and materials from damage or injury from the weather. If, in the opinion of the Engineer, any portion of the Work or materials has been damaged by reason of failure on the part of the Contractor to protect the Work, such Work and materials

shall be removed and replaced with new materials and Work to the satisfaction of the Engineer.

1.16 PROVISIONS FOR CONTROL OF EROSION

- A. The Contractor shall take sufficient precautions during construction to minimize the run-off of polluting substances such as silt, clay, fuels, oils, bitumens, calcium chloride, or other polluting materials harmful to humans, fish, or other life, into the supplies and surface waters of the State. Control measures must be adequate to ensure that turbidity in the receiving water will not be increased more than 10 nephelometric turbidity units (NTU), or as otherwise required by the State or other controlling body, in water used for public water supply or fish unless limits have been established for the particular water. In surface water used for other purposes, the turbidity must not exceed 25 NTU unless otherwise permitted. Special precautions shall be taken in the use of construction equipment to prevent operations that promote erosion.

1.17 PROVISIONS FOR THE CONTROL OF DUST AND LITTER

- A. The Contractor shall take sufficient precautions during construction to minimize the amount of dust created. Wetting down the Site may be required to prevent dust as a result of vehicular traffic. Control of blowing litter caused by any regrading by the Contractor shall be the responsibility of the Contractor.

1.18 ON-SITE STORAGE

- A. The Contractor should note that there may be special storage requirements and possible charges for noncompliance of on-site storage requirements for materials and equipment as specified in Section 01600, Materials and Equipment.

1.19 ELECTRICAL POWER AND TESTING EQUIPMENT

- A. The Contractor shall furnish electric power and all equipment and tools required for testing equipment. The cost of this electric power, equipment, and tools shall be included in the prices quoted in the Bid Form.

1.20 PROTECTION AGAINST ELECTROLYSIS

- A. Where dissimilar metals are used in conjunction with each other, the Contractor shall provide suitable insulation between adjoining surfaces to eliminate direct contact and any resulting electrolysis. The insulating material shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other approved materials.

1.21 DAMAGE DUE TO HIGH WATER

- A. The Contractor will be responsible for all damage done to his work by heavy rains or floods and he shall take all reasonable precautions to provide against damages by building such temporary dikes, channels, or shoring to carry off stormwater as the nature of the work may require.

1.22 EMERGENCY PHONE NUMBERS AND ACCIDENT REPORTS

- A. Emergency phone numbers (fire, medical, police) shall be posted at the Contractor's phone and the phone's location shall be made known to all.
- B. Accidents shall be reported immediately to the Engineer by messenger or phone.
- C. The Contractor shall document all accidents and shall submit to the Engineer a fully detailed written report about the accident after each accident.

1.23 ITEMS SPECIFIED ON DRAWINGS

- A. Items of material, equipment, machinery, and the like may be specified on the Drawings and not in the Specifications. The Contractor shall provide such items in accordance with the Specification on the Drawings.

1.24 DISINFECTION

- A. The Contractor shall clean, disinfect, and bacteriologically test and clear, in accordance with Chapters 62-550, 62-555, and 62-560 of the Florida Administrative Code (FAC), all water supply facilities affected by this project which shall come into contact with raw water, water being treated, or treated water before placing the facility in operation. This shall apply to new facilities installed as well as to existing facilities that are to be modified.
- B. The Contractor shall employ a disinfection method approved by the Engineer and Owner and shall fully satisfy the Owner that adequate disinfection has been achieved before placing a facility on-line.
- C. The cost of all disinfection work shall be included in the prices quoted in the Proposal. The Owner shall pay for all bacteriological clearance tests.

1.25 SALVAGE

- A. Any existing equipment or material, including but not limited to valves, pipes, fittings, couplings, etc., that is removed or replaced as a result of construction under this project may be designated as salvage by the Engineer or Owner and, if

so, shall be excavated, if necessary, and shall be cleaned and stored on or adjacent to the Site in a protected place specified by the Engineer or loaded onto trucks provided by the Owner. Any equipment or material not worthy of salvaging, as determined by the Owner, shall be disposed of by the Contractor at a suitable location at the Contractor's expense.

1.26 WORKMANSHIP, MATERIAL, AND EQUIPMENT

- A. When a particular product or products are specified or called for, it is intended and shall be understood that the proposal tendered by the Contractor include those products in his bid. Should the Contractor desire to substitute a product or products equal to those specified, the Contractor shall furnish information as described in the Standard General Conditions. The alternate product or products submitted by the Contractor shall meet the requirements of the Specifications and shall, in all respects, be equal to the product or products specified by name in the Specifications.
- B. All apparatus, mechanisms, equipment, machinery, and manufactured articles for incorporation into the Work shall be the new and unused standard products of recognized reputable manufacturers.

1.27 SERVICES OF MANUFACTURERS' FIELD SERVICE TECHNICIAN

- A. Bid prices of equipment furnished under Divisions 11, Equipment, 15, Mechanical, and 16, Electrical, shall include the cost of a competent field service technician of the manufacturers of all equipment to supervise the installation, adjustment, and testing of the equipment and to instruct the Owner's operating personnel on operation and maintenance. The approved manufacturer's operation and maintenance data as specified in Section 01830, Operations and Maintenance Manuals, shall be delivered to the Engineer before instructing the Owner's personnel. This supervision may be divided into two or more periods as required by the installation program.
- B. After the equipment has been installed and the equipment is presumably ready for operation, but before it is operated by others, the manufacturers' field service technician shall inspect, operate, test, and adjust the equipment. The inspection shall include at least the following points where applicable:
 - 1. Soundness (without cracked or otherwise damaged parts).
 - 2. Completeness in all details, as specified and required.
 - 3. Correctness of setting, alignment, and relative arrangement of various parts.
 - 4. Adequacy and correctness of packing, sealing, and lubricants.
 - 5. Calibration and adjustment of all related instrumentation and controls.

6. Energize equipment.
 7. Deficiency correction.
 8. Demonstration of compliance with application performance specification.
- C. The operation, testing, and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.
- D. Upon completion of this operation, testing, and adjustment, the manufacturers' field service technician shall submit to the Engineer, in triplicate, a complete, signed report of the results of the inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance.
- E. Each equipment manufacturer shall provide instruction to the Owner's operating personnel. Training shall not be performed until the requirements of Paragraphs B, C, and D above have been fully satisfied and any specified performance testing completed. Training shall be provided for the number of days specified in each equipment section of these Specifications. Training shall be provided on an 8-hour-per-day basis. Partial days (less than 8 full working hours) shall not be credited toward the specified durations. Training shall not be concurrent with on-going testing, debugging, or installation activities but shall be a separate activity devoted exclusively to the instruction of the Owner's personnel in the operation and maintenance of the manufacturers' equipment. Training shall be performed by qualified representatives of each equipment manufacturer specifically skilled in providing instruction to operation personnel. Training shall provide an overview of operations and maintenance requirements and shall include but not be limited to the following:
1. Description of unit and component parts.
 2. Operating capabilities and performance criteria.
 3. Operating procedures.
 4. Maintenance procedures
 5. Servicing and lubrication schedules.
 6. Troubleshooting.
 7. Electrical instrumentation and control requirements and interface as a minimum. The operating and maintenance data to be provided in accordance with Section 01830, Operations and Maintenance Manuals, shall be used as a basis for training.
- F. A certificate from the manufacturer stating that the installation of the equipment is satisfactory; that the unit has been satisfactorily tested and is ready for operation; and that the operating personnel have been suitably instructed in the operation,

lubrication, and care of the unit shall be submitted before start-up and acceptance by the Owner. The certificate shall indicate date and time the instruction was given and names of the operating personnel in attendance. This certification shall be submitted on the certification sheet included at the end of Section 11000, General Equipment Requirements.

- G. See the detailed Specifications for additional requirements for furnishing the services of the manufacturers' field service technician.
- H. For equipment furnished under Divisions other than 11, Equipment, 15, Mechanical, and 16, Electrical, the Contractor, unless otherwise specified, shall furnish the services of accredited field service technicians of the manufacturer only when some evident malfunction or over-heating makes such services necessary in the opinion of the Engineer.

1.28 OPERATING AND MAINTENANCE DATA

- A. Operating and maintenance data covering all equipment furnished shall be delivered directly to the Engineer, for approval, within 60 days before the facility's start-up. No payment shall be made for equipment installed or stored on-site until the Engineer has approved the adequacy and completeness of the operating and maintenance data. Data shall be prepared and submitted in full conformance with Section 01830, Operations and Maintenance Manuals. Final approved copies of operating and maintenance data shall have been delivered to the Engineer on the Owner's behalf 2 weeks before scheduling the instruction period with the Owner.

1.29 RESPONSIBILITY OF CONTRACTOR

- A. The Contractor shall be responsible for the entire Work determined by the Drawings, Specifications, and Contract from the date of the starting of the Work until it is accepted as evidence of approval of the Completion Certificate by the Owner. The Contractor shall be responsible for removals, renewals, and replacements due to action of the elements and all other causes except as otherwise provided in the Specifications. The Contractor shall keep the Contract under his own control and it shall be his responsibility to see that the Work is properly supervised and carried on faithfully and efficiently. The Contractor shall supervise the work personally or shall have a competent English-speaking superintendent or representative, who shall be on the site of the project at all working hours and who shall be empowered with full authority by the Contractor to direct the performance of the Work and make arrangement for all necessary materials, equipment, and labor without delay.

- B. Renewals or repairs required because of defective materials or workmanship or due to the action of the elements or other natural causes, including fire and flood, before the acceptance as determined by the Completion Certificate, shall be done in accordance with the Contract and Specifications at the expense of the Contractor.

1.30 CONSTRUCTION CONDITIONS AND SUBSURFACE INVESTIGATION

- A. The Contractor shall strictly adhere to the specific requirements of the governmental unit(s) or agency(ies) having jurisdiction over the Work. Wherever there is a difference in the requirements of a jurisdictional body and these Specifications, the more stringent shall apply.
- B. The Contractor shall be responsible for having determined to his satisfaction, before submitting his bid, the nature and location of the Work, the conformation of the ground, the character and quality of the substrata, the types and quantity of materials to be encountered, the nature of the groundwater conditions, the character of equipment and facilities needed before and during the execution of the Work, the general and local conditions, and all other matters that can in any way affect the Work under this Contract. The prices established for the work to be done will reflect all costs pertaining to the Work. Any claims for extras based on substrata, groundwater table, and other such conditions will not be allowed.

1.31 SUSPENSION OF WORK DUE TO WEATHER

- A. During inclement weather, all work that might be damaged or rendered inferior by such weather conditions shall be suspended. The orders and decisions of the Engineer as to suspensions shall be final and binding. The ability to issue such an order shall not be interpreted as a requirement to do so. During suspension of the work from any cause, the Work shall be suitably covered and protected so as to preserve it from injury by the weather or otherwise, and if the Engineer shall so direct, the rubbish and surplus materials shall be removed.

1.32 PERMITS

- A. Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Owner to do the Work from the appropriate governmental agency or agencies. No work shall begin until all applicable permits have been obtained and copies delivered to the Engineer. The Contractor shall bear all costs for obtaining all permits.

1.33 PUMPING

- A. The Contractor with his own equipment shall do all pumping necessary to prevent flotation of any part of the structures during construction operations.
- B. For the duration of the Contract and with his own equipment, the Contractor shall pump out water and wastewater that may seep or leak into the excavations or structures. Galleries and other operating areas shall be kept dry at all times. The Engineer will determine the extent of pumping required in the tanks, channels, and other non-operating areas.

1.34 OWNER OCCUPANCY AND OPERATION OF COMPLETED FACILITIES

- A. It is assumed that portions of the Work will be completed before the entire work is completed. Upon completion of construction in each individual facility, including testing, if the Owner, at its sole discretion, desires to accept the individual facility, the Contractor will be issued a dated certificate of completion and acceptance for each individual facility. The Owner will assume ownership and begin operation of the individual facility on that date and the 1-year guaranty period shall begin on that date. The Owner has the option of not accepting any individual completed facility, but accepting the entire work as a whole when it is completed and tested.

1.35 CLAIMS FOR PROPERTY DAMAGE

- A. Upon notification by the Owner or Engineer, the Contractor shall investigate each claim for property damage and shall file, within 10 days of such notification, a statement with the Owner or Engineer setting forth all facts and details relative to the claim.

1.36 DAILY REPORTS

- A. The Contractor shall submit daily reports of construction activities, including non-work days. The report shall include the following:
 - 1. Manpower, number of workers by craft.
 - 2. Equipment on the project.
 - 3. Major deliveries.
 - 4. Activities work with reference to the CPM schedule activity numbers.
 - 5. New problems.
 - 6. Other pertinent information.
- B. A similar report shall be submitted for/by each subcontractor.

- C. The reports shall be submitted to the Engineer's Field Office within 2 days of the respective report date. Each report shall be signed by the Contractor's Superintendent or Project Manager.

1.37 CONNECTIONS TO EXISTING SYSTEMS

- A. The Contractor shall perform all work necessary to locate, excavate, and prepare for connections to the terminus of the existing systems all as shown on the Drawings. The cost of this work and for the actual connection of the existing mains shall be included in the bid for the Project and shall not result in any additional cost to the Owner.

1.38 FINAL GUARANTEE

- A. The Contractor shall guarantee all work for 1 year from the date of the acceptance of Substantial Completion of the Work by the Owner.
- B. If, within the guarantee period, repairs or changes are required in connection with guaranteed work, which in the opinion of the Engineer are rendered necessary as the result of the use of materials, equipment, or workmanship that are inferior, defective, or not in accordance with the terms of the Contract, the Contractor shall do the following promptly upon receipt of notice from the Owner and without expense to the Owner:
 - 1. Place in satisfactory condition in every way all such guaranteed work and correct all defects in the guaranteed work.
 - 2. Make good all damage to the building or site, or equipment or piping, or their contents, 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.
 - 3. Make good any work or material or the equipment and contents of the building, structure, or site disturbed in fulfilling any such guarantee.
- C. If the Contractor, after notice, fails to proceed to comply with the terms of this guarantee within 10 days, the Owner may have the defects corrected and the Contractor and his surety shall be liable for all expenses incurred, provided however, that in 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 of such repairs.
- D. All special guarantees or warranties applicable to specific parts of the Work as may be stipulated in the Contract Specifications or other papers forming a part of this Contract shall be subject to the terms of this Paragraph during the first year of life of each such guarantee. The Contractor shall assemble all special guarantees

and manufacturers' warranties, along with a summary list of the special guarantees and warranties, and deliver these to the Engineer before the Work is accepted.

1.39 AUTOMATICALLY CONTROLLED EQUIPMENT

- A. Whenever batching or mixing plant equipment is required to be operated automatically under the Contract and a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually or by other methods for 48 hours after the breakdown or malfunction, provided this method of operation will produce results otherwise meeting the Specifications.

1.40 EQUIPMENT DATA FORMS

- A. The Contractor shall obtain, prepare, and submit a complete, detailed listing of equipment and motor data for all electrical items furnished under this Contract. This listing shall be submitted with the preliminary draft of Operations and Maintenance Data Manuals on Equipment Data sheets and the Equipment Manufacturer's Certificate of Installation, Testing, and Instruction and the Manufacturer's Certificate of Compliance forms, which are included at the end of Section 11000, General Equipment Requirements.

1.41 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK

- A. With the approval of the Engineer, the Contractor may use on the project such stone, gravel, sand, or other material determined suitable by the Engineer as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding Contract unit price and for the pay item for which the excavated material is used. The Contractor shall replace at his own expense, with other acceptable material, all of that portion of the excavation materials so removed and used which were needed for use in the embankments, backfills, approaches, or otherwise. No charge for the materials used will be made against the Contractor.

1.42 OWNER-FURNISHED MATERIAL

- A. The Contractor shall furnish all materials required to complete the Work. No materials will be furnished by the Owner.

1.43 MAINTENANCE AND LUBRICATION SCHEDULES

- A. The Contractor's attention is directed to Section 01830, Operations and Maintenance Manuals, for requirements relative to the submission of operating and maintenance data for the mechanical equipment. For all mechanical and

electrical equipment furnished, the Contractor shall provide a list including the equipment name, address, and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained.

1.44 INSTALLATION LISTS

- A. All manufacturers or equipment suppliers who propose to furnish equipment or products under Divisions 11, Equipment, 15, Mechanical, and 16, Electrical, shall submit an installation list to the Engineer along with the required Shop Drawings.
- B. The installation list shall include all installation where identical equipment has been installed and has been in operation for at least 1 year.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01400 QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. General

1. This Section defines minimum requirements for the Quality Assurance (QA) Program to be provided by the Contractor. The deliverable documents are defined, along with the method of execution of the QA Program.
2. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with the Contract Document requirements.
3. Specified tests, inspections, and related actions do not limit the Contractor's Quality Control (QC) procedures that facilitate compliance with the Contract Documents.

B. Definitions

1. Quality Assurance services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with Contract requirements.
2. Quality Control services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction comply with requirements.

C. Payment

1. Separate payment will not be made for providing and maintaining an effective Quality Assurance and Quality Control Program, and all costs associated with such a program shall be included in the applicable unit prices, lump-sum prices, or allowances contained in the Contract Price Breakdown.

1.02 WORK SEQUENCE

- A. Where reference is made to a particular standard, the revision in effect at the time of Bid opening shall apply except where a specific date is established.

- B. For products or workmanship specified by association, trades, or other consensus standards, the Contractor shall comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable code.
- C. If specified reference standards conflict with Contract Documents, the Contractor shall request clarification from the Engineer before proceeding.

1.03 QUALITY ASSURANCE

- A. The Contractor shall install all materials and equipment in a neat and first-class workman-like manner.
- B. The Contractor shall replace all existing paving, stabilized earth, curbs, driveways, sidewalks, fences, signs, and other improvements with the same type of material that was removed during construction without increase in the Contract Price or Contract Time.
- C. The Engineer reserves the right to direct the removal and replacement of any items that, in the Engineer's opinion, do not present an orderly and reasonably neat or workman-like appearance, provided such an orderly installation can be made using customary trade methods. The removal and replacement shall be done when directed in writing by the Engineer at the Contractor's own expense and without additional expense to the Owner.

1.04 TOLERANCES

- A. Monitor tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. If manufacturers' tolerances conflict with Contract Documents, request clarification from the Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.05 FIELD SAMPLES

- A. The Contractor shall furnish field samples at the site as required by individual Specifications Sections for review.
- B. Acceptable samples represent a quality level for the Work.

- C. Where field sample is specified in individual sections to be removed, the Contractor shall clear the area after the field sample had been accepted by the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The Contractor is responsible for quality control and shall establish and maintain an effective QC system in compliance with the Contract Documents. The QC system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract requirements. The system shall cover all Work and shall be keyed to the proposed design and construction sequence. The project QC Officer will be held responsible for the quality of work on the job and is subject to removal by the Engineer for non-compliance with quality requirements specified in the Contract. The project QC Officer in this context shall mean the individual with the responsibility for the overall management of the project quality.

3.02 QUALITY CONTROL PLAN

- A. General: Not later than 30 calendar days after receipt of Notice to Proceed, the Contractor shall furnish for review by the Engineer the QC Plan proposed to implement the requirements of the Contract. The Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used. The Engineer will consider an interim plan for the first 30 calendar days of operation.
- B. Content of the QC Plan: The QC Plan shall include, at a minimum, the following to cover all construction operations, both on-site and off-site, including work by subcontractors, fabricators, suppliers, and purchasing agents:
 - 1. A description of the quality control organization, including a chart showing lines of authority for all aspects of the Work specified. The staff shall include a Quality Control Officer who shall report to the Project Manager or executive.
 - 2. The name, qualifications (in résumé format), duties, responsibilities, and authorities of each person assigned a QC function.
 - 3. A copy of the letter to the Quality Control Officer signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the Quality Control Officer, including authority to stop work which is not in compliance with the Contract.

4. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off-site fabricators, suppliers, and purchasing agents.
 5. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will verify that identified deficiencies have been corrected.
 6. Reporting procedures, including proposed reporting formats.
- C. Acceptance of Plan: Acceptance of the Contractor's plan is required before the start of Work. Acceptance is conditional and will be predicated on satisfactory performance during the Work. The Engineer reserves the right to require the Contractor to make changes in its QC Plan and operations, including removing personnel as necessary to obtain the quality specified.
- D. Notification of Changes: After acceptance of the QC Plan, the Contractor shall notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.

3.03 SUBMITTALS

- A. Submittals shall be made as specified in Section 01330, Submittals and Acceptance. The QC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements.

3.04 TESTS

- A. Testing Services
1. All tests to determine compliance with the Contract Documents shall be performed by an independent commercial testing firm acceptable to the Owner. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified standards.
 2. Testing services provided by the Owner are for the sole benefit of the Owner; however, test results shall be available to the Contractor. Testing necessary to satisfy the Contractor's internal Quality Control Procedures shall be the sole responsibility of the Contractor.
 3. When necessary, the Contractor shall interrupt its Work for Owner sampling and testing. The Contractor shall have no Claim for increase in Contract Price or Contract Time due to such interruption. The Contractor shall cooperate in these testing activities as needed.
 4. Testing, including sampling, will be performed by the testing firm's laboratory personnel in the general manner indicated in the Specifications.

- B. Transmittal of Test Reports: Written reports of tests and engineering data furnished by the Contractor for the Engineer's review shall be submitted as specified for Shop Drawings.
- C. Manufacturer's Field Services
 - 1. The manufacturer's field services will be specified in the respective equipment sections.
 - 2. An experienced, competent, and authorized representative of the manufacturer of each item of equipment for which field services are indicated shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed into operation. The manufacturer's representative shall revisit the site as often as necessary until any and all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of the Engineer.
 - 3. Each manufacturer's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, has been operated under full load conditions, and has operated satisfactorily.

3.05 COMPLETION INSPECTION

- A. Final Completion Punch List: Near the completion of all Work, the QC Officer shall inspect the Work and develop a "punch list" of items that do not conform to the approved Drawings and Specifications. Such a list of deficiencies shall be included in the QC documentation and shall include the estimated date by which the deficiencies shall be corrected. The QC Officer or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Engineer that the Facility is ready for the Engineer's final inspection.
- B. Final Inspection and Acceptance: The Contractor's QC Officer and the Engineer will be in attendance at this inspection. Additional Engineer personnel may also be in attendance. The final acceptance inspection will be formally scheduled by the Engineer when all punch list deficiencies have been corrected. Notice will be given to the Engineer at least 14 days before the final inspection and must include the Contractor's assurance that all punch list items will be complete and acceptable by the date scheduled for the final inspection. Failure of the Contractor to have all Contract Work acceptably complete for this inspection will be cause for noncertification of final payment by the Engineer.

3.06 NOTIFICATION OF NONCOMPLIANCE

- A. The Owner or Owner's Representative will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

3.07 REPAIR AND PROTECTION

- A. On completion of testing, inspection, sampling, and similar services, the Contractor shall repair damaged construction and restore substrates and finishes.
- B. The Contractor shall protect all construction exposed by or for Quality Control service activities.
- C. The repair and protection are the Contractor's responsibilities, regardless of the assignment of responsibility for Quality Control services.

END OF SECTION

SECTION 01450
TESTING AND TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Owner will pay for the costs of all passing laboratory tests required to determine soil density, concrete compressive strength, and bacteriological clearance of water main. The cost of all testing shall be paid for from the Bid Item allowance as stated in the Bid Form. Costs will be determined from direct invoices from the testing laboratory to the Contractor. Failed tests will be back-charged to the Contractor at the time of final payment. All required soil, concrete, and bacteriological water testing shall be coordinated with and scheduled by the Contractor.
1. The Contractor shall cooperate with the laboratory to facilitate the execution of required services.
 2. The Owner shall approve the selection of the testing laboratory.
 3. Employment of a testing laboratory shall in no way relieve the Contractor of the obligation to perform work in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK

- A. Conditions of the Contract: Inspections and testing required by laws, ordinances, rules, regulations, orders, or approvals of public authorities.
- B. Respective Sections:
1. Certification of products.
 2. Laboratory tests required and standards for testing.

1.03 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. Submit to the Engineer for review a list and schedule of all tests to be conducted.
- C. Describe test procedures along with duration of tests.

- D. After each inspection and test, the Laboratory shall promptly submit two copies of the laboratory report to the Engineer, one copy to the Contractor, and one copy to the Owner.
- E. Include the following:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Name of field-testing technician or inspector.
 - 4. Date and time of sampling or inspection.
 - 5. Identification of product and Specifications Section.
 - 6. Location in the Project.
 - 7. Type of inspection or test.
 - 8. Date of test.
 - 9. Results of test.
 - 10. Conformance with Contract Documents.
- F. When requested by the Engineer, provide interpretation of test results.

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM D3740—Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - 2. ASTM E329—Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.05 QUALITY ASSURANCE

- A. The Laboratory is not authorized to do any of the following:
 - 1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Approve or accept any portion of the Work.
 - 3. Perform any duties of the Engineer of Record or the Engineer.

- B. The Contractor shall be responsible for the following:
1. Cooperating with laboratory personnel, providing access to work and to manufacturer's operations.
 2. Securing and delivering to the laboratory adequate quantities of representative samples of materials proposed to be used and that require testing.
 3. Providing to the laboratory the preliminary design mix proposed to be used for concrete and other materials mixes that require control by the testing laboratory.
 4. Furnishing incidental labor and facilities:
 - a. To provide access to Work to be tested.
 - b. To obtain and handle samples at the project site or at the source of the product to be tested.
 - c. To facilitate inspections and tests.
 - d. To store and cure test samples.
 5. Notifying the Engineer and laboratory sufficiently in advance of operations to allow the laboratory time to assign personnel and schedule tests.
 6. Employing and paying for the services of the same or a separate, equally qualified independent testing laboratory to perform additional inspections, sampling, and testing required for the Equipment Supplier or Contractor's (as applicable) convenience.
- C. Materials and equipment used in the performance of Work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard requirements for quality and workmanship are indicated in the Contract Documents. The Engineer may require the equipment supplier or Contractor (as applicable) to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor, and no extra charge to the Owner shall be allowed on account of such testing and certification.
- D. If the test and any subsequent retest results indicate that the materials or equipment fail to meet the requirements of the Contract Documents, the

equipment supplier or Contractor (as applicable) shall pay for the laboratory costs directly to the testing firm and these will not be reimbursable to the equipment supplier or Contractor (as applicable).

1.06 QUALIFICATIONS

- A. Comply with requirements of ASTM E329 and ASTM D3740.
- B. Laboratory: Licensed to operate in Florida.
- C. Laboratory Staff: Maintain a full-time Florida-registered Professional Engineer on staff to review the services performed under this project.
- D. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to either National Bureau of Standards (NBS) or accepted values of natural physical constants.
- E. Provide qualified personnel at the site. Cooperate with the Engineer and Contractor in performing services.
- F. Perform specified inspection, sampling, and testing of products in accordance with specified standards.
- G. Ascertain compliance of materials and mixes with requirements of Contract Documents.
- H. Promptly notify the Engineer and Contractor of observed irregularities or non-conformance of Work or Products.
- I. Perform additional inspections and tests required by Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01500
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 RESPONSIBILITY

- A. This Section specifies the minimum requirements for temporary facilities, utilities, and controls required to provide an adequate and safe work site at every stage during construction of the Project. The Contractor is solely responsible for the requirements set forth in this Section.

1.02 ONSITE TEMPORARY

- A. Except as otherwise indicated, the Contractor may, at his option, furnish stand-alone utility plants to provide needed services in lieu of connected services from available public utilities, provided such stand-alone plant facilities comply with all governing regulations. Before availability of temporary utility services, the Contractor will provide trucked-in/trucked-out containerized or unitized services for start-up of construction operations at the site.

1.03 COSTS

- A. Except as otherwise indicated, the costs of providing and using temporary utility services are included in the contract sum.

1.04 TEMPORARY FACILITIES

- A. The types of utility services required for temporary use at the project site include the following (other specific services may be required for specific construction methods of operations):
 - 1. Electrical Power Service.
 - 2. Water Service (potable for certain uses).
 - 3. Sanitary.
 - 4. Storm Sewer or Open Drainage/Run-off Control.
 - 5. Gas (fuel) Service.
 - 6. Internet Service.

1.05 TEMPORARY ELECTRICITY

- A. The Contractor shall make the necessary applications and arrangements and pay all fees and charges for electrical energy for power and light necessary for proper

completion of the Work and during its entire progress up to time of final acceptance by the Owner. The Contractor shall provide and pay for all temporary switches, connections, and meters.

1.06 TEMPORARY WATER

- A. The Contractor shall make all necessary application and arrangements and pay all fees and charges for water necessary for the proper completion of the Project up to the time of final acceptance. The Contractor shall provide and pay for any temporary piping and connections.

1.07 TEMPORARY SANITARY FACILITIES

- A. The Contractor shall provide adequate sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the site of the Work, shall be properly secluded from public observation, and shall be constructed and maintained during the progress of the Work in suitable numbers and at such points and in such manner as may be required or approved.

1.08 CLEANLINESS OF FACILITIES

- A. The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. He shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the Owner, or on adjacent property.

1.09 TERMINATION AND REMOVAL

- A. At the time the need for a temporary utility service has ended or has been replaced by use of permanent services, or no later than the time of final completion, the Contractor shall promptly remove the installation unless requested by the Engineer to retain it for a longer period. Any work that may have been delayed or affected by the installation and use of the temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces, shall be completed at this time. The Contractor shall replace any work damaged beyond acceptable restoration.

1.10 NOISE CONTROL

- A. The Contractor shall provide adequate protection against objectionable noise levels caused by the operation of construction equipment.

1.11 DUST CONTROL

- A. The Contractor shall provide for adequate protection against raising objectionable dust clouds caused by moving construction equipment, high winds, or any other cause.

1.12 WATER CONTROL

- A. The Contractor shall provide for satisfactory disposal of surplus water and shall submit a plan to the Engineer for review before initiating and implementing the plan. Approval shall be obtained from the proper authorities before the use of public or private lands or facilities for such disposal.

1.13 POLLUTION CONTROL

- A. The Contractor shall provide for adequate protection against polluting any public or private lands, lakes, ponds, rivers, streams, creeks, and other such areas by the disposal of surplus material in the form of solids, liquids, gases, or from any other cause.

1.14 ADVERSE IMPACT

- A. The Contractor shall evaluate and assess the impact of any adverse effects on the natural environment that may result from construction operations and shall operate to minimize pollution of air, ground, or surface waters vegetation, and afford the neighboring community the maximum protection during and up to completion of the construction project.

1.15 STREAMS, LAKES, AND OTHER BODIES OF WATER

- A. The Contractor shall take sufficient precautions to prevent pollution of streams, lakes, and reservoirs with fuels, oils, bitumens, calcium chloride, or other harmful materials. He shall conduct and schedule his operations to avoid or otherwise prevent pollution of siltation of streams, lakes, and reservoirs and to avoid interference with the movements of migratory fish.

1.16 CHEMICALS

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

1.17 EROSION CONTROL

- A. The Contractor shall not expose by construction operations a larger area of erosive land at any one time than the minimum necessary for efficient construction operations, and the duration of exposure of the uncompleted construction to the elements shall be as short as practicable. Erosion-control features shall be constructed concurrently with other work and at the earliest practicable time.

1.18 STORAGE FACILITIES

- A. All products, materials, and equipment shall be stored in accordance with the manufacturer's instructions, with seals and labels intact and legible. Products subject to damage by the elements shall be stored in weathertight enclosures. Temperature and humidity shall be maintained within the ranges required by the manufacturer's instructions. Fabricated products shall be stored above the ground on blocking or skids. Products that are subject to deterioration shall be covered with impervious coatings with adequate ventilation to avoid condensation. Loose granular materials shall be stored in a well-drained area on solid surfaces to prevent mixing with foreign matter. Any products that will come in contact with water shall be stored off the ground to prevent contamination.

1.19 INSPECTION

- A. Storage shall be arranged in such a manner to provide easy access for inspection. Periodic inspections shall be made of all stored products to ensure that they are maintained under specified conditions and free from damage or deterioration.

1.20 TEMPORARY PROTECTION

- A. After installation, the Contractor shall provide substantial coverings as necessary to installed products to protect them from damage from traffic and subsequent construction operations. Coverings shall be removed when no longer needed.

1.21 ADJACENT TO WORK

- A. The Contractor shall protect from damage all property along the line of the Work or in the vicinity of or in any way affected by the Work, the removal or destruction of which is not called for by the Drawings. Wherever such property is damaged due to the activities of the Contractor, it shall be immediately restored to its original condition by the Contractor at no cost to the Owner.

1.22 REMEDY BY OWNER

- A. In case of failure on the part of the Contractor to restore such property or make good such damage or injury, the Owner may, after 48 hours' notice to the Contractor, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary and the cost of such repairs, rebuilding, or restoration will be deducted from any monies due or which may become due to the Contractor under this Contract.

1.23 PROTECTION FROM DAMAGE

- A. The Contractor shall be responsible for protecting property in the areas in the vicinity of the Project and for protecting his equipment, supplies, materials, and work against any damage resulting from the elements, such as flooding, rainstorm, wind damage, or other such damage, and shall be responsible for damage resulting from the same. The Contractor shall provide adequate drainage facilities, tie-downs, or other protection throughout the contract period for the protection of his, the Owner's, and other properties from such damage.

1.24 TRAFFIC REGULATION

- A. Signs, marking barricades, and procedures shall conform to the requirements of the Florida Department of Transportation Manual on Traffic Controls and Safe Practices for Street and Highway Construction, Maintenance, and Utility Operations.

1.25 SIGNAGE

- A. The Contractor shall provide and maintain adequate barricades around open excavations.

1.26 REMOVAL OF SIGNAGE

- A. On completion of the Work, the Contractor shall remove all debris, excess materials, barricades, and temporary work, leaving walkways and roads clear of obstructions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01600 MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

This Section includes the minimum requirements for the furnished materials and equipment for this project. The more stringent requirements in the Technical Specification sections shall take precedence over these requirements for any conflicts.

- A. Materials and equipment furnished by the Contractor shall be new and shall not have been in service at any other installation unless otherwise approved. They shall conform to applicable specifications approved in writing by the Engineer.
- B. Manufactured and fabricated products shall be designed, fabricated, and assembled in accordance with the best engineering and shop practices. Like parts of duplicate units shall be manufactured to standard sizes and gauges so as to be interchangeable.
- C. Quantities of items that are identical shall be by the same manufacturer, regardless of the Design Package breakdown.
- D. Equipment sizes, capacities, and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.
- E. Materials and equipment shall not be used for any purpose other than that for which they are designed or specified.
- F. Where materials or equipment are specifically shown or specified to be reused in the Work, special care shall be used in removing, handling, storing, and reinstalling to ensure their proper function in the completed Work.
- G. Material and equipment incorporated into the Work:
 - 1. Shall conform to applicable specifications and standards.
 - 2. Shall comply with size, make, type, and quality specified or as specifically approved in writing by the Engineer.

3. Manufactured and fabricated products:
 - a. Rotating machinery shall be designed and fabricated to provide satisfactory operation without excessive wear and without excessive maintenance during its operating life. Rotating parts shall be statically and dynamically balanced and shall operate without excessive vibration.

1.02 ACCEPTANCE OF MATERIAL AND EQUIPMENT

- A. Only new materials and equipment shall be incorporated in the Work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the Engineer. No material shall be delivered to the site that does not meet the Contract Specifications.
- B. The Contractor shall submit data and samples sufficiently early to permit consideration and acceptance before materials are necessary for incorporating in the work. Any delay of acceptance resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of claim against the Owner.
- C. The materials and equipment used in the Work shall correspond to the approved samples or other data.
- D. If requested, the Contractor shall be required to submit to the Engineer ample evidence that each and every part of the materials, machinery, and equipment to be furnished is of a reliable make and of a type that has been in successful operation within the continental United States. No equipment will be considered unless the manufacturer has designed and manufactured equipment of a comparable type and size for at least 3 years. The Engineer or Owner will not allow any experimental or untried type of material or machinery to be installed.
- E. The equipment specified shall be carefully designed and installed to ensure that it adequately performs all required functions within the specified degree of precision. Each unit shall operate with each of the other parts of the equipment to provide a completely integrated system that shall operate to the satisfaction of the Engineer and Owner.
- F. All equipment, machinery, parts, and assemblies of equipment, machinery, or parts entering into the Work shall be tested as specified. Unless waived in writing by the Engineer, all field and operating tests shall be made in the presence of the Engineer or the Engineer's authorized representative. When such a waiver is issued, the Contractor or manufacturer shall furnish sworn statements in duplicate of the tests conducted and the results of the tests to the Engineer.

- G. The Contractor shall submit copies of welding procedures for all welding. Welders and welding operators shall be selected in accordance with the qualification requirements of the AWS Code. Welders and welding operators for stainless steel shall pass qualification tests using stainless steel filler metal and procedures developed for stainless steel. Procedures, welder, and operator qualifications shall be certified by an independent testing laboratory retained and paid by the Contractor.
- H. The Contractor shall not start fabrication of the Work until the Contractor receives written acceptance of the proof of welding procedures from the Engineer for each type of weld.
- I. The Contractor shall submit copies of mill certificate for each type of rolled steel and as required in the Specifications. The Contractor shall not start fabrication of the work until the Contractor receives written acceptance of all mill certificates from the Engineer.

1.03 MANUFACTURER'S INSTRUCTIONS FOR INSTALLATION

- A. The equipment installation details shall suit the existing and furnished equipment and are subject to acceptance by the Engineer.
- B. Any changes or revisions made necessary by the type and dimensions of the equipment furnished shall be made at the expense of the Contractor who shall furnish detailed drawings showing such changes or revision for the acceptance of the Engineer.
- C. The installation of all work shall comply with the manufacturer's printed instructions. The Contractor shall obtain and distribute copies of such instructions to parties involved in the installation, including six copies to the Engineer for distribution. One complete set of instructions shall be maintained at the job site during installation and until the Project is complete.
- D. All products and equipment shall be handled, installed, connected, cleaned, conditioned, and adjusted in accordance with the manufacturer's instructions and specified requirements. Should job conditions or specified requirements conflict with the manufacturer's instructions, such conflicts shall be called to the Engineer's attention for resolution and revised instructions.
- E. The Contractor shall perform work according to the manufacturer's instructions and not omit any preparatory step or installation procedure unless the instructions are specifically modified or the step or procedure exempted by the Contract Documents.

1.04 INSTALLATION OF EQUIPMENT

- A. The cost of the Work shall include the cost of competent manufacturers' representatives of all equipment to supervise the installation, adjustment, and testing of the equipment and to instruct the Owner's operating personnel on operation and maintenance.
- B. A certificate from the manufacturer stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested, is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit shall be submitted before Substantial Completion. The Manufacturer's Certificate of Compliance and Equipment Manufacturer's Certificate of Installation Testing and Instruction are included in Section 11000, General Equipment Requirements.
- C. The Contractor shall furnish the service of competent manufacturers' representatives for Contractor- or Owner-furnished equipment when evident malfunction or over-heating makes such services necessary or as determined by the Engineer. All such equipment shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.
- D. Special care shall be taken to ensure proper alignment of all equipment with particular reference to mechanical equipment such as pumps and electric drives. These units shall be carefully aligned on their foundations by qualified millwrights after their sole or base plates have been shimmed to true alignment at the anchor bolts. The anchor bolts shall be set in place and the nuts tightened against the shims. After the manufacturer has approved the foundation alignments, the bedplates or wing feet of the equipment shall be securely bolted in place. The alignment of equipment shall be further checked after securing to the foundations. After all alignments are confirmed, the sole or base plates shall be finally grouted in place. The Contractor shall be responsible for the exact alignment of equipment with associated piping, and under no circumstances, will "pipe springing" be allowed. Special installation requirements in the Technical Specifications shall take precedence over the requirements of this Section.
- E. The Contractor shall furnish all wedges, shims, filling pieces, keys, packing, grout, or other materials necessary to properly align, level, and secure an apparatus in place. All parts intended to be plumb or level must be proven exactly so. Any grinding necessary to bring parts to proper alignment after erection shall be done at the expense of the Contractor.
- F. The Contractor shall furnish the necessary materials and construct suitable concrete foundations or pads for all equipment installed by the Contractor, even

though such foundations or pads may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting.

- G. In setting pumps, motors, and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1 inch (2.54 cm) for grout under the equipment bases. Shims used to level and adjust the bases shall be steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and as inconspicuous as possible in the completed work. Unless otherwise permitted, all grout shall be a suitable non-shrinking grout.
 - 1. Grout shall be mixed and placed in accordance with the recommendations of the manufacturer. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamfer around the top edge of the finished foundation.
 - 2. Where such procedure is impracticable, the method of placing grout shall be as permitted. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner and, if necessary, as required by the Engineer, given burlap-rubbed finish, and painted with at least two coats of an acceptable paint.

1.05 SPECIAL TOOLS

- A. Manufacturers of equipment and machinery shall furnish two sets of any special tools (including grease guns or other lubricating devices) required for normal adjustment, operations and maintenance, and disassembly, together with instructions for their use. The Contractor shall preserve and deliver to the Owner these tools and instructions in good order before completing the Contract. Tools shall be high-grade, smooth, forged, alloy tool steel. Grease guns shall be lever-type.
- B. Special tools are considered to be those tools that because of their limited use are not normally available but that are necessary for the particular equipment.
- C. Special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such special tools until completion of the work, at which time they shall be delivered to the Owner.

1.06 LUBRICATION SYSTEM

- A. The minimum design criteria for lubricating moving parts of the equipment shall include 1 week of continuous operation during which no lubricants shall be added to the system.
- B. The system shall be designed to receive lubricants whether in operation or shut down and shall not leak or waste lubricants under either condition. The manufacturer's recommendations of grade and quality and a supply of the lubricants so recommended in quantities sufficient to conduct start-up and testing operations shall be furnished with the equipment.

1.07 TESTS AND TEST REPORTS

- A. When used in the Contract Documents, "Factory/Fabricating Shop Performance, Evaluation, Certification, and/or Acceptance Tests and Test Reports" shall be considered to mean the corresponding manufacturer's, fabricator's, and/or other builder's official test and tests reports. Included in these test reports shall be appropriate substantiating documentation/data ascertaining the correct and complete manufacture, fabrication, and "shop performance" (to the greatest extent normally practicable) of the particular material, equipment, system, and/or facilities proposed for eventual delivery. These are subdivided into three significant tests and test report types: 1) Certification Tests and Test Reports, 2) Factory Tests and Test Reports, and 3) Shop Performance/Evaluation Tests and Test Reports. Minimal requirements are described below.
- B. Certification Tests and Test Reports
 - 1. Standard specifications, code references, etc. for minimum quality and workmanship levels are indicated in the Contract Documents and Construction Documents. Statements, certificates, and other substantiating reporting data, called "Certification Test Reports" in this Section, of tests conducted on previously manufactured materials or equipment identical to that proposed for use shall be compiled by the Contractor.
 - 2. At a minimum, all Certification Test Reports shall contain an official analysis of sufficient material composition or show evidence of meeting or exceeding the specified material standard(s) referenced, e.g., ASTM, ASME, or other designations. All reports shall also indicate from whom the material was/will be purchased.
 - 3. The Contractor shall pay all costs of certification tests and test reports.

C. Factory Tests and Test Reports

1. Additional tests and reports performed on material or equipment by the manufacturer or fabricator to ascertain quality or workmanship are referred to here as "Factory Tests and Test Reports."
2. Before the delivery of any Factory Test Report, the Contractor shall first submit for review and approval a detailed description of the proposed testing, including reporting procedure and criteria. Such descriptions shall also be delivered to the Engineer for review as part of the first submission of the technical submittal.
3. Materials and equipment used in the performance of the Work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. If Work to be accomplished away from the construction site is to be inspected on behalf of the Owner during its fabrication or manufacture, the Contractor shall give prior notice to the Engineer of the place and time where such fabrication or manufacture is to be done. Such notice shall be in writing and delivered to the Engineer not less than 30 days before the Work is to be done so that the necessary arrangements for the particular factory inspection tests can be made.
4. Upon completion of the factory inspection tests and immediately following manufacture or fabrication, the Contractor shall compile a complete Factory Test Report following the approved format above. All such reports shall be delivered to the Engineer for review as part of the technical submittal corresponding to such tested material or equipment.

D. Shop Performance/Evaluation Tests and Test Reports

1. Material and equipment used in the performance of the Work of this Contract are also subject to evaluation and testing after the complete full-scale assembly into major equipment and/or systems. Shop Performance/Evaluation Tests, i.e., tests of simulated startup, steady-state, variable loading, and other normal operating conditions, for such assembled equipment/systems shall be accomplished in strict accordance with the standard testing practices specified or otherwise accepted by the Engineer.
2. Before the delivery of any Shop Performance/Evaluation Test Report, the Contractor shall submit for review a detailed description of the proposed performance/evaluation tests, including anticipated reporting procedures, data reduction, and criteria used. Where appropriate, such descriptions shall also be delivered to the Engineer for review as part of a first or subsequent submission of the technical submittal.
3. Should such performance/evaluation tests be accomplished away from the construction site, the Contractor shall give prior notice to the Engineer of the places and times where such tests will be accomplished. Such prior

notice shall be in writing and delivered not less than 30 days before such events so that necessary arrangements for the particular tests can be made.

4. The requirements above pertaining to Factory Tests and Test Reports shall be incorporated for shop Performance/Evaluation Tests and Test Reports. Unless factory tests are coincident with shop performance tests and vice versa for the same material or equipment, a minimum of 15 days shall be scheduled between such multiple equipment tests where extended travel is required.

E. Cost of Performance Shop Tests

1. The Contractor shall conduct shop performance full-scale tests at its expense on all equipment as specified. Each piece of equipment shall be tested completely assembled and the shop tests performed by the equipment manufacturer until successful tests are achieved.
2. If the performance tests are conducted outside the continental United States, the Contractor shall pay all transportation expenses incurred by the Owner's representatives in witnessing the tests at no additional cost to the Owner.

1.08 FIELD TESTING

- A. Field testing shall be conducted when called for in the Technical Specification Sections and on all completed systems in general. The Contractor shall provide services of a factory-authorized service representative to perform, approve, and certify the field testing specified in this Section. Field testing shall generally consist of performing the pre-startup and startup tests as specified in the Division 11 Specifications and the final mechanical performance test specified in Section 11000, General Equipment Requirements. The Contract Documents may require the Contractor to perform factory testing on equipment items before the Engineer approves their use for this project. The Contractor shall refer to the Division 11 Specifications regarding equipment shop testing requirements.
- B. After completing the installation, the Contractor shall test the system in the presence of the Engineer and under actual operating conditions. Tests shall be performed according to the manufacturer's recommendations.
- C. The Contractor shall include with its bid the services of the equipment manufacturer's field service technician for a period necessary to complete the Work to the satisfaction of the Engineer and the Owner.
- D. This service shall be for the purposes of checkout, initial start-up, certification, and instruction of facilities personnel.

- E. A written report covering the technician's findings and installation approval shall be submitted to the Engineer covering all inspections and outlining in detail any deficiencies noted.

1.09 ACCEPTANCE OF INSTALLATION

- A. The Engineer may accept an equipment system installation as ready for Substantial Completion when:
 - 1. The Engineer has accepted all factory tests and all other component testing.
 - 2. The Engineer has accepted all performance shop tests.
 - 3. All components of the system are installed and tested, including without limitation hydrostatic tests, leak tests, continuity tests, insulation resistance tests, phase rotation tests, bump tests, stroke testing, calibration, adjustment for proper operation, and all other component tests as appropriate.
 - 4. Field start-up activities have been completed and approved by the Engineer.
 - 5. The appropriate certificates have been submitted.
 - 6. All equipment has met the performance requirements.
 - 7. The Engineer has accepted integrated system tests and adjustments performed by the Contractor to demonstrate that the system as a whole functions reliably and meets the performance requirements, in manual and automatic modes, without failure, fault, or defect of any component or of the system as a whole.
 - 8. The Engineer has accepted integrated facilities tests performed by the Contractor to demonstrate that the entire Construction functions together reliably as an integrated facility and meets the performance requirements, in manual and automatic modes, without failure, fault, or defect of any component.
 - 9. The Engineer has accepted facility performance tests that demonstrate that the design criteria and performance criteria are met.
 - 10. The Engineer has accepted the O&M Manuals.
 - 11. All required Owner personnel have been trained.
 - 12. All other Contract requirements for Substantial Completion have been satisfied.

1.10 GREASE, OIL, AND FUEL

- A. All grease, oil, and fuel required for start-up and testing of equipment shall be furnished with the respective equipment.

- B. The Contractor shall be responsible for changing the oil in all drives and intermediate drives of each mechanical equipment from after initial break-in of the equipment, which shall be no greater than 30 days.

1.11 ELECTRICAL EQUIPMENT ENCLOSURES

- A. All items of electrical equipment that are furnished with process, heating, ventilating, or other equipment shall conform to the requirements specified under the appropriate electrical sections of the Specifications. Enclosures for electrical equipment, such as switches and starters, shall conform to the requirements specified under the appropriate electrical sections of the Specifications.

1.12 EQUIPMENT DRIVE GUARDS

- A. Screens, guards, or cages shall be provided for all exposed rotating or moving parts in accordance with accepted practices of applicable governmental agencies. Unless specified otherwise in the Technical Specifications sections, guards shall be constructed of galvanized sheet steel or galvanized woven wires or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps that will permit easy removal for servicing the equipment.

1.13 PROTECTION AGAINST ELECTROLYSIS

- A. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous-impregnated felt, heavy -bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

1.14 CONCRETE INSERTS

- A. Concrete inserts for hangers shall be designed to support safely, in the concrete that is used, the maximum load that can be imposed by the hangers used in the inserts. Inserts for hangers shall be of a type which will permit adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. All inserts shall be galvanized.

1.15 SLEEVES

- A. Unless otherwise indicated on the Drawings or specified, openings for the passage of pipes through floors and walls shall be formed of sleeves of standard-weight, galvanized-steel pipe. Each sleeve shall be of ample diameter to pass the pipe and its insulation, if any, and to permit such expansion as may occur. Sleeves shall be

of sufficient length to be flush at the walls and the bottom of the slabs and to project 2 inches above the finished floor surface. Threaded nipples shall not be used as sleeves.

- B. Sleeves in exterior walls below ground or in walls to have liquids on one or both sides shall have a 2-inch annular fin of 1/4-inch plate welded with a continuous weld completely around the sleeve at about mid-length. Sleeves shall be galvanized after the fins are attached.
- C. All sleeves shall be set accurately before the concrete is placed or shall be built-in accurately as the masonry is being built.

1.16 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall arrange for a qualified service representative from each company manufacturing or supplying certain equipment as listed in this Section (or in the respective Technical Specification sections) to perform the duties described in this Section.
- B. After the listed equipment has been installed and the equipment is presumably ready for operation but before it is operated by others, the representative shall inspect, operate, test, and adjust the equipment. The inspection shall include but not be limited to the following points as applicable:
 - 1. Soundness (without cracked, abraded, or otherwise damaged parts).
 - 2. Completeness in all details, as specified.
 - 3. Correctness of setting, alignment, and relative arrangement of various parts.
 - 4. Adequacy and correctness of packing, sealing, and lubricants.
- C. The operation, testing, and adjustment shall be as required to prove that the equipment is left in proper condition for satisfactory operation under the conditions specified.
- D. On completion of his or her work, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer a complete, signed report of the result of the inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustment made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a certificate that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

- E. After the Engineer has reviewed the reports from the manufacturer's representatives, the Contractor shall make arrangements to have the manufacturer's representatives present when the field acceptance tests are made.
- F. The Contractor, at a minimum, shall arrange for the service of qualified service representatives from the companies manufacturing or supplying the following equipment and as required in the Technical Specifications:
 - 1. Pumping Equipment
 - 2. Sampler Pumping Equipment
 - 3. Treatment Process Equipment
 - 4. Instrumentation and Control Systems
 - 5. Programmable Controllers
 - 6. Overhead Cranes
 - 7. Conveying Equipment
 - 8. Heating, Ventilating, and Air Conditioning Systems
 - 9. Chemical Storage and Feed Equipment
 - 10. Electric Motors
 - 11. Motor Control Centers
 - 12. Flow Meters
 - 13. Analyzers
 - 14. Hydraulic Actuated Control Valves
 - 15. Fiber Optic Communication System
 - 16. Computer Subsystems

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01650
DELIVERY, STORAGE, AND HANDLING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies the general requirements for the delivery, handling, storage, and protection of all items required in the construction of the Work. Specific requirements, if any, are specified with the related item.

1.02 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in this Section for storing and protecting the items.
- B. The Contractor shall do the following:
 - 1. Materials and equipment shall be loaded and unloaded by methods affording adequate protection against damage. Every precaution shall be taken to prevent injury to the material or equipment during transportation and handling. Suitable power equipment shall be used and the material or equipment shall be under control at all times. Under no condition shall the material or equipment be dropped, bumped, or dragged. When a crane is used, a suitable hook or lift sling shall be used. The crane shall be so placed that all lifting is done in a vertical plane. Materials or equipment skid loaded, palletized, or handled on skidways shall not be skidded or rolled against material or equipment already unloaded.
 - 2. Material and equipment shall be delivered to the job site by means that will adequately support it and not subject it to undue stresses. Material and equipment damaged or injured in the process of transportation unloading or handling shall be rejected and immediately removed from the site.
 - 3. The Contractor shall coordinate the delivery of all materials, including those furnished by the Owner. The Contractor shall be responsible for the proper transport, handling, and storing of all materials, and materials shall be protected to ensure their expected performance. Delivery schedules shall be coordinated by the Contractor, in advance, so that the Work will be done in a timely manner.

4. The Contractor shall coordinate deliveries of products with construction schedules to avoid conflict with work and conditions at the site. The Contractor shall also do the following:
 - a. Deliver products in undamaged condition, in the manufacturer's original containers or packaging, with identifying labels intact and legible.
 - b. Immediately on delivery, inspect shipments to ensure compliance with requirements of the Contract Documents and approved submittals and to ensure that the products are properly protected and undamaged.
5. The Contractor shall provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.
6. All materials and equipment shall be stored on-site in complete compliance with the manufacturer's recommendations.
7. Store products subject to damage by the elements in weather-tight enclosures.
8. Maintain temperature and humidity within the ranges required by the manufacturer's instructions.
9. Store fabricated products above the ground, on blocking or skids to prevent soiling or staining. Cover products that are subject to deterioration with impervious sheet coverings, and provide adequate ventilation to avoid condensation.
10. All materials and equipment to be incorporated in the Work shall be handled and stored by the Contractor before, during, and after shipment in a manner that will prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind to the material or equipment.
11. All materials which, in the opinion of the Engineer, have become so damaged as to be unfit for the use intended or specified shall be promptly removed from the site of the Work, and the Contractor shall receive no compensation for the damaged material or its removal.
12. The Contractor shall arrange storage in a manner to provide easy access for inspection and make periodic inspections of stored products to ensure that products are maintained under specified conditions, free from damage or deterioration.

13. The Contractor shall provide substantial coverings as necessary to protect installed products from traffic damage and subsequent construction operations and shall remove these coverings when they are no longer needed.
14. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract, within 7 days after written notice to do so has been given, the Owner retains the right to correct all deficiencies noted in the previously transmitted written notice and deduct the cost associated with these corrections from the Contractor's Contract. These costs may include expenditures for labor, equipment use, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.
15. Schedule delivery to reduce long-term onsite storage before installation and/or operation. Under no circumstances shall equipment be delivered to the site more than 1 month before installation without written authorization from the Engineer.
16. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged, or sensitive to deterioration.
17. Deliver products to the site in the manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting, and installing.
18. Unload and place all items delivered to the site in a manner which will not hamper normal construction operation nor that of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
19. Provide necessary equipment and personnel to unload all items delivered to the site.
20. The Contractor shall store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Follow storage instructions, review them with the Engineer, and keep a written record of this. Arrange storage to permit access for inspection.
21. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

22. Store cement and lime under a roof and off the ground and keep it completely dry at all times. All structural, miscellaneous, and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping, or cracking. Handle and store brick, block, and similar masonry products in a manner to keep breaking, cracking, and spilling to a minimum.
23. Store all mechanical and electrical equipment and instruments subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) in a weathertight building to prevent damage. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer. The building shall be provided with adequate ventilation to prevent condensation. The Contractor shall ensure that temperature and humidity are maintained within the range required by the manufacturer.
 - a. All equipment shall be stored fully lubricated with oil, grease, and other lubricants unless otherwise instructed by the manufacturer.
 - b. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding." Upon installation of the equipment, the Contractor shall start the equipment, at least at half load, once weekly for an adequate period to ensure that the equipment does not deteriorate from lack of use.
 - c. Lubricants shall be changed when installation is complete and as frequently as required thereafter during the period between installation and acceptance. The Contractor shall put new lubricants into the equipment at the time of acceptance.
 - d. Before accepting equipment that has been stored for some time, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01720
FIELD ENGINEERING

PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall do the following:

- A. Provide and pay for the following field engineering services required for the Project:
 - 1. Survey work required in the execution of the Project.
 - 2. Civil, structural, or other professional engineering services specified or required to execute the Contractor's construction methods.
- B. Retain the services of a registered land surveyor licensed in Florida to do the following:
 - 1. Identify existing control points and property line corner stakes as required.
 - 2. Verify all existing structure locations and all proposed structure corner locations, tank locations, and equipment locations within the Project site.
 - 3. Maintain an accurate location of all buried piping 4 inches in diameter and larger.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. The Contractor shall submit to the Engineer the name and address of the registered land surveyor or professional engineer.
- C. On request of the Engineer, the Contractor shall submit documentation to verify the accuracy of field engineering work.
- D. The Contractor shall submit a certificate signed by a registered land surveyor certifying that elevations and locations of improvements are in conformance or non-conformance with Subcontract Documents.
- E. At the end of the Project and before final payment, submit the certified drawings listed below with the Surveyor's title block (signed and sealed by the registered

land surveyor) of the items listed below. These drawings shall be included with and made a part of the project record documents.

1. Certified site survey at 1-inch = 10-foot scale on sheets 24 inches by 36 inches, indicating the building corners, sidewalks, paved areas, and location of all above-ground structures for the project site.
2. Certified drawing showing the location, lines, and grades of all lines 4 inches in diameter and larger buried and exterior to buildings and other buried facilities (e.g., valves, tanks, vaults) installed as a result of the work. This shall be at the same scale as the Engineer's yard piping drawing.
3. Certified drawings showing elevations of all flow control points such as weirs, elevations of all existing and new structures, and equipment. The Contract Drawings include cross-sections, which the Contractor may mark-up.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. All work shall be performed in accordance with the Minimum Technical Standards set forth by the Board of Professional Surveyors and Mappers.

1.04 QUALITY ASSURANCE

- A. Existing basic horizontal and vertical control points for the project are those designated on Drawings.
- B. Locate and protect control points before starting site work and preserve all permanent reference points during construction:
 1. Make no changes or relocations without prior written notice to the Engineer.
 2. Report to the Engineer when any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations.
 3. Require the surveyor to correctly replace project control points that may be lost or destroyed.
 4. Establish replacements based on original survey control.

1.05 QUALIFICATIONS

- A. Registered land surveyor of the discipline required for the specific service on the project, currently licensed in Florida.

1.06 SYSTEM DESCRIPTION

- A. The Contractor shall establish a minimum of 6 permanent benchmarks on the site, referenced to data established by survey control points:
 - 1. Record locations, with horizontal and vertical data, on Record Documents.
- B. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means:
 - 1. Site improvements:
 - a. Stakes for grading, fill, and topsoil placement.
 - b. Utility slopes and invert elevations.
 - 2. Building foundation, column locations, and floor levels.
 - 3. Controlling lines and levels required for mechanical and electrical trades.
- C. From time to time, verify layouts by the same methods.
- D. Maintain a complete and accurate log of all control and survey work as the work progresses.
- E. As a condition for approval of monthly progress payment requests, update the project record drawings monthly based on the work performed during the month ending at the pay request. The Contractor shall coordinate this monthly with the Owner's representative on the site as part of the pay request.
- F. Maintain an accurate record of piping changes, revisions, and modifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01735 CONTROL OF WORK

PART 1 GENERAL

1.01 SITE

- A. The Contractor shall furnish equipment, which will be efficient, appropriate, and large enough to secure a satisfactory quality of work and a rate of progress that will ensure the completion of the work within the Contract Time. If at any time the equipment appears to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress stated above, the Engineer may order the Contractor to increase the efficiency, change the character, or increase the equipment and the Contractor shall conform to such an order. Failure of the Engineer to give such an order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

- A. Do not enter or occupy private land outside of easements, except by permission of the land owner.

1.03 PIPE LOCATIONS

- A. Locate pipelines substantially as indicated on the Drawings. The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him of laying and jointing different or additional items where required.

1.04 OPEN EXCAVATIONS

- A. Adequately safeguard all open excavations by providing temporary barricades, caution signs, lights, and other means to prevent accidents to persons and damage to property. Provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workers. Remove bridges provided for access during construction when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard or if it excessively restricts traffic at any point, the Engineer may require special construction procedures, such as limiting the length of the

open trench, prohibiting stacking excavated material in the street, and requiring that the trench be closed overnight.

- B. Take precautions to prevent injury to the public due to open trenches. Provide adequate light at all trenches, excavated material, equipment, or other obstacles that could be dangerous to the public at night.

1.05 TEST PITS

- A. Excavate test pits, at the direction of the Engineer, to locate underground pipelines or structures in advance of the construction. Backfill test pits immediately after their purpose has been satisfied and restore and maintain the surface in a manner satisfactory to the Engineer.

1.06 MAINTENANCE OF TRAFFIC

- A. Unless permission to close a street is received in writing from the proper authority, place all excavated material so that vehicular and pedestrian traffic may be maintained at all times. If the construction operations cause traffic hazards, repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Engineer.
- B. Maintenance of traffic shall be in accordance with the Florida Department of Transportation (FDOT). The Contractor shall submit a Maintenance of Traffic Plan to the Owner and Engineer for approval prior to any construction, work, or temporary staging along Taylor Road. Detours around construction will be subject to the approval of the Owner and the Engineer. Where detours are permitted, provide all necessary barricades and signs as required to divert the flow of traffic. Expedite construction operations while traffic is detoured. The Owner will strictly control periods when traffic is being detoured.
- C. Take precautions to prevent injury to the public due to open trenches. Night watchmen may be required where special hazards exist, or police protection provided for traffic while work is in progress. The Contractor shall be fully responsible for damage or injuries whether or not police protection has been provided.

1.07 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for preserving all public and private property and use every precaution necessary to prevent damage to this property. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, the Contractor shall restore such property to a condition similar

or equal to that existing before the damage was done or make good the damage in other manner acceptable to the Engineer.

1.08 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

- A. The Contractor shall assume full responsibility for protecting all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains, and electric and telephone cables, whether or not they are shown on the Drawings. Carefully support and protect all such structures and utilities from injury of any kind. Immediately repair any damage resulting from the construction operations.
- B. The Contractor, however, shall bear full responsibility for obtaining all locations of underground structures and utilities (including existing water services, drain lines, and sewers). The Contractor shall maintain services to buildings and pay costs or charges resulting from damage to such services.
- C. Notify all utility companies in writing at least 72 hours (excluding Saturdays, Sundays, and legal holidays) before excavating in any public way. Also notify Sunshine State One Call of Florida, telephone 1-800-638-4097, at least 72 hours before starting work.
- D. If, in the opinion of the Engineer, permanent relocation of a utility owned by the District is required, the Engineer may direct the Contractor, in writing, to perform the work. Work so ordered will be paid for at the Contract unit prices, if applicable, or as extra work under the General Conditions. If relocation of a privately-owned utility is required, the Engineer will notify the Utility to perform the work as expeditiously as possible. The Contractor shall cooperate with the Engineer and Utility. No claim for delay will be allowed due to such relocation.
- E. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be part of the work under the Contract and all costs associated shall be included in the Contract Price.
- F. Coordinate the removal and replacement of traffic loops and signals, if required for the performance of the work, at no additional cost to the Owner.

1.09 WATER FOR CONSTRUCTION PURPOSES

- A. In locations where public water supply is available, the Contractor may be allowed to use water for construction purposes. The cost to obtain water shall be included in the Contract Price.

- B. The express approval of the Owner shall be obtained before water is used. Hydrants shall only be operated under the supervision of the Owner personnel.
- C. Waste of water by the Contractor shall be sufficient cause for withdrawing the use of water.

1.10 MAINTENANCE OF FLOW

- A. Provide for the flow of sewers, drains, and water courses interrupted during the progress of the work, and immediately cart away and remove all offensive matter. Discuss the entire procedure of maintaining existing flow with the Engineer well in advance of the interruption of any flow.

1.11 COOPERATION WITHIN THIS CONTRACT

- A. All firms or persons authorized to perform any work under this Contract shall cooperate with the General Contractor and subcontractors or trades and assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching and drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated in this Section.

1.12 CLEANUP AND DISPOSAL OF EXCESS MATERIAL

- A. During the Work, keep the site of operations as clean and neat as possible. Dispose of all residue resulting from the construction work and at the conclusion of the work remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations and leave the entire site of the work in a neat and orderly condition.
- B. To prevent environmental pollution arising from the construction activities related to the performance of this Contract, comply with all applicable Federal, State, and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and in other related sections.
- C. Disposing of excess excavated material in wetlands, stream corridors, and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by the Contractor will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. The Contractor will be required to remove the fill and restore the area impacted at no increase in the Contract Price.

1.13 SPECIAL WORK HOUR LIMITATIONS

- A. The Contractor shall limit hours of operation in accordance with Section 01100, Summary of Work. No work shall be performed at night, Saturdays, Sundays, or legal holidays except in cases of emergency. The Engineer must authorize all exceptions to this work-hour limitation in writing.

1.14 CHARACTER OF THE CONTRACTOR'S SUPERINTENDENT AND WORKERS

- A. The Contractor's superintendent and project manager shall conduct themselves in a professional manner. If, in the opinion of the Owner and the Engineer, the superintendent and project manager do not conduct themselves in a professional and courteous manner, the Engineer can recommend to the Owner that the superintendent and/or the project manager be relieved of their responsibilities and removed from the project. Upon written notice from the Owner, the Contractor shall immediately remove the superintendent and/or the project manager of their responsibilities and removed from the project. The work of this project must be conducted under the supervision of a full-time superintendent.
- B. Any person employed by the Contractor or by any subcontractor who in the opinion of the Engineer does not conduct him/herself in a professional and courteous manner or is intemperate or disorderly, shall at written request of the Engineer, be removed immediately by the Contractor or subcontractor employing such person, and that person shall not be allowed to work on any other portion of work in this Contract without written approval of the Engineer. Should the Contractor fail to remove such person(s) or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may recommend to the Owner that the work be suspended until compliance with such orders has been met. Contract time will not be stopped during this time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01740 FINAL CLEANING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall execute cleaning during progress of the Work and at the completion of the Work as required by General Conditions.

1.02 ENVIRONMENTAL CONCERNS

- A. Cleaning and disposal operations shall comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

2.01 CLEANING MATERIALS

The Contractor shall do the following:

- A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
- B. Use only those cleaning materials and methods recommended by the manufacturer of the surface material to be cleaned.
- C. Use cleaning materials only on surfaces recommended by the cleaning material manufacturer.

PART 3 EXECUTION

3.01 PERIODIC CLEANING

The Contractor shall do the following:

- A. Execute periodic cleaning to keep the work, the site, and adjacent properties free from accumulations of waste materials, rubbish, and windblown debris.
- B. Provide onsite containers for the collection of waste materials, debris, and rubbish.

- C. Remove waste materials, debris, and rubbish from the site periodically and dispose of at legal areas away from the site.

3.02 DUST CONTROL

The Contractor shall do the following:

- A. Clean interior spaces before the start of finish painting and continue cleaning on an as-needed basis until painting is finished.
- B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly coated surfaces.

3.03 FINAL CLEANING

The Contractor shall do the following:

- A. Employ skilled workers for final cleaning.
- B. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from interior and exterior surfaces exposed to view.
- C. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.
- D. Before final completion or Owner occupancy, inspect interior and exterior surfaces exposed to view and all work areas to verify that the entire Work is clean.

END OF SECTION

SECTION 01745
MISCELLANEOUS WORK AND CLEANUP

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required and perform the miscellaneous work not specified in other sections but obviously necessary for the proper completion of the work as shown on the Drawings.
- B. When applicable, perform the work in accordance with other related sections. When no applicable specification exists, perform the work in accordance with the best modern practice.
- C. The work of this Section includes but is not limited to the following:
 - 1. Crossing and relocating existing utilities.
 - 2. Cleaning up.
 - 3. Performing incidental work.
 - 4. Protecting and bracing utility poles.
 - 5. Restoring easement and rights-of-way.
 - 6. Obtaining and complying with construction permits.
 - 7. Removing trees.

1.02 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. FDOT Design Standards for Design, Construction, Maintenance, and Utility Operations on the State Highway System
 - 1. Index Series 600—Traffic Control Through Work Zones.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials required for this Section shall be the same quality of materials that are to be restored. Where possible, re-use existing materials that are removed.

PART 3 EXECUTION

3.01 CROSSING AND RELOCATING EXISTING UTILITIES

- A. Perform any extra work required in crossing culverts, watercourses including brooks and drainage ditches; storm drains; gas mains; water mains; electric, telephone, gas and water services; and other utilities. This work shall include bracing, hand excavation, backfill (except crushed stone), and any other work required for crossing the utility or obstruction not included for payment in other items in the Bid Form. Notification of Utility Companies shall be as specified in Section 01355, Special Provisions.
- B. In locations where existing utilities cannot be crossed without interfering with the construction of the work as shown on the Drawings, remove and relocate the utility in accordance with the appropriate Utility Companies if they relocate their own utility.
- C. At pipe crossings and where designated by the Engineer, furnish and place crushed stone bedding so that the existing utility or pipe is firmly supported for its entire exposed length. The bedding shall extend to the mid-diameter of the pipe crossed. Payment for crushed stone at pipe crossings will be made according to the unit price bid in the Bid Form.

3.02 CLEANING UP

- A. Remove all construction material, excess excavation, buildings, equipment, and other debris remaining on the job as a result of construction operations and restore the site of the work to a neat and orderly condition.

3.03 INCIDENTAL WORK

- A. Perform all incidental work not otherwise specified but obviously necessary to the proper completion of the work as shown on the Drawings and as specified in this Section.

3.04 PROTECTION AND BRACING OF UTILITY POLES

- A. Make all arrangements with the proper utility companies for bracing and protecting all utility poles that may be damaged or endangered by the operations. Work under this item shall include the related removal and reinstallation of guy wires or support poles whether shown on the Drawings or not.

3.05 RESTORING EASEMENTS AND RIGHTS-OF-WAY

- A. The Contractor shall be responsible for all damage to private property due to the operations. Protect from injury all walls, fences, cultivated shrubbery, vegetables, fruit trees, pavement, underground facilities such as water pipe, or other utilities that may be encountered along the route. If removal and replacement are required, it shall be done in a workmanlike manner so that replacement is equivalent to that which existed before construction.
- B. Existing lawn and sod surfaces damaged by construction shall be replaced. Cut and replace the lawn and sod or restore the areas with an equivalent depth and quality of loam, seed, and fertilizer as necessary to produce a stand of grass at least equal to that existing before construction. These areas shall be maintained and reseeded, if necessary, until all work under this Contract has been completed and accepted. Any additional work required to restore the property to the original condition shall be performed.
- C. Existing trees, shrubs, plants, and bushes outside of easements shall be fully protected as specified in Section 01355, Special Provisions. The work shall also include removing and replacing those trees, shrubs, and bushes as indicated on the Drawings. It shall include the careful excavation of the root ball, which shall be wrapped with burlap while out of the ground. Replant the plants after backfilling the trench, stake them in an upright position, and periodically water replanted trees, bushes, and shrubs. The Contractor is fully responsible for ensuring that any and all trees, bushes, and shrubs removed and replanted "take" and return to a viable state. Any replanted item that fails to "take" or that is so damaged as to be unsuitable for replanting shall be replaced, at no additional cost to the Owner, with a tree, bush, or shrub equal to the one removed.
- D. As described in Section 02230, Site Preparation, trees damaged beyond repair through no fault of the Contractor shall be removed. For bidding purposes, the Contractor shall assume that removing three trees may be required.

- E. The Engineer will inspect all work for provisional acceptance upon the written request received at least 10 days before the expected date of inspection.
 - 1. At the end of this period, any plant that is missing, dead, or not in satisfactory growth, as determined by the Engineer, shall be replaced.
 - 2. All replacements shall be plants of the same kind and size. They shall be furnished and planted as specified in this Section. The cost of replacement shall be borne by the Contractor except where it can be definitely shown that loss resulted from vandalism or the Owner's failure to maintain plantings as instructed.
 - 3. At the end of the guarantee period, the Engineer will inspect the plantings upon written request submitted by the landscape contractor at least 10 days before the expected date.
 - 4. After all necessary corrective work has been completed and tree staking has been removed, the Engineer will certify in writing the final acceptance of the planting.

3.06 CONSTRUCTION SIGNAGE

- A. Furnish, install, maintain, and remove warning devices and traffic and construction signs in accordance with FDOT Index Series 600.

3.07 PERMITS

- A. The Contractor is responsible for obtaining and complying with all permits or their implementation, including the Minor Impact Wetlands Permit and the NPDES Construction Dewatering Permit.

3.08 TREE REMOVAL

- A. Coordinate removal with the Engineer and the Owner. The Contractor is responsible for all damage to private property due to the operations. Protect from injury all walls, fences, cultivated shrubbery, pavement, underground facilities such as water pipe, or other utilities that may be encountered in the area. Any additional work required to restore the property to its original condition, other than the tree removal, shall be performed.

END OF SECTION

SECTION 01755
EQUIPMENT TESTING AND STARTUP

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall provide a competent field services technician of the manufacturers of all equipment furnished under Divisions 11, Equipment, 13, Special Construction, 15, Mechanical, and 16, Electrical, to supervise installation, adjustment, initial operation and testing, performance testing, final acceptance testing, and startup of the equipment.
- B. The Contractor shall perform specified equipment field performance tests, final acceptance tests, and startup services.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit name, address, and résumé of proposed field services technicians at least 30 days in advance of the need for such services.
- B. Submit for review detailed testing procedures for shop tests, field performance tests, and final acceptance tests as specified in the various equipment specification sections. Test procedures shall be submitted at least 30 days in advance of the proposed test dates and shall include at least the following information:
 - 1. Name of equipment to be tested, including reference to specification section number and title.
 - 2. Testing schedule of proposed dates and times for testing.
 - 3. Summary of power, lighting, chemical, water, sludge, gas, etc., needs and identification of who will provide them.
 - 4. An outline of specific assignments of the responsibilities of the Contractor and manufacturers' factory representatives or field service personnel.
 - 5. Detailed description of step-by-step testing requirements, with reference to appropriate standardized testing procedures and laboratory analyses by established technical organizations (e.g., ASTM, WPCF Standard Methods).
 - 6. Samples of forms to be used to collect and record test data and to present tabulated test results.

- C. Submit copies of test reports upon completion of specified shop, performance, and acceptance tests. Test reports shall incorporate the information provided in the test procedures submittals, modified to reflect the actual conducting of the tests and the following additional information:
 - 1. Copies of all test data sheets and results of lab analyses.
 - 2. Summary comparison of specified test and performance requirements vs. actual test results.
 - 3. Should actual test results fail to meet specified test and performance requirements, a description of actions to be taken before re-testing the equipment.
- D. Submit copies of the manufacturer's field service technician's report summarizing the results of the initial inspection, operation, adjustment, and pre-tests. The report shall include detailed descriptions and tabulations of the points inspected, tests and adjustments made, quantitative results obtained, suggestions for precautions to be taken to ensure proper maintenance, and the equipment supplier's Certificate of Installation in the format specified in this Section.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Water Works Association (AWWA)
 - 1. AWWA C653—Disinfection of Water Treatment Plants.
- B. American Society for Testing and Materials (ASTM)
- C. Water Pollution Control Federation (WPCF)
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

- A. Field service technicians shall be competent and experienced in the proper installation, adjustment, operation, testing, and startup of the equipment and systems being installed.

- B. Manufacturers' sales and marketing personnel will not be accepted as field service technicians.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PRELIMINARY REQUIREMENTS

- A. After the equipment has been installed and the equipment is presumably ready for operation but before it is operated by others, the manufacturer's field service technician shall inspect, operate, test, and adjust the equipment. The inspection shall include at least the following points where applicable:
 - 1. Soundness (without cracks or otherwise damaged parts).
 - 2. Completeness in all details, as specified and required.
 - 3. Correctness of setting, alignment, and relative arrangement of various parts.
 - 4. Adequacy and correctness of packing, sealing, and lubricants.
- B. The operation, testing, and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.
- C. Upon completion of this work, the manufacturer's field service technician shall submit a signed report of the results of his/her inspection, operation, adjustments, and tests.

3.02 WITNESS REQUIREMENTS

- A. Shop tests or factory tests may be witnessed by the Owner and/or the Owner's representatives, as required by the various equipment specifications.
- B. Field performance and acceptance tests shall be performed in the presence of the Owner, the Owner's designated personnel, and/or the Owner's representatives.

3.03 STARTUP AND ACCEPTANCE OF THE EQUIPMENT AND RELATED SYSTEMS

- A. General Requirements
 - 1. Successfully execute the step-by-step procedure of startup and performance demonstration specified in this Section.

2. The startup and performance demonstration shall be successfully executed before Substantial Completion and acceptance by the Owner of the equipment and its related systems.
3. All performance tests and inspections shall be scheduled at least 5 working days in advance or as otherwise specified with the Owner and the Engineer. All performance tests and inspections shall be conducted during Monday through Friday, unless otherwise specified.

B. Preparation for Startup

1. Upon completion of the equipment and all its related systems, all tanks shall be flushed and hydraulically checked for leaks, cracks, and defects in accordance with Section 01810, Watertightness Test for Hydraulic Structures.
2. All mechanical and electrical equipment shall be checked to ensure that it is in good working order and properly connected. Preliminary run-ins of the various pumps, compressors, and other remaining equipment shall be made. All systems shall be cleaned and purged as required. All tanks, pump wells, and pipelines which are hydraulically checked shall be drained and returned to their original condition once the water testing is complete.
3. All instruments and controls shall be calibrated through their full range. All other adjustments required for proper operation of all instrumentation and control equipment shall be made.
4. The Contractor shall perform all other tasks needed for preparing and conditioning the equipment for proper operation.
5. No testing shall be conducted or equipment operated until the Engineer has verified that all specified safety equipment has been installed and is in good working order.
6. No testing shall be conducted or equipment operated until the Engineer has verified that all lubricants, tools, maintenance equipment, spare parts, and approved equipment operation and maintenance manuals have been furnished as specified.

C. Facilities Startup

1. The startup period shall not begin until all equipment has been tested as specified and is ready for operation. The Owner shall receive spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data, and the specified operation and maintenance instruction before the startup. All valves shall be tagged before this startup.

2. Demonstrate 7 consecutive 24-hour days of successful operation of the facility as a prerequisite of Substantial Completion and Acceptance.
3. If the equipment fails to demonstrate satisfactory performance on the first or any subsequent attempt, the Contractor shall make all necessary alterations, adjustments, repairs, and replacements. When the equipment is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the equipment has operated continuously to the satisfaction of the Owner and Engineer for the specified duration.
4. The Owner will furnish all operating personnel (other than vendor's or subcontractor's service personnel) needed to operate equipment during the final test period; however, these personnel will perform their duties under the Contractor's direct supervision. Until performance tests are completed and units and systems are accepted by the Owner as substantially complete, the Contractor shall be fully responsible for the operation and maintenance of all new equipment.
5. The Owner will provide all necessary chemicals and electricity. However, the Contractor shall provide all necessary personnel of the various construction trades, i.e., electricians, plumbers, etc., and field service personnel of the major equipment suppliers on an 8-hour-per-day basis at the facilities and on a 24-hour-per-day basis locally during the startup period. Major equipment suppliers shall include but not be limited to the following:
 - a. Telemetry, Instrumentation, and Control Equipment.
 - b. Chemical Feed Pumps.
 - c. All Pumping Equipment.
 - d. Hydraulic Control Valves.
6. At no time during startup shall the Contractor allow the facility to be operated in a manner that subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

END OF SECTION

SECTION 01770
PROJECT CLOSEOUT

PART 1 GENERAL

1.01 SUBSTANTIAL COMPLETION

- A. When the Contractor considers that the Work or designated portion of the Work is Substantially Complete, the Contractor shall submit written notice to the Owner or the Owner's Representative with a list of items to be completed or corrected.
- B. If the Owner and Engineer's review finds that the Work is not substantially complete, the Owner or Owner's Representative will promptly notify the Contractor in writing, listing observed deficiencies.
- C. The Contractor shall remedy deficiencies and send a second written notice of Substantial Completion.
- D. When the Owner and Engineer finds the Work is Substantially Complete, the Engineer will prepare a Certificate of Substantial Completion.

1.02 FINAL COMPLETION

- A. When the Contractor considers that the Work or designated period of the Work is complete, the Contractor shall submit written certification to the Owner indicating the following:
 - 1. The Contract Documents have been reviewed.
 - 2. The Work has been reviewed for compliance with the Contract Documents.
 - 3. The Work has been completed in accordance with the Contract Documents and deficiencies listed with Certificates of Substantial Completion have been corrected.
 - 4. The Work is complete and ready for final inspection.
 - 5. All required shop drawings, catalog cuts, operations and maintenance manuals, instruction manuals, test reports, samples, and all other submittals have been submitted and reviewed by the Engineer.
 - 6. All deliverables have been delivered or placed as accepted by the Engineer.
- B. If the Owner or Owner's Representative's review reveals that the Work is incomplete, the Owner will promptly notify the Contractor in writing listing observed deficiencies.

- C. The Contractor shall remedy deficiencies and send a second certification of Final Completion.
- D. When the Owner and Engineer finds that the Work is complete, the Engineer and Owner will consider closeout submittals.

1.03 ADDITIONAL REVIEW FEES

- A. If the status of Completion of Work requires more than two reviews of the Work by the Engineer due to failure of the Work to comply with the Contractor's claims on the first and second reviews, the Owner will deduct from the final payment to the Contractor the amount of the Engineer's compensation for additional review services.

1.04 CLOSEOUT SUBMITTALS

- A. Evidence of Compliance with Requirements of Governing Authorities:
 - 1. Certificate of Occupancy.
 - 2. All required Certificates of Government Inspections.
- B. Operation and Maintenance Manuals: Under provisions of Section 01830, Operations and Maintenance Manuals.
- C. Record Documents: Under provisions of Section 01785, Record Documents.
- D. Evidence of Payment and Release of Liens: In accordance with Conditions of the Contract.
- E. Consent of Surety to Final Payment.

1.05 STATEMENT OF ADJUSTMENT OF ACCOUNTS

- A. Submit final statement reflecting adjustments to total Contract Price, indicating the following:
 - 1. Original total Contract Price.
 - 2. Previous change orders.
 - 3. Changes under allowances.
 - 4. Changes under unit prices.
 - 5. Deductions for uncorrected Work.
 - 6. Penalties and bonuses.
 - 7. Deductions for liquidated damages.

8. Deductions for Engineer's additional review fees.
9. Other adjustments to total Contract Price.
10. Total Contract Price as adjusted.
11. Previous payments.
12. Sum remaining due.

- B. Upon the Owner's review and approval, the Engineer will issue a final Change Order reflecting approved adjustments to the total Contract Price not previously made by change orders.

1.06 APPLICATION FOR FINAL PAYMENT

- A. Submit application for final payment in accordance with provisions of Conditions of the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01780
WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall do the following:

- A. Compile specified warranties and bonds.
- B. Co-execute submittals when so specified.
- C. Review submittals to verify compliance with Contract Documents.
- D. Submit submittals to the Engineer for review.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Assemble warranties, bonds, and service and maintenance contracts executed by each of the respective manufacturers, suppliers, and subcontractors.
- B. Number of original signed copies required: two each.
- C. Table of Contents: Neatly typed, in sequence of the Specifications. Provide completion information for each item as follows:
 - 1. Product or work item.
 - 2. Firm, address, telephone and fax numbers, and name and email of principal.
 - 3. Scope.
 - 4. Date of beginning of warranty, bond, or service and maintenance contract.
 - 5. Duration of warranty, bond, or service and maintenance contract.
 - 6. Provide information for Owner's personnel:
 - a. Proper procedure in case of failure.
 - b. Instances that might affect the validity of warranty or bond.

7. Contractor, with address, telephone and fax numbers, and the name and email of responsible principal.
- D. Submittal of warranties, bonds, and service and maintenance contracts shall be included in submittals for review and before Final Completion with actual dates included.
- E. The Contractor's obligation to correct defective or nonconforming Work shall run for 1 year (or such longer period may otherwise be specified in the Contract Documents) beginning from the date Substantial Completion is achieved.

1.03 WARRANTIES

- A. Warranties shall be in accordance with the Contract Documents.
- B. All mechanical and electrical equipment together with devices of whatever nature and all components that are furnished and/or installed by the Contractor shall be guaranteed.
- C. The guarantee shall be against the manufacturing and/or design inadequacies, materials, and workmanship not in conformity, improper assembly, hidden damage, failure of devices and/or components, excessive leakage, or other circumstances that would cause the equipment to fail under normal design and/or specific operating conditions for 1 year or such longer period as may be shown and/or specified from and after the date of Substantial Completion.
- D. The Contractor shall replace and install each piece of equipment, device, or component that shall fail within the term specified above of the guarantee with reasonable promptness without increase in the Contract Price. If the Contractor fails to provide timely repairs as specified in this Section, the Owner shall issue a claim against the Contractor's Bond. In some instances, if approved by the Owner, the Contractor may be allowed to repair the equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01785
RECORD DOCUMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section details the minimum requirements for the Contractor for maintenance and recording of Record Documents.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. The Contractor shall store documents and samples in the Contractor's field office apart from documents used for construction and shall do the following:
 - 1. Provide files and racks for storage of documents.
 - 2. Provide cabinet or secure storage space for storage of samples.
- B. The Contractor shall institute a computerized record control program.
- C. The Contractor shall make documents and samples available at all times for inspection by the Engineer.
- D. At Contract closeout, the Contractor shall transmit Record Documents and samples with cover letter to the Engineer, listing the following:
 - 1. Date.
 - 2. Project title and number.
 - 3. Contractor's name and addresses.
 - 4. Number and title of each Record Document.
 - 5. Signature of Contractor or its authorized representative.
 - 6. Contract Section and Subsection numbers.
 - 7. Location.
- E. Before assembling and submitting records, the Contractor shall review for completeness the records maintained by its subcontractors.
- F. Tracings of all Construction Documents and Shop Drawings made by the Contractor, subcontractors, and suppliers of materials or equipment shall be corrected to show the Work as actually completed or installed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PROJECT RECORD

- A. The Contractor shall label and file Record Documents and samples in accordance with the corresponding Specification Section number. Each document shall be labeled "PROJECT RECORD" in neat, large, printed letters. Record Documents shall be maintained in a clean, dry, and legible condition. Record documents shall not be used for construction purposes.

3.02 RECORDING

The Contractor shall record construction information as follows:

- A. Record and update daily Record information from field notes on a set of opaque drawings and to the satisfaction of the Engineer.
- B. Provide felt tip marking pens, maintaining separate colors for each major system, for recording information.
- C. Record information concurrently (daily) with construction progress. Work shall not be concealed until required information is recorded.
- D. Mark Record Drawings to reflect the following:
 - 1. Measured horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements.
 - 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.
 - 3. Field changes of dimension and detail.
 - 4. Changes made by modifications.
 - 5. Details not on original construction drawings.
- E. CAD Requirements for Record Drawings: The Contractor shall provide the Engineer with a complete set of Record Drawings in the latest version of AutoCAD format upon completion of the Work. No additional compensation will be allowed for the Contractor to provide the Record Drawings. The Contractor shall use the AutoCAD drawings furnished by the Engineer for this purpose. Record Drawings must be submitted in the AutoCAD format of the contract drawings. No other CAD software or format will be accepted. It is Contractor's

sole responsibility to ensure that the Record Drawings conform to the following CAD requirements:

1. Drawings shall be submitted to the Engineer on CD-ROM. Each CD shall be clearly labeled with the appropriate project number, client name, date, and file names included on each CD. If files are compressed, a description of the compression software must be included along with a copy of the appropriate uncompressing software.
 2. All changes to the Drawings must be done in accordance with the appropriate scale of the Drawing revised and shall be delineated by placing a "cloud" around the areas revised and adding a revision triangle indicating the appropriate revision number.
 3. Each Drawing must have the revision block completed to indicate the revision number, date, and initials of the person revising the Drawing. The description of the revision must say "Record Drawing." This procedure must be followed for every Drawing even when no changes are made to the Drawing.
 4. All revisions to Drawings must be put on separate layers with the layer names prefixed Record followed by the appropriate existing layer name. The colors and line types of the appropriate existing layers shall be adhered to when creating new layers.
 5. The Contractor shall supply one full set of Record Drawings in the format and of the quantity as desired by the Owner.
- F. The Contractor shall have the Licensed Land Surveyor certify the Record Drawings as being correct and complete.

END OF SECTION

SECTION 01810
WATERTIGHTNESS TEST FOR HYDRAULIC STRUCTURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, and incidentals required and perform tightness testing of water-containing structures as listed in this Section and all retesting until the structures meet the requirements as specified in this Section.

1.02 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. Submit to the Engineer the results of each watertightness test of each structure. The submittal format shall be similar to that shown in Figure A attached to the end of this Section.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. The testing of prestressed concrete and reinforced concrete tanks or water containment structures shall conform to the following standards and as modified in this Section:
 - 1. American Concrete Institute (ACI)
 - a. ACI 344R-W—Design and Construction of Circular Wire and Strand Wrapped Prestressed Concrete Structures.
 - b. ACI 344R-T—Design and Construction of Circular Prestressed Concrete Structures with Circumferential Tendons.
 - c. ACI 350.1—Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures (ACI 350.1-10) and Commentary.

2. American Water Works Association (AWWA)

- a. AWWA D110—Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.

1.04 QUALITY ASSURANCE

- A. Coordinate timing and procedures for obtaining testing water and structure testing with the Owner well in advance of the actual testing.
- B. Water Source and Disposal
1. Water for testing shall be provided by the Owner.
 2. The Contractor shall supply all labor, equipment, and materials.
 3. Test water shall be disposed of by the Contractor in an approved manner. Water shall not be disposed of by discharging it onto the ground surface of public or private land.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The Contractor shall prepare structures for testing as follows:
1. Inspect the structure to be tested for potential leakage paths such as cracks, voids, etc. and repair any leakage paths in compliance with the provisions specified in this Section or as approved by the Engineer.
 2. Thoroughly clean the structure to be tested of dirt, mud, and construction debris before beginning watertightness tests. The floor and sumps shall be flushed with water to provide a clean surface ready for testing.
 3. Inlet and outlet pipes not required to be operational for the tests may be temporarily sealed or bulkheaded before testing.
 4. Confirm the adequacy of seals around valves and reset or seal as approved by the Engineer. Estimates of valve leakage will not be allowed as adjustments to the measured tank or structure leakage.
- B. The Contractor shall perform watertightness tests before backfilling around structures to allow observing and detecting leakage points. Walls may be backfilled before testing only when approved in writing by the Engineer. The request to backfill before testing shall include a description of the method proposed to detect leakage points after the backfill is in place. Approval to place

backfill before testing shall not relieve the Contractor of the responsibility of conducting watertightness tests.

3.02 TESTING PROCEDURES

A. Conditions of Testing

1. The Contractor shall not begin initial filling of concrete structures until all concrete elements of the structure have attained the designed compressive strength of the concrete nor less than 14 days after all concrete walls or base slabs have been placed.
2. Initial filling of reinforced concrete structures shall not exceed a rate of 4 feet in 24 hours.
3. The Contractor shall fill unlined or partially lined concrete structures to the maximum operating water surface level and maintain the water at that level for at least 72 hours before beginning watertightness tests to minimize water absorption into the concrete during testing. The testing of fully lined concrete structures may be started as soon as the structure is filled.

B. Testing Procedures

1. The duration of the test shall not be less than that required for a drop in the water surface of 1/2 inch based on the calculated maximum allowable leakage rate for 3 days.
2. Loss-of-volume measurements shall be taken at 24-hour intervals. The loss of volume is usually determined by measuring the drop in water surface elevation and computing the change in volume of the contained water. Measure water surface elevation at not less than two locations at 180° apart and preferably at four locations 90° apart. Record water temperature 18 inches below the water surface when taking the first and last sets of measurements.

C. Reports

1. Submit to the Engineer watertightness test results for each structure tested on the form shown in Figure A or a form with a similar format.
2. Notify the Owner and Engineer of the scheduling of tests 3 working days before the tests. The Engineer and Owner may monitor any watertightness testing performed on the structures.

3.03 ACCEPTANCE

- A. The following conditions shall be considered as NOT meeting the criteria for acceptance regardless of the actual loss of water volume from the structure:
 - 1. Groundwater leakage into the structure through floors, walls, or wall-floor joints.
 - 2. Structures that exhibit flowing water from joints, cracks, or from beneath the foundation (except for underdrain systems).
 - 3. Lined concrete structures or prestressed concrete structures on which moisture can be picked up by a dry hand from the exterior surface of the walls.
- B. The watertightness of concrete tanks and structures shall be considered acceptable when loss of water volume is within the criteria listed below:
 - 1. For unlined tanks with a sidewater depth of 25 feet or less, loss of volume not exceeding 0.1% in 24 hours.
 - 2. For tanks with lined walls and a sidewater depth of 30 feet or less, loss of volume not exceeding 0.06% in 24 hours. Steel diaphragms in concrete walls shall be considered the same as a wall liner.
 - 3. For completely lined tanks, loss of volume not exceeding 0.025% in 24 hours.

3.04 REPAIRS AND RETESTING

- A. The Contractor may retest structures failing the watertightness test and not exhibiting visible leakage after an additional stabilization period of 7 days. Tanks failing this second test shall be repaired before further testing.
- B. The Contractor shall repair structures which fail the watertightness test and structures showing visible leakage in compliance with the provisions specified in this Section or as approved by the Engineer.
- C. Repairs and retesting of tanks shall be accomplished at no additional cost to the Owner.

3.05 SCHEDULE

- A. The following structures, where applicable, shall be tested for watertightness:
 - 1. Gravity Intake Structure
 - 2. Recharge Pump Wet Well

FIGURE A
WATERTIGHTNESS TEST REPORT

PROJECT _____ SUBMITTED BY _____

STRUCTURE* _____ TEST DATES _____

Allowable loss of water volume _____ percent in 24 hours.

Measured loss of water volume _____ percent in 24 hours.

TEST READINGS

Water temperature at start _____ degrees F. Water temperature at end _____ degrees F.

<u>Date</u>	<u>Time</u>	Location <u>1</u>	Location <u>2</u>	Location <u>3</u>	Location <u>4</u>	Initials
1. _____	_____	_____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____	_____	_____
5. _____	_____	_____	_____	_____	_____	_____

Change in level _____

Average change in level _____

Correction for precipitation/evaporation _____

Corrected change in level = CL = _____

$(\text{CD} \times (\text{surface area}) \times (100)) = \text{measured percent water loss in 24 hours.}$

$(\text{initial water volume}) \times (\text{number of test days})$

Notes and field observations**

* Attach a sketch showing a plan of the structure and measurement locations.

** Place date and initials at the beginning of each entry.

END OF SECTION

SECTION 01820 TRAINING

PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall do the following:

- A. Instruct and train the Owner's personnel in the operation and maintenance of the equipment and systems supplied and/or installed under this Contract.
- B. Incorporate operation and maintenance data and training services furnished by the suppliers into the training program such as shop drawings, equipment manuals, and start-up engineering and training assistance.
- C. Ensure that system suppliers provide a qualified training instructor to help the Contractor train the Owner's employees in the proper operation and maintenance of all equipment and systems.
- D. Prepare instructors and training materials required for complete factory, field, classroom, and hands-on training.
- E. Furnish training videos and manuals during the training program.
- F. Include in the total Contract Price the cost for training equipment; preparing training manuals; conducting classroom instructions; performing field, factory, and hands-on training; and coordinating and incorporating training service provided by suppliers and all other activities required to provide a comprehensive training program of sufficient length, as determined by the Owner.

1.02 WORK SEQUENCE

- A. All factory training programs, if required, shall be completed before start-up of the Owner's system and shall use equipment similar to the Owner's equipment.
- B. The field training programs shall be conducted in accordance with the approved schedule.
- C. Individuals requiring training shall be trained in small groups during Mondays through Fridays. The Contractor will normally provide training during the 8-hour dayshift.

- D. The hands-on training shall be conducted with a maximum of 10 students per instructor.
- E. The Contractor shall coordinate and submit a training schedule to the Engineer 30 days before the first training event.

1.03 QUALITY ASSURANCE

- A. Preparation of training materials and instructions to be provided shall be performed by personnel:
 - 1. Trained and experienced in operation and maintenance of equipment and systems installed under this Contract.
 - 2. Familiar with the training requirements of the Owner.
- B. The Contractor shall furnish résumés, including three outside references, for each instructor to be used in the training program.
- C. The Engineer and Owner may review the résumés. Based on the review of the résumés and contacts with references, the Engineer shall approve, request additional information, or reject proposed instructors for the training program. If a proposed instructor is rejected, the Contractor shall submit the résumé and references of another candidate within a reasonable time.

1.04 TRAINING PLAN

- A. At the completion of the Work, the Contractor shall provide a competent and experienced person thoroughly familiar with the Work for not less than 3 days to instruct permanent operating personnel in the operation of equipment and control systems.
- B. At least 30 days before training, the Contractor shall submit to the Engineer a detailed training plan including the following:
 - 1. Title and objectives.
 - 2. Training schedule.
 - 3. Prerequisite training and experience of attendees.
 - 4. Recommended types of attendees (e.g., managers, engineers, operators, maintenance staff).
 - 5. Course description and outline of course content.
 - 6. Duration.
 - 7. Location (e.g., training center or site).
 - 8. Format (e.g., lecture, self-study, demonstration, hands-on).
 - 9. Instruction materials and equipment requirements.

1.05 FORM OF TRAINING MANUALS

A. The Contractor shall prepare training packages in the form of an instruction manual for use by the Owner's personnel. At least 30 days before the training, the Contractor shall submit the training packages to the Engineer for acceptance.

B. Format

1. Size: 8 1/2 x 11 inches (21.59 x 27.94 cm).
2. Paper: 20-pound (9.072 kg) minimum, white, for typed pages.
3. Text: Manufacturer's printed data or neatly word processed including the following:
 - a. Table of contents.
 - b. Pretest.
 - c. Learning objectives.
 - d. General operations, theory, and specific equipment information.
4. Drawings
 - a. Provide reinforced punched binder tab, bind in with text.
 - b. Reduce larger drawings and fold to size of text pages, not larger than 11 x 17 inch (27.94 x 43.18 cm).
5. Cover: Identify each volume with the following:
 - a. Title of Project.
 - b. Identity of separate structure or system as applicable.
 - c. Identity of general subject matter covered in the manual.
 - d. Locations.

C. Binders

1. Commercial quality three-post binders with durable and cleanable plastic covers.
2. Maximum post width shall be 3 inches (7.62 cm).
3. When multiple binders are used, correlate the information into related consistent groupings.

1.06 VIDEOTAPED TRAINING MATERIAL

Training shall be in accordance with Section 11000, General Equipment Requirements, and as described below.

The Contractor shall do the following:

- A. Produce or provide video training material subject to approval of the Owner.
- B. Furnish four copies of each videotape in DVD format in plastic case with title, the Owner's name, and time on a label in a clear plastic sleeve.
- C. Bear all costs associated with production and provision of the DVDs.

1.07 INSTRUCTIONS

- A. At the completion of Work, the Contractor shall provide a competent and experienced person thoroughly familiar with the Work for a period of time as directed by the Owner to instruct permanent operating personnel in the operation of equipment and control systems.
- B. The Contractor shall furnish complete sets of operating instructions applying to each piece of equipment installed in conjunction with this Contract. The sets shall be provided in the quantity as desired by the Owner.
- C. An "As-Installed" diagram of all control wiring and operating instructions shall be mounted in a watertight pocket on the inside door of the control panel of each unit.
- D. Unless otherwise specified, the Contractor shall provide engraved metal, plastic tags, or instructions on any valve, switch, control, pipe or other piece of equipment which is not self evident as to its function or mode of operation. This includes, but is not limited to, all exposed piping and all switches. This shall particularly apply to operations that must be manually sequenced.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01830
OPERATIONS AND MAINTENANCE MANUALS

PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall do the following:

- A. Compile product data and related information appropriate for the Owner's maintenance and operation of products furnished under the Contract.
 - 1. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of the Specifications. The data presented in the Operations and Maintenance (O&M) Manuals shall be specifically related to this Contract and application.
 - 2. Incorporate maintenance and operation data furnished by the Owner, if any.
- B. Furnish all labor, equipment, materials, and all other items to supply and deliver to the Engineer O&M Manuals for the Work in accordance with the requirements of this Section.
- C. Provide O&M Manuals for all equipment, including instrumentation, electrical, and process control system equipment and software for the entire Facility.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Manuals that, in general, shall have two levels: a facilities-wide systems level and an individual-component level.
 - 1. The facilities-wide systems level shall do the following:
 - a. Describe the facilities-wide systems, including diagrams.
 - b. Explain start-up, shutdown, normal operations, and malfunctions of the facilities-wide systems.
 - c. Tabulate a lubrication schedule for the facilities-wide systems.
 - d. Describe preventive maintenance checking procedures for the facilities-wide systems.
 - e. Include a cross-reference to all individual component manuals.

2. The individual-component level shall contain the following:
 - a. Storage requirements.
 - b. Installation instructions.
 - c. Alignment instructions and tolerances.
 - d. Operating instructions.
 - e. Troubleshooting instructions.
 - f. Lubrication requirements.
 - g. Maintenance instructions.
 - h. Parts list.
 - i. Recommended spare parts list and how to obtain same.

B. Format:

1. Size: 8 1/2 x 11 inch (21.59 x 27.94 cm).
2. White paper: 20-pound (9.072 kg) minimum.
3. Text: Manufacturer's printed data or neatly word-processed.
4. Drawings:
 - a. Provide reinforced, punched binder tab, bind in with text.
 - b. Reduce larger drawings and fold to size of text pages but not larger than 11 x 17 inches (27.94 x 43.18 cm).
 - c. Place all drawings at the end of each section and drawing shall be printed on one side only.
5. Provide a blank page for each separate product or each piece of operation equipment.
 - a. Provide a word-processed description of the product and major component parts of equipment.
 - b. Provide indexed tabs.
6. Cover: Identify each volume with typed or printed title, "OPERATIONS AND MAINTENANCE INSTRUCTIONS," listing the following:
 - a. Title of Project.
 - b. Identity of separate structure as applicable.
 - c. Identity of general subject matter covered in the manual.

C. Media

1. Original word-processed CD shall be delivered to the Engineer.
2. All word processing must be done using the latest version of Microsoft Word.
3. All drawings except control system configuration drawings must be submitted on CD using AutoCAD.

D. Binders

1. Filled to not more than 75% capacity.
2. When multiple binders are used, arrange the data into related consistent groupings.

E. The Contractor shall submit the following:

1. Equipment Manuals—Five copies of the O&M Instruction Manual for each piece of equipment shall be submitted to the Engineer with delivery of the equipment. O&M manuals will not include the manufacturer's test results and Record specifications.
2. Systems O&M Manuals—Five copies of the systems O&M Manuals, bound and indexed and submitted to the Engineer no later than 60 days before the Facility's Phase I start-up. Systems O&M Manuals will be complete except for field results and refinements added as result of demonstrations.
3. Final O&M Manuals—Five copies of the Final Equipment and Systems O&M Manuals, bound and indexed and submitted to the Engineer before the Substantial Completion under this Contract.
4. The cost of these Manuals submitted shall be included in the total Contract Price. Copies supplied under Item 2 will not be included under Item 3.

F. Any modifications required after final O&M submission shall be made to the manuals by issuance of addenda in the form of change pages to the manual. The addenda will identify where the new data are to be inserted, what data are to be removed, and new index sheets as necessary and list of shop drawings and submittals.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to herein shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. Florida Administrative Code (FAC)

1. Rule 62-555.350 FAC—Operation and Maintenance of Public Water Systems.

1.04 QUALITY ASSURANCE

A. Data shall be prepared by personnel:

1. Trained and experienced in maintaining and operating the described products.
2. Familiar with requirements of this Section.
3. Skilled as a technical writer to the extent required to communicate essential data.
4. Skilled as a draftsman competent to prepare required drawings.

1.05 CONTENTS, EACH VOLUME

A. Neatly word-processed table of contents for each volume, arranged in systematic order, to include the following:

1. Contractor, name of responsible principal, address, fax number, and telephone number.
2. A list of each product required to be included, indexed to content of the volume.
3. A list with each product, name, address, fax number, and telephone number of the following:
 - a. Subcontractor or installer.
 - b. A list of each product to be included, indexed to content of the volume.
 - c. Identify area of responsibility of each subcontractor or installer, if more than one.
 - d. Local source of supply for parts and replacement.
 - e. Manufacturer.

4. Identify each product by product name and other identifying symbols as set forth in the Contract Documents.

B. Product Data

1. Include only those sheets that are pertinent to the specific product.
2. Annotate each sheet to achieve the following:
 - a. Clearly identify the specific product or part installed.
 - b. Clearly identify data applicable information.
 - c. Delete references to inapplicable information.

C. Drawings

1. Supplement product data with drawings as necessary to illustrate the following clearly:
 - a. Relations of component parts of equipment and systems.
 - b. Control and flow diagrams.
 - c. Owner Tag Numbers.
2. Coordinate drawings with information in Record Documents to ensure correct illustration of completed installation.
3. Do not use Record Documents as maintenance drawings.

D. Written text as required to supplement product data for the particular installation:

1. Organize in consistent format under separate headings for different procedures.
2. Provide a logical sequence of instructions for each procedure.
3. Describe how the complete system is to operate.

E. Copy of pertinent information related to warranty, bond, and service Contract issued.

1. Provide information sheet for Owner's personnel with the following information:
 - a. Proper procedures in event of failure.
 - b. Instances that might affect the validity of warranties or bonds.

F. Training manuals used in training courses will become part of this Manual.

1.06 MANUAL FOR MATERIALS AND FINISHES

- A. Content, for architectural products, applied materials, and finishes:
 - 1. Manufacturer's data, giving full information on products:
 - a. Catalog number, size, composition.
 - b. Color and texture designations.
 - c. Information required for re-ordering special-manufactured products.
 - 2. Instructions for care and maintenance:
 - a. Manufacturer's recommendation for types of cleaning agents and methods.
 - b. Cautions against cleaning agents and methods that are detrimental to product.
 - c. Recommended schedule for cleaning and maintenance.
- B. Content, for moisture-protected and weather-exposed products:
 - 1. Manufacturer's data, giving full information on products:
 - a. Applicable standards.
 - b. Chemical composition.
 - c. Details of installation.
 - 2. Instructions for inspection, maintenance, and repair.
- C. Additional requirements for maintenance data as required by other sections of the Specifications.

1.07 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Content, for each electrical, mechanical, instrumentation, and communication system, as appropriate:
 - 1. A table identifying each piece of equipment, each associated control or instrument, the location of the control or instrument, and the function of the control or instrument.

2. A description of the system and its component parts:
 - a. Function, normal operating characteristics, and limiting conditions for the system, the sub-system, and the component parts.
 - b. Performance curves, engineering data, and tests.
 - c. Complete nomenclature and commercial numbers of replaceable parts.
3. Circuit directories of panel board:
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
4. As-installed color-coded wiring diagrams.
5. Instrument loop diagrams showing the path that a control or instrumentation signal takes from its origin to the action it takes.
 - a. An electrical schematic for each item.
 - b. A chart listing the controls/instruments in a loop identifying the equipment's abbreviated symbol, a description of the symbol, design criteria, process flow, quantity supplied, and manufacturer's model and serial number.
6. Operating procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Special operating instructions.
7. Maintenance procedures:
 - a. Routine operations.
 - b. Guide to "trouble-shooting."
 - c. Disassembly, repair, and re-assembly.
 - d. Alignment, adjustment, and checking.
8. The manufacturer's printed operating and maintenance instructions.
9. A list of the original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
10. Other data as required under other sections of the Specifications.

11. Abnormal and emergency operations:
 - a. Potential overloads.
 - b. Procedures for equipment breakdown.
 - c. Action to be taken in a power outage.
 - d. Identity of alarms by equipment location and action to correct.
 - e. Equipment safety features, requirements, and potential hazards.
12. Programming manuals for programmable devices including list of standard programming.

B. Content, for each unit of equipment and system, as appropriate:

1. Description of unit and component parts:
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Model number and name plate data for each piece of equipment.
 - e. Assembly drawings.
 - f. List of all special tools required to service equipment and/or systems including where the tools are stored.
2. Operating procedures:
 - a. Start-up, break-in, routine, and normal operating instructions.
 - b. Regulation, control, stopping, shut-down, and emergency instructions.
 - c. Summer and winter operating instructions.
 - d. Special operating instructions.
 - e. Control settings and ranges.
3. Maintenance procedures:
 - a. Type and frequency of preventive maintenance activities required for each piece of equipment.
 - b. Guide to "trouble-shooting."
 - c. Disassembly, repair, and re-assembly.
 - d. Alignment, adjusting, and checking.

4. Servicing and lubrication schedule:
 - a. List of lubricants required.
 - b. Period between lubrications.
 5. Manufacturer's printed operating and maintenance instructions. (This is not to be a generalized catalog of the entire product line.)
 6. Description of sequence of operation.
 7. The original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance:
 - a. Predicted life of parts subject to wear.
 - b. Items recommended to be stocked as spare parts.
 8. As-installed control diagrams.
 9. Each Contractor's coordination drawings.
 10. List of the original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
 11. Other data as required under pertinent sections of the Specifications.
 12. Charts of equipment, instrument, and valve tag numbers with location and function:
 - a. Reference drawing that shows equipment, instrument, or valve location.
 - b. Manufacturer's model and serial number.
 - c. Valve actuator type (manual, hydraulic, electric, or pneumatic).
 13. Local services (process water and air, drains, HVAC, natural gas, and steam).
- C. The Contractor shall prepare and include additional data when the need for such data becomes apparent during instruction of the Owner's personnel.
- D. Additional requirements for O&M data required by other sections of the Specifications.

PART 2 PRODUCTS

2.01 O&M MANUALS

- A. Binders: The manuals shall be supplied in binders that are the same as those provided in Paragraph 1.02D. above.
- B. Electronic Version: Word-processed portions of the manuals shall also be provided on CDs. The electronic-version manuals must be capable of being read, edited, and printed with Microsoft Word or Owner-approved file format at the time of the transmittal of documents. The format will be provided to the Contractor upon request. All drawings shall be generated using personal computer and plotter with the software package program from AutoCAD.

PART 3 EXECUTION (NOT USED)

END OF SECTION

DIVISION 2
SITE CONSTRUCTION

SECTION 02000
REFERENCED FDOT SPECIFICATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the work necessary to provide for the construction where indicated on the Drawings.

1.02 RELATED WORK

- A. Section 01350, Environmental Protection Procedures.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Product data for reinforced concrete pipe, along with gaskets, is required to indicate performance in accordance with the specifications.
- B. Shop drawings for drainage structures including: curb inlets, ditch bottom inlets, manholes, and mitered end sections is required to indicate performance in accordance with the specifications. Include shop drawings for frames, covers, and grates with each drainage structure.
- C. Submit maintenance of traffic plan(s) for each phase of construction.

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time, unless otherwise noted. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. The 2019 edition of the *FDOT Standard Specifications for Road and Bridge Construction* (Standard Specifications) and Roadway and Traffic Design Standards shall be referred to for construction, workmanship, and quality control as specified with exceptions as noted in this Section. The referenced FDOT

Standard Specifications that apply to this project include the following sections along with the sections referenced within these sections:

- 104, Prevention, Control and Abatement of Erosion and Water Pollution
 - 110, Clearing and Grubbing
 - 120, Excavation and Embankment
 - 125, Excavation for Structures and Pipe (Stormwater System Only)
 - 145, Geosynthetic Reinforcement
 - 200, Rock Base
 - 204, Graded Aggregate Base
 - 230, Limerock Stabilized Base
 - 425, Inlets, Manholes, and Junction Boxes
 - 430, Pipe Culverts
 - 449, Precast Concrete Drainage Products
 - 514, Plastic Filter Fabric (Geotextile)
 - 522, Concrete Sidewalk and Driveways
 - 530, Revetment Systems
1. Where the referenced FDOT Specifications cite "the Department," this shall be modified to "the Owner and/or Engineer" by this contract.
 2. Payment for this project is in accordance with the Bid Form.
 3. Additional requirements superseding the applicable portions of the above FDOT Standard Specifications are provided in the subsequent sections of these Technical Specifications.

1.05 WARRANTIES

- A. Warranties shall be in accordance with the Contract Documents.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

PART 2 PRODUCTS

2.01 GENERAL

- A. The 2019 edition of the *FDOT Standard Specifications for Road and Bridge Construction* (Standard Specifications) and Roadway and Traffic Design Standards shall be referred to for construction, workmanship, and quality control

as specified with exceptions as noted in this Section. The referenced FDOT Standard Specifications that apply to this project include the following sections along with the sections referenced within these sections:

- 104, Prevention, Control and Abatement of Erosion and Water Pollution
 - 110, Clearing and Grubbing
 - 120, Excavation and Embankment
 - 125, Excavation for Structures and Pipe (Stormwater System Only)
 - 145, Geosynthetic Reinforcement
 - 200, Rock Base
 - 204, Graded Aggregate Base
 - 230, Limerock Stabilized Base
 - 425, Inlets, Manholes, and Junction Boxes
 - 430, Pipe Culverts
 - 449, Precast Concrete Drainage Products
 - 514, Plastic Filter Fabric (Geotextile)
 - 522, Concrete Sidewalk and Driveways
 - 530, Revetment Systems
1. Where the referenced FDOT Specifications cite "the Department," this shall be modified to "the Owner and/or Engineer" by this contract.
 2. Payment for this project is in accordance with the Bid Form.
 3. Additional requirements superseding the applicable portions of the above FDOT Standard Specifications are provided in the subsequent sections of these Technical Specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. The 2019 edition of the *FDOT Standard Specifications for Road and Bridge Construction* (Standard Specifications) and Roadway and Traffic Design Standards shall be referred to for construction, workmanship, and quality control as specified with exceptions as noted in this Section. The referenced FDOT Standard Specifications that apply to this project include the following sections along with the sections referenced within these sections:

- 104, Prevention, Control and Abatement of Erosion and Water Pollution
- 110, Clearing and Grubbing
- 120, Excavation and Embankment
- 125, Excavation for Structures and Pipe (Stormwater System Only)
- 145, Geosynthetic Reinforcement

- 200, Rock Base
 - 204, Graded Aggregate Base
 - 230, Limerock Stabilized Base
 - 425, Inlets, Manholes, and Junction Boxes
 - 430, Pipe Culverts
 - 449, Precast Concrete Drainage Products
 - 514, Plastic Filter Fabric (Geotextile)
 - 522, Concrete Sidewalk and Driveways
 - 530, Revetment Systems
1. Where the referenced FDOT Specifications cite "the Department," this shall be modified to "the Owner and/or Engineer" by this contract.
 2. Payment for this project is in accordance with the Bid Form.
 3. Additional requirements superseding the applicable portions of the above FDOT Standard Specifications are provided in the subsequent sections of these Technical Specifications.

END OF SECTION

SECTION 02230 SITE PREPARATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, and equipment required and perform all site preparation, complete as shown on the Drawings and as specified in this Section.
- B. The Contractor shall obtain all permits required for site preparation before proceeding with the work, including clearing and tree removal.
- C. The areas to be cleared, grubbed, and stripped shall be minimized to the extent possible for the scope of work and in consideration of the actual means and methods of construction used. No unnecessary site preparation shall be performed within these areas.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. Submit to the Engineer copies of all permits required before clearing, grubbing, and stripping work.

1.03 WARRANTIES

- A. Warranties shall be in accordance with the Contract Documents.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

- A. The Contractor shall preserve and protect trees and other vegetation as identified in the Contract Drawings.

3.02 GRUBBING

- A. The Contractor shall only grub and remove stumps, roots in excess of 1-1/2 inches in diameter, matted roots, brush, timber, logs, concrete rubble, and other debris encountered when authorized by the Engineer or Owner. The removal shall only be to a depth of 18 inches below original grade or 18 inches beneath the bottom of foundations, whichever is deeper.
- B. The Contractor shall refill all grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface in accordance with Section 02300, Earthwork for Structures, and Section 02305, Earthwork for Utilities.

3.03 STRIPPING

- A. Topsoil shall be free from brush, trash, large stones, and other extraneous material. Avoid mixing topsoil with subsoil.
- B. The Contractor shall stockpile and protect topsoil until it is used in landscaping, loaming, and seeding operations and dispose of surplus topsoil after all work is completed.

3.04 DISPOSAL

- A. Dispose of material and debris from site preparation operations by hauling such materials and debris to an approved offsite disposal area. No rubbish or debris of any kind shall be buried on the site.
- B. Burning of cleared and grubbed materials or other fires for any reason will not be permitted.

3.05 PROTECTION

- A. Trees and other vegetation shall be protected from damage by all construction operations by erecting suitable barriers, guards and enclosures, or by other approved means. The Contractor shall conduct minimal clearing operations and shall do so in a manner to prevent damaging trees and vegetation designated to

remain and to the work being constructed. The Contractor shall provide for the safety of employees and others.

- B. The Contractor shall maintain protection until all work in the vicinity of the work being protected has been completed.
- C. The Contractor shall not operate heavy equipment or stockpile materials within the branch spread of existing trees without authorization from the Owner or Engineer.
- D. The Contractor shall immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during the work shall immediately be cut off cleanly inside the exposed or damaged area. Treat cut surfaces with an acceptable tree wound paint spread over the exposed root area.
- E. When work is completed the Contractor shall remove all dead and downed trees.
- F. The Contractor shall restrict construction activities to those areas within the limits of construction designated on the Drawings, within public rights-of-way, and within easements provided by the Owner. Adjacent properties and improvements on these properties, public or private, which become damaged by construction operations shall be promptly restored to their original condition to the full satisfaction of the property owner.
- G. The Contractor shall remove trees damaged beyond saving, through no fault of the Contractor, within the project footprint.

END OF SECTION

SECTION 02240
DEWATERING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the work necessary to complete the dewatering activities. All work in this Section shall be done in accordance with the requirements of the Environmental Resource Permit and Water Use Permit (if required) as issued by the Florida Department of Environmental Protection (FDEP).
- B. In addition to the requirements listed in this Section, the Contractor shall obtain, if required, and comply with all requirements of the Generic Permit for the Discharge of Ground Water From Any Non-Contaminated Site Activity as described in FAC 62-621-300.
- C. Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control groundwater flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Remove dewatering system if no longer needed.
- D. The Contractor shall dewater so as to prevent damage to existing work. The Contractor shall repair or replace damage resulting from the dewatering activities promptly, remedy environmental damage as approved by the Engineer, and pay any and all fines levied to Contractor at no additional cost or time to the Owner.
- E. The Dewatering Plan shall be signed and sealed by the licensed professional engineer responsible for its preparation.
- F. The Contractor shall design the dewatering system. The Contractor shall be responsible for obtaining whatever investigations are necessary, before bidding, to design the dewatering system.

1.02 SUBMITTALS

The Contractor shall submit the following in accordance with Section 01330, Submittals and Acceptance:

- A. Before construction, the Contractor shall obtain a dewatering permit from the Florida Department of Environmental Protection as required. At a minimum, the dewatering plan submitted with the dewatering application shall include the following:
 - 1. Duration of dewatering for each area.
 - 2. Number and size of pumps.
 - 3. Method of dewatering each area.
 - 4. Methods for routing/containing the discharge.
 - 5. Methods of isolating dewatering areas.
 - 6. Time dewatering structure will be in place.
 - 7. Proposed discharge points.

Five copies of the plan shall be submitted to the Engineer for record purposes only.
- B. The Contractor shall be responsible for determining if a Water Use Permit will be required. If a Water Use Permit is required, it is the Contractor's responsibility to obtain the required information from the Engineer and Owner to complete the Water Use Permit application to submit with the Dewatering Plan. If a Water Use Permit is required, the Contractor shall submit five copies of the application to the Owner/Engineer for submittal purposes only.
- C. The Contractor shall be responsible for obtaining a Generic Permit for the Discharge of Produced Ground Water from any Non-Contaminated Site Activity as set forth in FDEP Rule 62-621.300(2), FAC. The Contractor shall obtain the required permit Form 62-621.300(2) and the required information from the Engineer and Owner to complete the Generic Permit for the Discharge of Produced Ground Water from any Non-Contaminated Site Activity application to submit with the Dewatering Plan. The Contractor shall submit five copies of the application to the Owner/Engineer for submittal purposes only.
- D. Provide photographs or videotape, sufficiently detailed, of existing conditions of adjoining properties, facilities, and other construction and site improvements that might be later misconstrued as damage caused by dewatering operations.

- E. Submit Record Drawings at Project closeout identifying and locating utilities and other subsurface structural, electrical, or mechanical items encountered during dewatering.

- 1. Note locations and capping depth of wells and well points.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. Florida Administrative Code (FAC)

- 1. FAC 62-621-300—FDEP – Generic Permits.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.
- B. Pre-installation Conference: Conduct conference at the Project site to present and discuss dewatering means, methods, and monitoring program.
- C. Identify a person who shall be present at all times during the execution of this portion of the Work and who shall be thoroughly familiar with the dewatering system being installed for this Project, the referenced standards, environmental and permit requirements, the requirements of this Work, and who shall direct all work performed under this Section.
- D. It shall be the responsibility of the Contractor to determine the water levels before and during the dewatering work.

1.05 QUALIFICATIONS

- A. The Contractor shall provide at least one person who shall be present at all times during the execution of this portion of the Work and who shall be thoroughly familiar with the dewatering system being installed, the referenced standards, the requirements of this Work, and who shall direct all work performed under this Section.
- B. The Contractor shall be responsible for determining the water level before beginning excavation and construction.

1.06 PRE-BID INSPECTION AND TESTING

- A. The Contractor is advised that site soil borings may indicate groundwater levels below the levels which may occur in response to normal, seasonal, extreme, or prolonged rainfall. The Contractor is further advised that site soil borings may not necessarily represent soil conditions to be encountered elsewhere on the job site, other than at the specific boring locations.
- B. Before bidding, the Contractor shall perform a detailed site inspection and, if desired, obtain the Owner's permission to perform site-specific testing as he deems necessary to obtain all required information relative to project dewatering requirements.
- C. The Contractor shall include as part of his Bid the total cost of all surface and subsurface dewatering as required to construct the Project in complete compliance with the Drawings and these Specifications.

1.07 PROJECT CONDITIONS

- A. The Contractor shall not interrupt utilities serving facilities occupied by Owner or others unless approved by the Owner and Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
- B. A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. The Owner will not be responsible for interpretations or conclusions drawn from these data.
 - 1. The geotechnical report is an attachment to the Specifications.
 - 2. The Contractor shall be responsible for additional test borings and to make additional test borings and conduct other exploratory operations necessary for dewatering.
- C. Survey adjacent structures and improvements, (e.g. wells, bridge, utility poles, etc.) employing a professional land surveyor licensed in Florida to establish exact elevations at fixed points to monitor settlement. Clearly identify monitoring points and reference vertical datum, and benchmarks. Monitor and record existing initial elevations.
 - 1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify the Engineer if changes in elevations occur or

if cracks, sags, or other damage is evident in adjacent construction and existing structures.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 DEWATERING SYSTEM

- A. The dewatering system shall be adequate to drain the soils to be excavated to the extent that the piezometric water level in the construction area is a minimum of 2 feet below the bottom of the excavation, side slopes of excavations, or bottom of the footings at all times, or as otherwise required to obtain the specified compaction and installation conditions. Pipeline trenches must be dewatered at least 1 foot below the trench bottom.
- B. If layered soils are encountered, the hydrostatic head in the zone below the subgrade elevation shall be relieved to prevent uplift.
- C. Unless otherwise noted and before any excavating below or within 2 feet above the groundwater level, a dewatering system shall be placed into operation to lower water levels to the extent specified previously and then shall be operated continuously 24 hours a day, 7 days a week, throughout the excavation to maintain and protect all work until the work has been completed to the satisfaction of the Engineer.
- D. Where used, well points shall be installed in an Engineer-approved manner and in sufficient numbers to provide the necessary removal of water as stated previously. Well points and header piping shall be installed so that traffic on public thoroughfares and site access roads will not be impeded.
- E. The Contractor shall be solely responsible for the arrangement, location, and depths of the dewatering system necessary to accomplish the specified work. The dewatering system shall stay in full operation until not less than 90% of the total building load is applied, as will be determined by the Engineer, or until excavations and trenches have been backfilled and compacted.
- F. Where needed, a portable coffer dam system such as Dam-It Dams or AquaDam may be utilized. The Contractor is responsible for coordinating with the manufacturers directly to determine the appropriate size, material, and whether any additional fluming may be required for the application.
- G. To prevent excessive noise, exhaust from all pumps and engines shall be silenced and muffled.

- H. Wellpoint or surface water pump discharge shall be controlled to prevent erosion, undermining, and all other damage and be piped to approved locations.
- I. The Contractor is responsible for determining what approvals and permits are required to comply with any and all applicable regulations and permitting requirements relating to dewatering activities. With the Engineer's assistance the Contractor shall obtain all necessary approvals and permits and comply with any and all applicable regulations and permitting requirements concerning all dewatering activities, including pumpage and discharge. The Contractor is solely responsible for all costs associated with the proper implementation of dewatering activities.
- J. The Contractor shall perform all dewatering work in strict compliance with Section 01350, Environmental Protection Procedures, and the Contract Drawings.
- K. Excavations shall be kept free from water during the placing of concrete and for 36 hours after or until concrete forms are removed.
- L. 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 groundwater from entering excavations, ponding on prepared subgrades, or flooding the site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- M. 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 the Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- N. Install sufficient dewatering equipment to drain water-bearing strata above and below the bottom of foundations. If excavating through layered soils, relieve any potential groundwater hydrostatic head in the zones below to prevent uplift.
 - 1. Open-sump pumping which leads to loss of fines, subgrade softening, and slope instability shall not be permitted.

- O. 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 in a manner that avoids flooding or accumulation on private property. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

3.02 OBSERVATION WELLS

- A. The Contractor shall install observation wells as may be required to record accurate water levels.
- B. The Contractor shall be responsible for maintaining all observation wells and observing and recording the elevation of the piezometric water levels daily.
- C. Wells damaged or destroyed shall be replaced at no additional cost to the Owner.

3.03 CLEANUP

- A. Upon completing dewatering elsewhere on the Project, the Contractor shall remove all equipment and leave the project site in a neat, clean, and acceptable condition satisfactory to the Owner. Wellpoint holes and excavations shall be adequately backfilled and compacted to prevent settlement.

END OF SECTION

SECTION 02300
EARTHWORK FOR STRUCTURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, equipment, tools, appliances, and materials and perform all operations necessary for the following:
1. Preparing subgrades for slab-on-grade and grasses.
 2. Excavating and backfilling for buildings and structures.
 3. Laying the subbase course for concrete.
 4. Excavating and backfilling for utility trenches.
 5. Excavating and backfilling for trenches for buried mechanical and electrical utilities and pits for buried utility structures, as indicated on the Contract Drawings and described in this Section.

1.02 SUBMITTALS

The Contractor shall submit the following shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
1. Classification according to ASTM D2487 of each onsite and borrow soil material proposed for fill and backfill.
 2. Laboratory compaction curve according to ASTM D1557 for each onsite and borrow soil material proposed for fill and backfill.
- B. The Contractor shall submit records before the start of this work. The Contractor shall verify that the existing conditions are correct as shown on the plans and mentioned in these Specifications. The Contractor shall note any discrepancies found immediately and notify the Owner and Engineer.
- C. Testing Agency Invoices indicating if the invoice is for an initial test or a re-test of the Contractor's work.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of

this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM C33/C33M—Standard Specification for Concrete Aggregates.
2. ASTM D698—Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
3. ASTM D1556/D1556M—Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D1557—Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
5. ASTM D2167—Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
6. ASTM D2487—Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D2937—Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
8. ASTM D2940/D2940M—Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways or Airports.
9. ASTM D3740—Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
10. ASTM D6938—Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
11. ASTM E329—Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. Occupational Safety and Health Administration (OSHA)

1. OSHA 2226—Trenching and Excavation Safety.

1.04 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E329 to conduct soil materials and definition testing, as documented according to ASTM D3740.

B. The Contractor shall do the following:

1. Ensure that excavations provide adequate working space and clearance for the work to be performed and for installing piping and buried utilities. In no case shall excavation faces be undercut.
2. Ensure that foundation surfaces are clean and free of loose material of any kind when pipelines and buried utilities are placed on them.
3. Excavate, trench, and backfill in compliance with applicable requirements of governing authorities having jurisdiction.
4. Ensure that shoring and sheeting for excavations are designed by a Florida-registered Professional Engineer and are in accordance with OSHA 2226.
5. Before beginning any excavation or grading, ensure the accuracy of all survey data indicated on the Contract Drawings and in the Specifications and/or as provided. If the Contractor discovers any inaccuracies, errors, or omissions in the survey data, the Contractor shall immediately notify the Owner so that proper adjustments can be anticipated or ordered. If the Contractor begins any excavation or grading, this shall be considered an acceptance of the survey data by the Contractor, after which time the Contractor has no claim against the Owner resulting from alleged errors, omissions, or inaccuracies of the survey data.
6. Ensure that tolerances for excavation are plus or minus 0.10 foot to the required line and to the required grade. Tolerance for compaction of in-place material shall be plus or minus 0.10 foot to the required grade, unless otherwise noted.

1.05 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*: The course placed between the subbase course and hot-mix asphalt paving.
- C. *Bedding Course*: The course 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*: The course supporting the slab-on-grade that also minimizes the upward capillary flow of pore water.
- F. *Excavation*: Removing material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. *Authorized Additional Excavation*: Excavation below subgrade elevations or beyond indicated lines and dimensions.
 - 2. *Unauthorized Excavation*: Excavation below subgrade elevations or beyond indicated lines and dimensions. Unauthorized excavation as well as remedial work shall be without additional compensation.
- G. *Fill*: Soil materials used to raise existing grades.
- H. *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.
- I. *Subgrade*: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- J. *Utilities*: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

- A. General: The Contractor shall provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D2487 Soil Classification Groups SW and SP or a combination of these groups, free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsuitable Soils: Soil Classification Groups GW, GP, GM, GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
 - 1. Unsuitable soils also include satisfactory soils not maintained within 2% of optimum moisture content at time of compaction.

- D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95% passing a 1-1/2-inch sieve and not more than 8% passing a No. 200 sieve.
- E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90% passing a 1-1/2-inch sieve and not more than 12% passing a No. 200 sieve.
- F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100% passing a 1-inch sieve and not more than 8% passing a No. 200 sieve.
- G. Sand: ASTM C33/C33M; fine aggregate, natural, or manufactured sand.
- H. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

PART 3 EXECUTION

3.01 PREPARATION

- A. The Contractor shall protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. The Contractor shall prepare subgrade for earthwork operations as specified in Section 02230, Site Preparation.
- C. The Contractor shall protect and maintain erosion and sedimentation controls, which are specified in Section 01350, Environmental Protection Procedures.

3.02 DEWATERING

- A. The Contractor shall prevent surface water and groundwater from entering excavations, from ponding on prepared subgrades, and from flooding the Project site and surrounding area.

- B. The Contractor shall 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.
 - 2. Install a dewatering system, specified in Section 02240, Dewatering, to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.

3.03 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.04 EXCAVATION, GENERAL

- A. Unclassified Excavation: The Contractor shall excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and 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 unsuitable soil materials, replace with satisfactory soil materials.

3.05 EXCAVATION FOR STRUCTURES

- A. The Contractor shall excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10 foot. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb the bottom of the excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot. Do not disturb the bottom of excavations intended as bearing surfaces.

3.06 EXCAVATION FOR UTILITY TRENCHES

- A. The Contractor shall excavate trenches to indicated gradients, lines, depths, and elevations.
- B. The Contractor shall excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches on each side of pipe or conduit.
- C. Trench Bottoms: The Contractor shall 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 and sharp objects along trench subgrade.
 - 1. For conduit less than 6 inches in nominal diameter and flat-bottomed multiple-duct conduit units, hand excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2. For pipes 6 inches or larger in nominal diameter, shape the bottom of trench to support the bottom 90° of pipe circumference. Fill depressions with tamped sand backfill.
 - 3. Alternately, excavate trenches 4 inches deeper than the bottom of pipe elevation to allow for the bedding course. Hand excavate for bell of pipe.

3.07 SUBGRADE INSPECTION

- A. The Contractor shall notify the Engineer when excavations have reached the required subgrade.
- B. If the Engineer determines that unsuitable soil is present, the Contractor shall continue excavation and replace with compacted backfill or fill material in accordance with this Section.
- C. The Contractor shall proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll the subgrade in one direction, repeating proof-rolling in the direction perpendicular to the first direction. Limit vehicle speed to 3 miles per hour (mph).

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the 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 for unit prices or additional work.
- E. The Contractor shall reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities without additional compensation.

3.08 UNAUTHORIZED EXCAVATION

- A. The Contractor shall fill unauthorized excavation under foundations or wall footings by extending the bottom elevation of concrete foundation or footing to the excavation bottom without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi, may be used when approved by the Engineer.

3.09 STORAGE OF SOIL MATERIALS

- A. The Contractor shall stockpile excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water.
 1. Stockpile soil materials away from edge of excavations. Do not store within the drip line of remaining trees.

3.10 BACKFILL

- A. The Contractor shall place and compact backfill in excavations promptly, but not before completing the following:
 1. Constructing 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. The Contractor shall place backfill on subgrades free of mud.

3.11 UTILITY TRENCH BACKFILL

- A. The Contractor shall place backfill on subgrades free of mud.
- B. The Contractor shall place and compact the bedding course on trench bottoms and where indicated. Shape the bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. The Contractor shall backfill trenches excavated under footings and within 18 inches of bottom of footings with suitable soil.
- D. The Contractor shall fill trenches with concrete to elevation of bottom of footings. Concrete is specified in Section 03300, Cast-In-Place Concrete.
- E. The Contractor shall place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. The Contractor shall backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G. The Contractor shall place and compact final backfill of satisfactory soil to final subgrade elevation.

3.12 SOIL FILL

- A. The Contractor shall plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. The Contractor shall place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
- C. The Contractor shall place soil fill on subgrades free of mud.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. The Contractor shall place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. The Contractor shall 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. The Contractor shall compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact the top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95%.
 - 2. Under walkways, scarify and recompact the top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92%.
 - 3. Under lawn or unpaved areas, scarify and recompact the top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90%.
 - 4. For utility trenches, compact each layer of initial and final backfill soil material at 85% in unpaved lawn areas. Final backfill compaction shall meet the requirement listed above depending on the location of the trench.

3.14 GRADING

- A. General: The Contractor shall 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 Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.15 FIELD QUALITY CONTROL

- A. The number and location of the tests shall be as specified in these Specifications and as reasonably required to verify compliance with the Contract Documents.
- B. The Contractor shall coordinate activity with the Engineer and the testing agency to permit testing as directed in the presence of the Engineer.
- C. The cost of all testing to achieve specified requirements shall be borne by the Contractor. The Contractor shall be reimbursed by the Owner for passing field tests.
- D. The costs of any and all retests due to failure to achieve specified requirements shall be solely borne by the Contractor and are not reimbursable under this Contract.
- E. All materials proposed for use shall be tested as follows:

Material	Required Test	Min No. Tests
Satisfactory Soil Materials	Soil Classification using ASTM D2487 (including all tests contained therein)	One per source of materials to determine conformance with materials specified herein; additional test whenever there is any apparent change.
	Soil moisture-density relationship using Modified Proctor ASTM D1557	One per source of material or apparent change in material.

- F. The Contractor shall allow the testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after the test results for previously completed work comply with requirements.
- G. Footing Subgrade: At footing subgrades, the testing agency will perform at least one test of each soil stratum 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 Engineer.
- H. The testing agency will test compaction of soils in place according to ASTM D1556/D1556M, ASTM D2167, ASTM D2937, and ASTM D6938 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 2,000 square feet 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 test for each 100 feet or less of wall length but no fewer than two tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 400 feet or less of trench length but no fewer than two tests.
- I. When the testing agency reports that subgrades, fills, or backfills have not achieved the degree of compaction specified, the Contractor shall scarify and moisten or aerate or remove and replace soil to the depth required and recompact and retest until specified compaction is obtained.
- J. The approved testing agency shall transmit copies of field testing results as follows:
1. One copy to the Owner.
 2. Two copies to the Engineer.
 3. Two copies to the Contractor.

The field test reports shall include, at a minimum, project title; project location; location of sample(s) tested; time of testing; date of testing; testing person's full name; testing agency name, address, and telephone number; and test results.

- K. No soil material shall be used until (1) the Engineer has reviewed and approved test reports and (2) the Contractor submits certification that the soil material proposed for construction is clean and meets gradation and other parameters specified in this Specification.
- L. At no cost to the Owner, the Contractor shall remove and replace or correct all materials and work which tests indicate do not conform, in the opinion of the Engineer, to the requirements of these Specifications.
- M. The results of in-place density tests shall be considered satisfactory if the density in each instance is equal to or greater than the specified density. Soil moisture content at the time of testing shall conform to requirements of these Specifications.
- N. Where unsatisfactory compaction is revealed by the tests, the Contractor shall re-excavate, backfill, recompact, and/or rework the backfill as required to obtain the required degree of compaction over the entire depth of the excavation.
- O. The testing agency shall transmit to the Engineer copies of all testing agency invoices submitted to the Contractor for payment. Invoices shall clearly indicate specific services and date and time services are rendered and shall indicate if the invoiced testing cost is an initial test of the Contractor's work or is a re-test

required due to the Contractor's failure to initially achieve the specified requirements.

3.16 PROTECTION

- A. Protecting Graded Areas: The Contractor shall protect newly graded areas from traffic and erosion and keep them free of trash and debris.
- B. The Contractor shall repair and reestablish grades to the 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 reshape and recompact, subject to approval by the Engineer.
- C. Where settling occurs before the Project Correction Period elapses, The Contractor shall 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 the greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: The Contractor shall transport surplus satisfactory soil to designated storage areas on the Owner's property and stockpile and spread this soil as approved by the Engineer.
 - 1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION

SECTION 02305
EARTHWORK FOR UTILITIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall provide all materials, equipment, labor, and work necessary to completely construct the project in accordance with the Contract Documents. This work includes but is not limited to the following:
1. Excavating and removing unsatisfactory materials.
 2. Preparing trench foundations.
 3. Providing satisfactory material for all trenches as specified and as required.
 4. Obtaining, storing, maintaining, and disposing of materials.
 5. Dewatering, shoring, and sheeting.
 6. Placing, compacting, testing, final grading, and demolishing subgrade.
 7. Performing all other work required by the Contract Documents.
- B. The Contractor is responsible for performing all work so as not to damage existing roadways, facilities, utilities, structures, etc. and shall repair and replace such damage to equal or better than its original undamaged condition without cost to the Owner.
- C. The Contractor shall examine the site before submitting a bid, taking into consideration all conditions that may affect the work.
- D. The Contractor shall coordinate all additional subsurface investigations and testing included with this work with the Engineer before performing the excavation and foundation preparation work. In general, if the Contractor finds different and unsuitable/unsatisfactory soil conditions during the work, the Contractor shall notify the Engineer and the Owner immediately.

1.02 SUBMITTALS

The Contractor shall submit the following shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D2487 of each onsite and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D1557 for each onsite and borrow soil material proposed for fill and backfill.

The Contractor shall submit records before the start of this work. The Contractor shall verify that the existing conditions are correct as shown on the plans and mentioned in these Specifications. The Contractor shall note any discrepancies found immediately and notify the Owner and Engineer. The records shall include the following:

- 1. Location of all existing underground utilities, structures, etc. surrounding the areas to be excavated that may be impacted by the work.
- 2. Location of test excavations.
- 3. Location of inspections.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply:

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM D1556/D1556M—Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 2. ASTM D1557—Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 3. ASTM D2487—Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - 4. ASTM D2937—Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
 - 5. ASTM D3282—Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

6. ASTM D3740—Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction.
 7. ASTM D6938—Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 8. ASTM E329—Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- B. Florida Statutes (FS)
1. Florida Trench Safety Act (90-96, Laws of Florida).
- C. Occupational Safety and Health Administration (OSHA)
1. 29 CFR 1926, Subpart P—Safety and Health Regulations for Construction, Excavations.
 2. OSHA 2226—Trenching and Excavation Safety.

1.04 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E329 to conduct soil materials and definition testing, as documented according to ASTM D3740.
- B. The Contractor shall do the following:
1. Ensure that excavations provide adequate working space and clearance for the work to be performed and for installing piping and buried utilities. In no case shall excavation faces be undercut.
 2. Ensure that foundation surfaces are clean and free of loose material of any kind when pipelines and buried utilities are placed on them.
 3. Excavate, trench, and backfill in compliance with applicable requirements of governing authorities having jurisdiction.
 4. Ensure that shoring and sheeting for excavations are designed by a Florida-registered Professional Engineer and are in accordance with OSHA 2226.
 5. Before beginning any excavation or grading, ensure the accuracy of all survey data indicated on the Contract Drawings and in these Specifications and/or as provided. If the Contractor discovers any inaccuracies, errors, or omissions in the survey data, the Contractor shall immediately notify the Owner so that proper adjustments can be anticipated or ordered. If the Contractor begins any excavation or grading, this shall be considered an acceptance of the survey data by the Contractor, after which time the

Contractor has no claim against the Owner resulting from alleged errors, omissions, or inaccuracies of the survey data.

6. Ensure that tolerances for excavation are ± 0.10 foot to the required line and to the required grade. Tolerance for compaction of in-place material shall be ± 0.10 foot to the required grade.
7. Ensure that all trench materials derived from the project site and imported to this site are examined, tested, and classified by an Engineer-approved soils testing laboratory.

1.05 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*: The course placed between the subbase course and hot-mix asphalt paving.
- C. *Bedding Course*: The course 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*: The course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. *Excavation*: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 1. *Authorized Additional Excavation*: Excavation below subgrade elevations or beyond indicated lines and dimensions in accordance with the Contract Documents and as approved by the Engineer.
 2. *Bulk Excavation*: Excavation more than 10 feet in width and more than 30 feet in length.
 3. *Unauthorized Excavation*: Excavation below subgrade elevations or beyond indicated lines and dimensions without approval of the Engineer. Unauthorized excavation shall be without additional compensation.
- G. *Fill*: Soil materials used to raise existing grades.

- H. *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.
- I. *Subgrade*: The surface or elevation remaining after completing excavation, or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- J. *Utilities*: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.06 TESTING REQUIREMENTS

- A. The Contractor shall furnish a soil survey for satisfactory material and samples of materials.
- B. Testing for source material, for classification, and for prequalification of material (on or off site) shall be performed by an independent testing agency retained by the Contractor and approved by the Engineer.
- C. Testing for in-place compacted fill shall be performed by the same independent testing agency as approved by the Engineer and retained by the Contractor.
- D. The number and location of the tests shall be as specified in these Specifications and as reasonably required to verify compliance with the Contract Documents.
- E. The Contractor shall coordinate activity with the Engineer and the testing agency to permit testing as directed in the presence of the Engineer.
- F. The cost of all testing to achieve specified requirements shall be borne by the Contractor. The Contractor shall be reimbursed by the Owner for passing field tests.
- G. The costs of any and all retests due to failure to achieve specified requirements shall be solely borne by the Contractor and are not reimbursable under this contract.

H. All materials proposed for use shall be tested as follows:

Material	Required Test	Min. No. Tests
Satisfactory Soil Materials	Soil Classification using ASTM D2487 (including all tests contained therein)	One per source of materials to determine conformance with materials specified in these Specifications; additional tests whenever there is any apparent change.
	Soil moisture-density relationship using Modified Proctor ASTM D1557	One per source of material or apparent change in material.

I. Soil materials shall be tested during construction as follows:

Material	Required Test	Min. No. Tests
Satisfactory Soil Material in-place after compaction	Field Density ASTM D1556/D1556M – Sand Cone Method, or ASTM D6938 – Nuclear Density Method, or ASTM D2937 – Drive Cylinder Method	For each layer of trench bottom subgrade before addition of soil materials, refill, bedding, and backfill, and for each 400 lineal feet of trench or fraction thereof, whichever is greater; two tests for each drainage, manhole, or wet well structure; additional test whenever there is any change in native soil, groundwater, or soil moisture conditions.

J. The approved testing agency shall transmit copies of required laboratory test results as follows:

1. One copy to the Owner.
2. Two copies to the Engineer.
3. Two copies to the Contractor.

The laboratory test reports shall include, at a minimum, project title; project location; location of sample; source, time, and date of testing; testing agency's name, address, and telephone number; and test results. Each test report shall be signed and sealed by the Professional Engineer representing the testing agency as specified in these Specifications.

K. The approved testing agency shall transmit copies of field testing results as follows:

1. One copy to the Owner.
2. Two copies to the Engineer.
3. Two copies to the Contractor.

The field test reports shall include, at a minimum, project title; project location; location of sample(s) tested; time of testing; date of testing; testing person's full name; testing agency name, address, and telephone number; and test results.

- L. No soil material shall be used until 1) the Engineer has reviewed and approved test reports and 2) the Contractor submits certification that the soil material proposed for construction is clean and meets gradation and other parameters specified in these Specifications.
- M. At no cost to the Owner, the Contractor shall remove and replace or correct all materials and work that tests indicate do not conform, in the opinion of the Engineer, to the requirements of these Specifications.
- N. The results of in-place density tests shall be considered satisfactory if the density in each instance is equal to or greater than the specified density. Soil moisture content at the time of testing shall conform to requirements of these Specifications.
- O. Where the tests reveal unsatisfactory compaction, the Contractor shall re-excavate, backfill, recompact, and/or rework the backfill as required to obtain the required degree of compaction over the entire depth of the excavation.
- P. The testing agency shall transmit to the Engineer copies of all testing agency invoices submitted to the Contractor for payment. Invoices shall clearly indicate specific services and date and time services are rendered and shall indicate if the invoiced testing cost is an initial test of the Contractor's work or is a re-test required due to the Contractor's failure to initially achieve the specified requirements.

PART 2 PRODUCTS

2.01 STRUCTURAL MATERIALS

- A. Materials used for shoring and bracing, such as sheet piling, uprights, stringers, and crossbraces, shall be in good serviceable condition. Any timber used shall be sound and free from large or loose knots.
- B. Pressure-treated timber shall be used where wood sheeting or piling is specified or indicated to be cut and left in place.

2.02 TRENCH SOIL MATERIALS

- A. Materials used for trench construction shall be free of clumps of clay, rock or gravel, debris, waste, frozen materials, and other deleterious matter as determined by the Engineer and shall be satisfactory soil materials as follows:

Area Classification	Soil Materials
In excavations and trenches	Excavated and borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material."

B. Satisfactory Soil Materials

1. Soil Classification Groups: Satisfactory soil materials for each trench shall be as follows:

Satisfactory Soil Material (ASTM D3282, Soil Classification Groups)		
In-situ Foundation	Bedding, Haunching, and Initial Backfill	Final Backfill
SW SP	SW SP	SW SP

2. Maximum Particle Size Limitations for Satisfactory Soil Materials: The maximum allowable particle size for satisfactory soil materials within each trench for each type of utility shall be as follows:

Conduit	Maximum Allowable Particle Size		
	In-situ Foundation	Bedding, Haunching, and Initial Backfill	Final Backfill
Plastic Pipe (PVC, CPVC, HDPE, etc.) less than 6-inch-diameter	See Note 1	1/2 inch	3 inches
Plastic Pipe (PVC, CPVC, HDPE, etc.) 6-inch-diameter and Larger	See Note 1	3/4 inch	3 inches
Concrete Pipe			
Steel Pipe			
Ductile Iron Pipe			
Fiberglass Pipe	See Note 1	3/4 inch or three times the wall thickness, whichever is less	3 inches
Other Conduit Materials	See Note 2	See Note 2	See Note 2

- (1) There is no requirement when satisfactory undisturbed native soil material is used. Disturbed portions of the foundation and/or unsatisfactory native soil material shall be replaced with satisfactory soil materials meeting all the requirements for Bedding.
- (2) The maximum allowable particle size shall be in accordance with the manufacturer's written recommendation.

3. Additional Requirements of Satisfactory Materials: Satisfactory soil materials shall be free of debris, waste, frozen materials, vegetation, or other deleterious matter. Soils within 4 inches of the exterior surface of the pipe shall be free of gravel, stones, or other materials that may abrade the pipe surface.
- C. Unsatisfactory Materials: Unsatisfactory soil material shall mean ASTM D2487, Soil Classification Groups GW, GP, GM, GC, SC, CL, ML, OL, CH, MH, OH, PT, and other highly organic soils and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

The Contractor shall do the following:

- A. Carefully verify by hand methods the location of all surrounding underground utilities before performing utility excavations and trenches.
- B. Protect utilities to be left in place from damage.
- C. Do not interrupt existing utilities serving facilities occupied and used by the Owner, except when permitted in writing by the Owner.
- D. Protect benchmarks, survey points, and existing structures, roads, sidewalks, monitoring wells, paving, curbs, etc. against damage from equipment, vehicular or foot traffic, settlement, lateral movement, undermining, washout, and all construction-related activities.
- E. Repair and replace damage to existing facilities to equal or better than their original undamaged condition without cost to the Owner and to the approval of the Engineer.
- F. Protect excavations and trenching by shoring, bracing, sheet piling, underpinning, or other methods as required to prevent cave-ins or loose dirt from falling into excavations and trenches.
- G. Do not operate earth-moving equipment within 5 feet of walls of concrete structures for depositing or compacting backfill material.

- H. Compact the backfill material placed next to concrete walls with hand-operated tampers or similar equipment that will not damage the structure.
- I. Excavate, fill, backfill, and grade to elevations required by the Contract Documents.
- J. Pile excavated materials suitable for backfill in an orderly manner a sufficient distance from excavations to prevent overloading, slides, and cave-ins.
- K. Do not obstruct access ways.
- L. Dewater excavations and trenches in accordance with Section 02240, Dewatering.
- M. Refer to the Contract Drawings for additional requirements related to earthwork and protection of existing features.

3.02 TRENCH EXCAVATION

- A. Before excavating the trench, the Contractor shall prepare the surface including clearing and grubbing as specified in Section 02230, Site Preparation.
- B. The Contractor shall be required to fully comply with all applicable OSHA Excavation Safety Standards and to abide by them as covered by the most current version of the Florida Trench Safety Act (90-96, Laws of Florida).
- C. The Contractor shall ensure that mechanical equipment used for trench excavation shall be of a type, design, and construction and shall be so operated that conduit/utility, when accurately laid to specified alignment, will be centered in the trench with adequate clearance between the conduit/utility and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will not be permitted.
- D. The Contractor shall not use mechanical equipment in locations where its operation would cause damage to trees, buildings, culverts, other existing property, utilities, structures, etc. above or below ground. In all such locations, the Contractor shall use hand-excavating methods.
- E. The Contractor shall not use blasting.
- F. The Contractor shall cut trenches sufficiently wide to enable proper installation of services and to allow for testing and inspection. The Contractor shall also trim and shape trench bottoms and leave them free of irregularities, lumps, and projections. Trench width shall be excavated as specified on the Contract Drawings.

- G. The Contractor shall construct trench walls to avoid side wall collapse or sloughing. Trenches shall be either braced or open construction in accordance with the Contract Documents. No separate payment will be made for any special procedure used in connection with the excavation.
- H. Where sheeting and bracing are not required, the Contractor shall construct trench walls in the bottom of the excavation as vertical as possible to the maximum height allowable by OSHA. Trench walls above this height shall be sloped to guard against side wall collapse or sloughing as specified on the Contract Drawings.
- I. Where sheeting and bracing are required, the sheeting and bracing system shall meet the requirements in these Specifications.
- J. Excavations shall be to the design elevations shown on the Contract Drawings or as specified, unless unsatisfactory or unsuitable foundation materials are encountered in the bottom of the excavation. Where unsatisfactory or unsuitable foundation materials are encountered, this material shall be undercut and removed as indicated on the Contract Drawings and replaced with satisfactory soil material meeting all the requirements for Bedding. The lift thicknesses and compaction requirements for the replacement soil shall also meet the requirements for Bedding.
- K. The Contractor shall be careful not to overexcavate except where necessary to remove unsatisfactory or unsuitable materials, irregularities, lumps, rock, and projections. Unnecessary overexcavation shall be replaced as specified in these Specifications at the Contractor's sole expense.
- L. The Contractor shall accurately grade bedding soil materials at the bottoms of the trenches to provide uniform bearing and support for each section of conduit/utility at every point along its entire length except where it is necessary to excavate the bedding for conduit/utility bells (e.g., pipe bells), etc. or for proper sealing of conduit/utility joints. Abrupt changes in grade of the trench bottom shall be avoided.
- M. The Contractor shall dig bell holes and depressions after the bedding has been graded to ensure that the conduit/utility rests on the prepared bedding for as much of its full length as practicable. Bell holes and depressions shall be only of such length, depth, and width as required to make the joint.
- N. The Contractor shall do the following:
 - 1. Pile all excavated material in a manner that will not endanger the work or erode the stormwater management facilities or water courses.

- O. The Contractor shall keep all satisfactory materials that are suitable for use/reuse in the trench construction separated from unsatisfactory materials.
- P. Except where otherwise authorized, indicated, or specified, the Contractor shall replace, at the Contractor's own expense, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations with concrete or flowable fill.

Q. The Contractor shall adhere to these Additional Excavation Requirements for piping:

1. Excavate trenches so that the piping can be laid to the lines, grades, and elevations indicated on the Contract Drawings.
2. For piping designated to be laid to a minimum cover requirement, grade trenches to avoid high and low points to the extent practical. Record Drawings of such pipes shall present top-of-pipe and grade elevations at all high and low points along each pipe segment, at the end points of each pipe segments, and at intervals not to exceed 100 feet along each pipe segment.
3. Except at locations specifically indicated otherwise on the Contract Drawings, the required minimum cover over the top of the pipe from finished grade for various pipe diameters shall be as follows:

	Pipe Diameter			
	48-inch or less	66-inch	72-inch	96-inch
Minimum Cover	3 feet	4 feet	4.5 feet	5 feet

4. Continue dewatering operations along each pipe segment until the required minimum cover is provided. During the dewatering operations, the ground water level in the trench shall remain at all times a minimum of 1 foot below bottom of trench excavations.

R. The Contractor shall adhere to these Additional Excavation Requirements for Electrical Utilities:

1. Avoid abrupt changes in grade of the trench bottom.
2. The required minimum cover over the top of electrical conduits from finished grade shall be as follows:

	Electrical Conduits (Lines less than 5 kV)	Electrical Conduits (Lines 5 kV and up)
Minimum Cover	2 feet	3 feet

3. The required minimum clearance from the bottom of mat foundations and/or footings shall be 2 feet. Provide additional cover where necessary to satisfy the minimum clearance requirement.
 4. Provide additional cover depth if necessary to avoid interference of other cables, ducts, piping, structures, and other utilities.
- S. The Contractor shall adhere to this Additional Excavation Requirement for Appurtenances:
1. Ensure that excavations for valves and similar appurtenances shall be sufficient to leave at least 12 inches in the clear between the outer surfaces and the embankment or timber used to hold and protect the walls.

3.03 PROTECTION OF PERSONS AND PROPERTY

- A. The Contractor shall do the following:
1. Barricade and post excavations with warning signs for the safety of persons. Provide warning lights during hours of darkness.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations against damage including loading, settlement, lateral movement, undermining, and washout.
- B. Conduct topsoil removal operations to ensure the safety of persons and to prevent damage to existing structures and utilities, construction in progress, trees and vegetation to remain standing, and other property.

3.04 SHEETING AND BRACING

- A. Where sheeting and bracing are required to support the side walls of the excavation, the Contractor shall retain a Professional Engineer, registered in Florida, to design sheeting and bracing. The design shall establish requirements for sheeting and bracing and shall comply with all applicable codes; authorities having jurisdiction; and federal, state, and local regulations.
- B. The sole responsibility for the design, methods of installation, and adequacy of sheeting and bracing shall be and shall remain that of the Contractor and the Contractor's Professional Engineer. The Contractor shall provide all necessary

sheeting and bracing or other procedures as required to ensure safe working conditions and to protect the excavations.

- C. Sheeting and bracing shall consist of braced steel sheet piling, trench box, braced wood lagging, and soldier beams or other approved methods.
- D. The Contractor shall immediately fill and compact voids formed outside the sheeting. Where soil cannot be properly compacted to fill the void, the Contractor shall use Class B concrete as backfill at no additional cost to the Owner.
- E. The Contractor shall install sheeting outside the required clearances and dimensions. Sheeting shall be plumb, securely braced, and tied in position. Sheeting shall be adequate to withstand all pressure to which it may be subjected. The Contractor shall correct any movement or bulging at no expense to the Owner to provide the necessary clearances and dimensions.
- F. The Contractor shall maintain sheeting and bracing in excavations and trenches for the entire time excavations will be open.
- G. The Contractor shall not brace sheeting against pipe being laid. Sheeting shall be braced so that no concentrated load of horizontal thrust is transmitted to the pipe.
- H. Sheeting shall not be withdrawn if driven below the spring line of any pipe. The Contractor shall cut off tops as indicated on the Contract Drawings and leave bottoms permanently in place.

3.05 DEWATERING, WATER REMOVAL, AND DRAINAGE MAINTENANCE

- A. Dewatering shall be in accordance with Section 02240, Dewatering. Where the below descriptions differ, Section 02240, Dewatering, shall govern.
- B. Water shall not be permitted to accumulate in excavations. The Contractor shall provide dewatering systems to convey water away from excavations so that softening of foundations bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be as specified in Section 02240, Dewatering, and as approved by the Engineer before being installed by the Contractor. Groundwater levels shall be maintained a minimum of 1 foot below bottom of trenches or excavations.
- C. Dewatering systems and equipment shall be in place as required to eliminate water during the excavation period until the work is completed. The Contractor shall provide ample means and equipment with which to remove promptly and dispose of properly all water entering any excavation. This includes the use of

sand or gravel as required to maintain adequate flow during the pipe laying or installation of other items of work within the excavation.

- D. Water pumped or drained shall be disposed of in a suitable manner without damage to adjacent property, to other work under construction, or to roads. Water shall not be discharged onto surface improvements without adequate protection of the surface at the point of discharge. All gutter, drains, culverts, sewers, and inlets shall be kept clean and open for surface drainage. Water shall not be directed across or over pavements except through approved pipes or properly constructed troughs. The Contractor shall obtain permission from the Owner of any property involved before constructing water courses or installing discharge pipe or hose for removal of water and provide for disposal of the water without ponding or creating a public nuisance.
- E. All pumps used for dewatering shall have noise-reduction features and shall be able to run continuously with minimal attendance. If required by the Owner or Engineer, the pumps shall be enclosed on all sides with a plywood enclosure, with padded material suitable for outdoor conditions on the inside of the enclosure, to further reduce pump engine noise to an acceptable level. All applicable ordinances and codes for noise abatement shall be followed. The Contractor shall maintain pumps at all times, as necessary. When pumps are no longer required, the Contractor shall remove the pumps, wellpoints, pipes, and other apparatus from the area.
- F. It is essential that the discharge of the trench dewatering pumps be conducted to natural drainage channels, drains, or storm sewers.
- G. Where trenches are constructed in ditches or other water courses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds 1%, the Contractor shall install ditch checks. Unless otherwise indicated on the Contract Drawings, ditch checks shall be concrete or as otherwise approved by the Engineer. Ditch checks shall extend not less than 2 feet below the original ditch or water course bottom for the full bottom width and at least 18 inches into the side slopes and shall be at least 12 inches thick.

3.06 BACKFILLING AND COMPACTION

- A. The Contractor shall not backfill trenches until required tests are performed.
- B. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified, or the condition shall be otherwise corrected as directed.

- C. The Contractor shall perform the following steps to ensure compaction at the bottom of the trench or excavation before bedding:
1. Remove disturbed native soil material and/or any soils not meeting the requirement of satisfactory soil material as indicated on the Contract Drawings.
 2. Compact the bottom of the trench excavation (undisturbed native subsurface soil) to no less than 95% of the Modified Proctor maximum dry density in accordance with ASTM D1557, before placement of foundation, bedding, piping, and backfill.
- D. To backfill below and around pipe to the spring line of the pipe, the Contractor shall do the following:
1. Construct foundation and bedding as indicated on the Contract Drawings before placement of pipe.
 2. Install each pipe at proper grade, alignment, and final position.
 3. Deposit satisfactory soil material uniformly and simultaneously on each side of pipe in completed course layers to prevent lateral displacement.
 4. Compact under pipe haunches and on each side of pipe to the pipe spring line as shown on the Contract Drawings to hold the pipe in the proper position during subsequent pipe backfilling and compaction operations.
 5. Construct haunching as indicated on the Contract Drawings.
- E. To trench backfill above pipe spring line to finished grade, the Contractor shall do the following:
1. Deposit satisfactory soil material around and above pipe in uniform layers as shown on the Contract Drawings.
 2. Backfill and compact trenches from the spring line of the pipe to the top of the trench in completed course layers as shown on the Contract Drawings.
 3. Use material previously defined in these Specifications as satisfactory soil material.
 4. Compact by hand or mechanical tampers.

3.07 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. The Contractor shall remove and legally dispose of waste materials, including excavated material classified as unsatisfactory soil material, trash, and debris from the property at no additional cost to the Owner.

END OF SECTION

SECTION 02370
EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall take every reasonable precaution throughout construction to prevent the erosion of soil and the sedimentation of streams, bays, storm systems, or other water impoundments, ground surfaces, or other property as required by federal, state, and local regulations.
- B. The Contractor shall provide protective covering for disturbed areas upon suspension or completion of land-disturbing activities. Permanent vegetation shall be established at the earliest practicable time. Temporary and permanent erosion-control measures shall be coordinated to ensure economical, effective, and continuous erosion and siltation control throughout the construction and post-construction period.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. Florida Department of Transportation (FDOT)
 - 1. FDOT Section 103—Temporary Work Structures.
 - 2. FDOT Section 104—Prevention, Control, and Abatement of Erosion and Water Pollution.
 - 3. FDOT Section 530—Revetment Systems.
 - 4. FDOT Section 982—Fertilizer.
 - 5. FDOT Section 985—Geosynthetic Materials.

1.04 REGULATORY REQUIREMENTS

- A. The Contractor shall prevent damage to properties outside the construction limits from siltation due to construction of the project and assume all responsibilities to the affected property owners for correction of damages which may occur. Erosion-control measures shall be performed conforming to the requirements of and in accordance with plans approved by applicable state and local agencies and as specified by the erosion-control portion shown on the Drawings and as required by these Specifications. The Contractor shall not allow mud and debris to accumulate in the streets or enter drainage ditches, canals, or waterways. Should the Contractor pump water from excavations during construction, appropriate siltation preventative measures shall be taken before the pumped water is discharged into any drainage ditch, canal, or waterway.

1.05 PRACTICES

The Contractor shall adhere to the following:

- A. Avoid dumping soil or sediment into any stream bed, pond, ditch, or watercourse.
- B. Maintain an undisturbed vegetative buffer where possible between a natural watercourse and trenching and grading operations.
- C. Avoid equipment crossings of streams, creeks, and ditches where practicable.

1.06 EROSION AND SEDIMENT-CONTROL DEVICES AND FEATURES

- A. The Contractor shall construct all devices (silt fences, retention areas, etc.) for sediment control at the locations required to protect federal, state, and local water bodies and water courses and drainage systems before beginning to excavate the site. All devices shall be properly maintained in place until a structure or paving makes the device unnecessary or until directed to permanently remove the device.
- B. The Contractor shall use mulch to temporarily stabilize areas subject to excessive erosion and to protect seed beds after planting where required.
- C. Filter fabric or other approved methods shall be placed and secured over the grates of each existing inlet, grating, or storm pipe opening near the area of excavation to prevent silt and debris from entering the storm systems.
- D. The Contractor shall use silt fences and floating turbidity barriers as shown on the plans or as needed to restrict movement of sediment from the site.

- E. The Contractor shall establish vegetative cover on all unpaved areas disturbed by the work.

PART 2 PRODUCTS

2.01 GENERAL

- A. Open-mesh biodegradable mulching cloth.
- B. Fertilizer shall be 10-10-10 grade or equivalent.
- C. Lime shall be Dolomitic Agricultural Ground limestone, in accordance with FDOT Section 982.
- D. Grass shall be in accordance with Section 02920, Seeding and Sodding.
- E. Silt fence shall consist of non-biodegradable filter fabric (Trevira, Mirafi, etc.), in accordance with FDOT Section 985, wired to galvanized wire mesh fencing and supported by wood or metal posts.
- F. Floating or staked turbidity barriers as specified in FDOT Section 985 and FDOT Section 104.
- G. Erosion Stone: FDOT Section 530.
 - 1. Sand-Cement Riprap.
 - 2. Concrete Block.
 - 3. Rubble 20 to 300 pounds each.
- H. Filter Fabric for placing under Riprap shall meet the requirements of FDOT Section 985.
- I. Baled hay or straw in accordance with FDOT Section 104.

PART 3 EXECUTION

3.01 CLEARING

- A. The Contractor shall schedule and perform clearing and grubbing so that subsequent grading operation and erosion-control practices can follow immediately after. Excavation, borrow, and embankment operations will be conducted as a continuous operation. All construction areas not otherwise protected shall be planted with permanent vegetative cover within 30 working days after completing active construction.

3.02 STABILIZING

- A. The angle for graded slopes and fills shall be no greater than the angle that can be retained by vegetative cover or other adequate erosion-control devices or structures. All disturbed areas outside of embankment left exposed will, within 30 working days of completion of any phase of grading, be planted or otherwise provided with either temporary or permanent ground cover, devices, or structures sufficient to restrain erosion.

3.03 REGULATORY REQUIREMENTS

- A. Whenever land-disturbing activity is undertaken on a tract, a ground cover sufficient to restrain erosion must be planted or otherwise provided within 30 working days on that portion of the tract upon which further active construction is to be undertaken.
- B. If any earthwork is to be suspended for any reason for longer than 30 calendar days, the areas involved shall be seeded with vegetative cover or otherwise protected against excessive erosion during the suspension period. Suspension of work in any area of operation does not relieve the Contractor of the responsibility to control erosion in that area.

3.04 VEGETATIVE COVER

- A. Preparation of Seedbed. Areas to be seeded shall be scarified a depth of 4 inches until a firm, well-pulverized, uniform seedbed is prepared. Fertilizer shall be applied during the scarification process in accordance with the following rates:
 - 1. Fertilizer—10 to 15 pounds per 1,000 square feet.
- B. Seeding. Disturbed areas along embankments shall be permanently seeded with mix specified in Section 02920, Seeding and Sodding.
- C. The Contractor shall mulch all areas immediately after seeding. Mulch shall be applied and anchored as specified previously in this Section.

3.05 MAINTENANCE

- A. The Contractor shall maintain all temporary and permanent erosion-control measures in functioning order. Temporary structures shall be maintained until such time as vegetation is firmly established and grassed areas shall be maintained until completion of the project. Areas which fail to show a suitable stand of grass or which are damaged by erosion shall be immediately repaired. No additional

payment will be made to the Contractor for re-establishing erosion-control devices, which may become damaged, destroyed, or otherwise rendered unsuitable for their intended function during the construction of the project.

- B. The Contractor shall remove all silt, sediment, and debris buildup regularly to maintain functioning storm systems and erosion-control devices.

3.06 REMOVAL OF SEDIMENT CONTROL DEVICES

- A. At completion of the project, the Contractor shall dismantle and remove the temporary devices used for sediment control during construction. All erosion-control devices in seeded areas shall be left in place until the grass is established. The Contractor shall seed areas around devices and mulch after removing or filling temporary control devices.
- B. The Contractor shall clean up all areas at the completion of the project.

END OF SECTION

SECTION 02740 DIRECTIONAL DRILLING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes furnishing all labor, materials, equipment, and incidentals necessary to complete each directional drill installation shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Section 02240, Dewatering.
- B. Section 02305, Earthwork for Utilities.
- C. Section 02370, Erosion and Sedimentation Control.
- D. Section 15148, Fusible Polyvinyl Chloride Pipe and Appurtenances.

1.03 SUBMITTALS

The following shall be submitted in sufficient detail to show full compliance with the specification:

- A. Qualifications: Submit statement of qualifications and records of previous similar jobs for the horizontal directional drill contractor.
- B. Product Pipe: Submit manufacturer's catalog data for the product pipe as required in the pipe specifications. The product data shall also include the dimension ratio, minimum allowable bending radius, and the safe pull force for each product pipe being installed by directional drill.
- C. Drilling Fluids: Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Material Safety Data Sheets.
- D. Software: Submit indication of the software that the Contractor will use to perform analyses in accordance with Article 1.06, Quality Assurance.
- E. Analyses: Submit software analyses results in accordance with Article 1.06, Quality Assurance.
- F. Contingency Plan: Submit a hydraulic fracture (frac-out) contingency plan in accordance with Article 1.06, Quality Assurance.

- G. Equipment: Submit a description of the rig(s) proposed for the project at each location, showing the method of control of the boring head, head type, pulling force of the equipment, age, reamer type(s), manufacturer type, and other germane information. This information shall demonstrate that the equipment pulling force is at least 1.25 the maximum calculated peak-pulling requirement.
- H. Certificates: Submit statement that Contractor has inspected the drill equipment including the drill rod and determined that they are in satisfactory condition for its intended use.
- I. Record Drawings: Submit an electronic copy and three hard copies of the record drawings within five days after completing the pull back in accordance with the Article 1.10, Record Drawings.
- J. Drilling Logs: Maintain and submit upon completion of work complete drilling logs of guided directional drill operations.

1.04 QUALITY ASSURANCE

- A. The proposed product pipe installation lengths, depths, and curvatures presented on the Drawings are for bidding purposes only. The Driller shall be solely responsible for the successful installation of each product pipe. The Driller shall analyze each installation and make modifications necessary to successfully install each product pipe.
- B. The Driller shall analyze each installation using BoreAid TM, DrillPath TM, or other approved software and perform hand calculations as necessary if Driller's software is not capable performing all of the required analyses. The results of the analyses/calculations shall be submitted and shall include as a minimum the following:
 - 1. Proposed entry and exit angles.
 - 2. Proposed radii of curvature for all directional changes.
 - 3. Proposed profile and drill path. The profile shall show ground surfaces, waterway bottoms/beds (if applicable), and proposed product pipe installation.
 - 4. Product pipe deflection, buckling, external pressure, and stress calculations demonstrating that the forces/stresses exerted on the product pipe during and after installation will not exceed 80% of the manufacturer's safe limits.
 - 5. Pull back force calculations demonstrating that peak pulling requirement does not exceed 80% of the manufacturer's safe pull pack force.

6. Maximum borehole pressure calculations and demonstration that the maximum borehole pressure will not result in a hydraulic fracture (frac-out).
 7. Method of buoyancy control (if required/used) to reduce forces/stresses exerted on the product pipe.
- C. The Contractor shall submit a frac-out contingency plan that describes frac-out planning, prevention, monitoring, response, notification to the Owner, Engineer, and regulatory agencies, and cleanup procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage, and handling shall be in accordance with Section 01650, Delivery, Storage, and Handling, and the additional requirements herein.
- B. Inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects shall be rejected and removed from the job site.
- C. Disposal of fluids is the responsibility of the Driller. Disposal of fluids shall be done in a manner that is in compliance with all permits and applicable federal, state, and local regulations.

1.06 QUALIFICATIONS

- A. The Driller's superintendent assigned to this project must be experienced in work of this nature and must have successfully completed a minimum of five similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last 3 years under employment of the drilling company. Conventional open-trenching experience or bore-and-jacking experience will not be acceptable substitutes for directional drilling experience. Among reference projects provided, all should include drills of at least 20-inch pipe with bores of at least 1,500 linear feet in Florida. At least three shall include drills under water bodies with use of a remote guidance system for at least 24-inch pipe.
- B. As part of the bid submission, the Contractor shall submit documentation of such project(s). The documentation for experience shall include but not be limited to the following:
 1. Name(s) and description(s) of project(s).
 2. Résumés of drill company owner, operations manager, superintendent, and onsite supervisor assigned to the specific project.
 3. Pipe type(s), diameter(s), and lengths.
 4. Type and manufacturer of equipment used.

5. Soil conditions encountered.
6. Start and completion dates.
7. Reference Contact names, numbers, and addresses.

1.07 RECORD DRAWINGS

- A. The record drawings shall include a plan, profile, and all information recorded during the progress of the work. The record drawings shall be tied to the project's survey control.

1.08 DEFINITIONS

- A. *Horizontal Directional Drilling (HDD)*: A steer-able system for the underground installation of pipes, conduits, and cables using a surface launched rig. A pilot bore is drilled using a rotating drill string and then is enlarged by a back reamer to the size required for the product pipe. The necessary deviation during pilot boring is provided by a slanted face to the drill head, an asymmetric drill head, eccentric fluid jets, or a combination of these, usually in conjunction with an aboveground electronic locator or a remote guidance system.
- B. *Maxi (Conventional) HDD*: Typically used for the largest-diameter pipelines/ conduits and longest length installations. Pipe diameters are typically 18 inches or larger, lengths can exceed 1,000 feet, and the pullback force is typically in excess of 70,000 pounds. The drill string is usually remote-tracked provided from sensors near the leading end of the drill string.
- C. *Mini HDD*: Typically used for the smaller diameter pipelines/conduits and for shorter distances. Pipe diameters are typically 6 inches or smaller, lengths are less than 600 feet, and pullback forces are up to 20,000 pounds. The drill string is typically tracked with a surface held walkover transmitter/receiver.
- D. *Midi HDD*: Typically used for intermediate sizes and lengths of pipelines/ conduits. Pipelines are typically between 6 inches and 18 inches diameter, lengths are up to 1,000 feet, and pullback forces from 20,000 to 70,000 pounds. Midi HDD equipment may employ similar capabilities to the Maxi HDD rigs but have more limitations on capacity. The drill string is typically tracked with a surface held walkover transmitter/receiver.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Boring equipment shall be matched to the conditions of the project and shall have a pulling force at least 1.25 the maximum calculated peak-pulling requirement for each installation given the site-specific conditions.
- B. Boring equipment shall have a mechanical drilling rig with a controlled directional boring head using either a fluid or mechanical cutting head (or combination of both), assisted and cooled by an approved drilling fluid of low pressure and volume.
- C. Approved boring equipment shall be that manufactured by American Augers, Case Construction, Charles Machine Works (Ditch Witch), Straight Line, Tulsa Rig Iron, Vermeer, or approved equal.
- D. The location/tracking system employed for determining the location of the drilling head during the pilot bore shall include but not be limited to the position of the boring head, the roll angle, the tilt angle, depth below grade, temperature of data transmitter, and remaining battery life.
- E. The Driller shall select the appropriate drill equipment, which at least meets the minimum requirements established in this specification, to be used for this project. Driller shall own all selected equipment and have a minimum of two of all primary items including: drilling rig, drilling fluid mixing/pumping/recycling system, vacuum trucks, mud disposal equipment and location/tracking system.
- F. The drill equipment including rod shall be inspected and approved for use by the Driller prior to arrival at the work site.

2.02 DRILLING FLUIDS

- A. A high-quality drilling fluid shall be used to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Composition of the fluid must comply with all federal, state, and local environmental regulations.
- B. The drilling fluid shall be a bentonite slurry mixed with potable or reclaimed water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. The Driller is responsible for any required pH adjustments. A polymer-based slurry will be considered only if the Driller demonstrates that a bentonite slurry will not be suitable for this project and the proposed polymer slurry is acceptable to the Florida Department of

Environmental Protection. Drilling fluids that are petroleum-based or that contain additives that may contaminate the surrounding soils or groundwater shall not be allowed.

- C. The type of proposed drilling fluid with a complete listing of all additives along with Material Safety Data Sheets shall be submitted for approval before work begins.
- D. Potable water or reclaimed water will be made available to the Driller. This water will be metered and invoiced to the Contractor at the current effective rate.

2.03 PRODUCT PIPE

- A. The nominal diameter and material type of each product pipe shall be as shown on the Drawings.
- B. FPVC pipe shall conform to the requirements of Section 15148, Fusible Polyvinyl Chloride Pipe and Appurtenances. The maximum dimension ratio (i.e., the thinnest allowable wall thickness) for FPVC pipe being installed by direction drill shall be Dimension Ratio (DR) 18 for pressure pipe and DR 25 for gravity pipe.

PART 3 EXECUTION

3.01 GENERAL

- A. No work or drilling shall commence until the Contractor has submitted the required information and received written approval from the Engineer regarding the drill path and related procedures.
- B. The Contractor or Driller shall locate all utilities, structures, etc. within the construction area before any work begins and before equipment is mobilized.
- C. Before drilling operations begin, all erosion control devices and dewatering shall be in-place and functional in accordance with Section 02370, Erosion and Sedimentation Control, and Section 02240, Dewatering.
- D. The boring rig shall be sufficiently and adequately anchored for the task.
- E. Directional drilling equipment machine safety requirements shall include common grounding system to prevent electrical shock in the event of underground electrical cable strike. The grounding system shall connect all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operator's booth, worker grounding mats, and any other interconnected equipment to a common ground. The drill shall be equipped with an "electrical

strike" audible and visual warning system that will notify the system operators of an electrical strike.

- F. The Contractor and Driller shall conform to all requirements of Section 02305, Earthwork for Utilities, including, but not limited to, excavation, protection of persons and property, sheeting and shoring, backfill and compaction, and disposal of excess and waste materials.
- G. The Contractor or Driller shall be responsible for transporting, containing, and storing any water required for the drilling operations, cleanup, and other needs.
- H. All drilling fluid excess shall be contained in entry and/or exit pits and pumped/treated/stored as needed to preclude spills and escape to the surrounding environment. Ensure that entry and exit pits are of sufficient size and volume to contain the expected return of drilling fluids and cuttings.
- I. Relief wells may be implemented as a mitigation measure to control potential frac-out and ecological impacts of drilling. The Driller shall submit a detailed plan indicating location, depth, and method of creating the relief wells in addition to how drilling fluid will be collected and contained from them.
- J. Drilling fluid returns can be collected in the entrance pit, exit pit, or spoils recovery pit. The Driller shall immediately clean up any drilling fluid spills or overflows from these pits.
- K. Disposal of the drilling fluids shall be the responsibility of the Driller and shall be conducted in compliance with all relative environmental regulations, right-of-way and work space agreements, and permit requirements.
- L. The product pipe shall be installed within the limits indicated on the Drawings.

3.02 DRILL SET-UP AND PITS

- A. The Contractor and Driller may use the set-up areas identified on the Drawings. If additional areas are required, the Contractor shall be responsible for coordinating the additional areas at no additional cost to the Owner.
- B. Drill entrance and exit pits are required. The Driller shall be responsible for design and construction of the drill entrance and exit pits.
- C. The drill entrance and exit pits shall be maintained at minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or processing system or removal from the site.

- D. Drilling mud shall not be allowed to flow freely on the site or around the entrance or exit pits. Erosion and sediment control devices shall be set up around each pit. Mud spilled shall be removed as soon as possible and the ground restored to original condition. Pits shall be shored to OSHA standards and the requirement of Section 02305, Earthwork for Utilities.

3.03 DRILL ENTRANCE AND EXIT ANGLE

- A. The entrance and exit angles shall such that the elevation profile maintains adequate cover to reduce risk of frac-out and that ground exit occurs as specified herein. Driller shall be responsible for ensuring that entrance and exit angles ensure pullback forces do not over stress the pipe.
- B. In no case shall the entry or exit angles of the installed pipeline shall be less than 8 degrees from the horizontal and or more than 18 degrees from the horizontal.
- C. In addition to the allowable limits of Article 3.04 B the entry and exit angles shall in accordance with those used in the analyses performed in Article 1,06 Quality Assurance.

3.04 PILOT HOLE

- A. A pilot hole shall be drilled for all product pipe installations 6-inch-diameter and larger.
- B. The type and size of the pilot string cutting head and the diameter of the drill rod shall be selected by the Driller for each specific application.
- C. The cutting head shall be assisted by and cooled by drilling fluid of low pressure and volume.
- D. The pilot hole shall be drilled along the approved path. Pilot hole tolerances are as follows:
 - 1. Vertical tolerance: Provide cover in accordance with the approved profile developed under Article 1.06, Quality Assurance.
 - 2. Horizontal tolerance: 3 feet from the centerline of the product pipe.
 - 3. Curve Radius: No curve will be accepted with a radius less than 1.25 times the manufacturer's recommended minimum bending radius for the product pipe being installed by directional drill. NOTE: There are additional stresses imposed on the product pipe due to pulling it around curves versus bending the product pipe in a trench. The minimum bending radius for a product pipe installed by direction drill is greater than the minimum bending radius for the same product pipe installed in a trench.

4. Entry Point Location: The pilot hole entry point shall be established by the Contractor.
 5. Exit Point Location: The exit point location shall be established by the Contractor.
 6. The installed pipeline cover requirements as shown on the drawings and as specified herein shall not be violated.
- E. If significant differing soils or strata from those provided in the geotechnical data and reports are encountered during the pilot boring, the Driller shall be responsible for changing the drill head and slurry and other means as may be appropriate to complete the bore.
- F. The Driller shall adjust the viscosity of the drilling fluid to match the conditions of the project. The Owner shall bear no responsibility for loss of drilling fluid or loss of drilling equipment if an obstacle or unknown condition is encountered during the work.
- G. The Owner shall not be responsible for underground obstacles (such as boulders, tree stumps, loose and unconsolidated soils, hard rock, or utilities) or structures that may be encountered during the work.
- H. If hydraulic fracture occurs, the Contractor and Driller shall implement the approved frac-out contingency plan and repair all related damages, cleanup of fluids, and make corrections to preclude future events. Such corrections may include but not be limited to re-profiling the bore or changing the viscosity of the drilling fluid or plugging the fracture or a combination of these. If the borehole is abandoned and an alternate route is chosen, the abandoned borehole shall be filled with excavatable flowable fill.
- I. Where construction activities are close to or under water bodies (lakes, creeks, canals, retention basins) or wetlands, special attention shall be given to the proposed profile to ensure that hydraulic fracture does not occur under the water feature. Additionally, silt fences and similar approved erosion control devices shall be used to protect the water body(s) from the construction activities.

3.05 BACK-REAMING

- A. Back-reaming shall be required for all product pipe installation 6-inch-diameter and larger.
- B. The type of back-reamer to be utilized shall be determined by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The back-reamer type shall be selected by the Driller for each specific application.

- C. Back-reaming shall be conducted in single or multiple passes of the borehole and shall enlarge the borehole to at least 1.4 times the outer diameter of the product pipe to be installed. Larger reaming may be required depending on subsurface conditions encountered. The number of back-reaming passes and the borehole size, provided the minimum requirements are met, shall be the Driller discretion.

3.06 PULL BACK

- A. Unless approved otherwise, the entire product pipeline to be installed via directional drill shall be fully assembled prior to commencement of pull back operations.
- B. The product pipeline shall be supported during pullback operations in a manner to enable it to move freely and prevent damage. Properly spaced rollers and at proper heights shall be used to transition the product pipe from the horizontal to oblique positions for insertion into the borehole.
- C. Unless approved otherwise, the product pipeline shall be installed in one continuous pull.
- D. The product pipe shall be installed with a continuous #10 gauge tracer wire of sufficient type to remain intact and usable upon completion of the installed product pipe.
- E. Torsional stress shall be minimized by using a swivel to connect the pull section to the reaming assembly.
- F. Maximum allowable tensile force imposed on the pull section shall not exceed 80% of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe size or materials, the lowest safe pull strength value shall govern and the maximum allowable tensile force shall not exceed 80% of this value.
- G. External pressure shall be minimized during installation of the pullback section in the reamed hole. Damaged pipe resulting from external pressure shall be replaced at no cost to the Owner. Buoyancy modification shall be at the discretion of the Driller.
- H. The Driller shall take precautions to protect the product pipeline from damage and marring during the installation and pullback operation. Such precautions shall include but not be limited to using rollers, pulleys, idlers, and trunnions.

3.07 GUIDANCE SYSTEMS

- A. Walkover guidance systems are acceptable for the upland drill on this project. A magnetic survey tool located behind the pilot string cutting head shall also be used for this project.

3.08 DOCUMENTATION

- A. The Driller shall maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at least every 15 feet along the drill path. In addition, logs shall be kept that record, as a minimum, the following every 15 minutes throughout each drill pass, back-reaming pass, or product pipe installation pass:
 - 1. Drilling fluid pressure.
 - 2. Drilling fluid flow rate.
 - 3. Drilling fluid temperature.
 - 4. Drill thrust force.
 - 5. Drill pullback force.
 - 6. Drill head torque.
- B. Each day, the Driller shall also record the total amount of drilling mud used and viscosity of the drilling mud. If the viscosity of the drilling mud is changed, the Driller shall record the new viscosity and the time the mud viscosity was changed.
- C. Samples of each log sheet shall be submitted to the Owner/Engineer for approval before work begins.
- D. The Engineer shall have access to instrumentation, readings, and logs at all times during operation.
- E. After the pull is completed, the Driller shall provide record drawing information of the installed product pipeline. The record drawing information shall provide the horizontal and vertical location of the product pipeline tied to the project control datum. At a minimum, the entry and exit locations, angles, and elevations shall be recorded and the locations and depths of the product pipeline shall be recorded at intervals along the entire length of the profile. For profiles under non-submerged surfaces, the interval shall be 10-foot. For profiles under submerged surfaces (such as a lake, stream, canal, or river), the interval shall be 20-foot. This information shall be provided to the Owner/Engineer within 7 calendar days after the completion of each bore path.

3.09 MAINTENANCE OF TRAFFIC

- A. During assembly and pullback of the pipe, the pipe must be laid out in such a way to minimize disrupting and interfering with vehicular and pedestrian traffic or other operational conflicts that the Owner/Engineer identify.
- B. The Contractor shall be responsible for safe maintenance of pedestrian and vehicular of traffic. If the construction activities require such action a maintenance-of-traffic plan shall be submitted to the Owner/Engineer for approval before work begins. The plan shall be in accordance with Florida Department of Transportation Standard Index 600 Series and Technical Specifications.

3.10 UTILITY LOCATES

- A. Contractor shall locate all utilities prior to start of excavation or drilling. The Contractor shall be responsible for damage to utilities and shall repair damaged utilities at no cost to the Owner.

3.11 CLEANUP

- A. Immediately upon completion of work of this Section, all rubbish and debris shall be removed from the job site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat condition acceptable to the Engineer.
- B. "Blow holes" or "breakouts" of drilling fluid to the surface shall be cleaned up immediately and the surface area returned to its original condition. All drilling fluids, spoils, and separated materials shall be disposed of in compliance with federal, state, and local environmental regulations.
- C. After the product pipe installation is completed, the Contractor and/or Driller shall restore the pits and drill rig anchors and work areas to their pre-construction or better condition. Seeding shall not be allowed in lieu of sod unless granted in writing by the Owner/Engineer.

END OF SECTION

SECTION 02920 SEEDING AND SODDING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section includes requirements for the following areas of work:

1. Fine grading.
2. Preparation of areas to receive seeding and sodding.
3. Fertilizing of areas to receive seeding and sodding.
4. Maintenance.
5. Seeding.
6. Hydroseeding.
7. Sodding of new areas to receive seeding and sodding.
8. Mulching.

1.02 RELATED WORK

A. Section 02000, Referenced FDOT Specifications.

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.

B. Certificates:

1. Seed, hydroseed, and sod shall be accompanied by certificate from vendors certifying these items meet the requirements of these Specifications, stating botanical name, percentage by weight, and percentage of purity.

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. Federal Specification (FS) O-F-241—Fertilizers, Mixed, Commercial.

- B. American Society for Testing and Materials (ASTM)—Equivalent AASHTO standards may be substituted as approved.
- C. The Florida Department of Transportation (DOT) Standard Specifications for Road Bridge Construction (Standard Specifications) shall be referred to for both specific and general standards for materials, construction, workmanship, and quality control as specified in this Section with exceptions, as noted herein. Note that any reference in the Standard Specifications to the terms “Department” or “District Materials Engineer” shall be replaced by the term “Owner.”

1.05 QUALITY ASSURANCE

- A. The Contractor shall provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.06 WARRANTIES

- A. Warranties shall be in accordance with the Contract Documents.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.
- B. Deliver, store, protect, and handle products to the site and prevent damage from wetness and weather conditions.
- C. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
- D. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of the manufacturer.
- E. No sod that has been cut for more than 72 hours may be used unless specifically authorized. A letter of certification from the grassing Contractor as to when the sod was cut and what type shall be provided to the Engineer upon delivery of the sod to the job site.

1.08 MAINTENANCE

- A. Maintenance shall be as indicated under Part 3, Execution, of this Section.

1.09 DEFINITIONS

- A. *Weeds:* Weeds include but are not limited to Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.10 REGULATORY REQUIREMENTS

- A. The Contractor shall comply with regulatory agencies for fertilizer and herbicide composition.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. The Contractor shall provide topsoil from off-site borrow or from project on-site excavation as approved by the Engineer.

2.02 SEED MIXTURE

Seed Mixture:

- A. March 15 to September 15:
 - 1. Browntop Millet.
- B. Remainder of the Year:
 - 1. 1/2 Browntop Millet.
 - 2. 1/2 Rye.

2.03 SOD

- A. The Contractor shall provide strongly rooted sod, not less than 2 years old and free of weeds and undesirable native grasses. Provide only sod capable of growth and development when planted (viable, not dormant), Sod shall be provided in rectangles a minimum of 12 by 24 inches.
 - 1. Argentine Bahia (Palletized Sod).

2.04 FERTILIZER FOR SOD (NOT USED)

2.05 FERTILIZER FOR SEED (NOT USED)

2.06 WATER FOR SEEDING AND SODDING

- A. Water shall be free of acid, alkali, or organic materials and shall have a pH of 7.0 to 8.5. The Contractor shall provide all water needed for grassing by providing permanent or temporary piping valves and temporary trucks to convey water from the source to the point of use. The Contractor shall provide any meters required and pay for water used if the water is taken from a public water system. Water shall be free of petroleum products, pesticides, and any other deleterious impurities.

2.07 EROSION-CONTROL FABRIC

- A. The Contractor shall provide 70% agricultural straw with 30% coconut fiber matrix stitches with degradable nettings designed to degrade within 18 months. Erosion-control anchors shall be as recommended by the manufacturer.

2.08 STRAW MULCH

- A. Straw mulch shall be used on all newly graded and topsoiled areas sloped 3:1 or steeper to protect areas against washouts and erosion. Straw mulch shall consist of threshed straw of oats, wheat, barley, or rye that is free from noxious weeds, mold, or other objectionable material. The straw mulch shall contain at least 50% by weight of material that is 10 inches or longer. Straw shall be in an air-dry condition and suitable for placement with blower equipment.

2.09 TACKIFIER

- A. Latex acrylic copolymer shall be Soil Sealant with coalescing agent as manufactured by Soil Stabilization Products Company, Inc., Merced, CA or equal and shall be used as straw mulch tackifier.

PART 3 EXECUTION

3.01 COORDINATION OF WORK

- A. The Contractor shall coordinate all work activities to provide for establishing grass cover at the earliest possible time in the construction schedule to minimize erosion of topsoil.

3.02 SOIL PREPARATION

Concerning soil preparation, the Contractor shall do the following:

- A. Dispose of any existing sod, growth, rocks, or other obstructions which might interfere with tilling, seeding, sodding, or later maintenance operations. Remove stones over 1-1/2 inches in any dimensions and sticks, roots, rubbish, and other extraneous matter. Remove from work area or site: do not stockpile.
- B. Till to a depth of not less than 12 inches. Thoroughly loosen and pulverize topsoil.
- C. Grade areas to be seeded and sodded to a smooth, even surface with loose, uniformly firm texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas which can be planted in the immediate future.
- D. Moisten prepared areas to be seeded and sodded before planting if the soil is dry. Water thoroughly and allow the surface to dry off before seeding and sodding. Do not create a muddy soil condition.
- E. Restore prepared areas to specified condition if eroded or otherwise disturbed after the fine grading and before planting.
- F. Spread the planting soil mixture to depth required to meet thickness, grades, and elevations indicated after light rolling and natural settlement. Do not spread if the material is frozen or if the subgrade is frozen.
- G. Preparing Unchanged Grades:
 - 1. Where seeding and sodding in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil as follows:
 - a. Till to a depth of not less than 12 inches.
 - b. Apply soil amendments and initial fertilizers.
 - c. Remove high areas and fill in depressions.
 - d. Till soil to a homogeneous mixture of fine texture, free of lumps, clods, stones, roots, and other extraneous matter.
- H. Allow for a 3-inch sod thickness in areas to be added next to gravel surface or paving.
- I. Before preparing unchanged areas, remove existing grass, vegetation, and turf. Dispose of such material outside of the Owner's property: do not turn over into soil being prepared for seeding and sodding.

- J. Place approximately one-half of the total amount of planting soil required. Work into the top of the loosened subgrade to create a transition layer and then place the remainder of the planting soil.

3.03 FERTILIZING FOR SEEDING (NOT USED)

3.04 SEEDING

- A. Apply seed at the rate designated on the schedule evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on the same day.
- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Roll seeded area with appropriate equipment to achieve seed embedment and soil compaction.
- E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.05 HYDRO-SEEDING

- A. Apply seeded slurry with a hydraulic seeder at the rate designated on schedule evenly in two intersecting directions.
- B. Do not hydro-seed area in excess of that which can be mulched on the same day.
- C. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.06 SEED PROTECTION

- A. When seeding is complete, apply straw mulch at a rate of 2,500 lb/acre. Apply tackifier as required.
- B. Cover seeded slopes where grade is 4 inches per foot or steeper with erosion fabric. Roll fabric onto slopes without stretching or pulling.
- C. Lay fabric smoothly on surface, bury top end of each section in 6-inch-deep excavated topsoil trench. Provide a 2- to 4-inch overlap of adjacent rolls. Backfill the trench and rake smooth, level with the adjacent soil.

- D. Secure outside edges and overlaps in accordance with the manufacturer's recommendations.
- E. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
- F. At the sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges a minimum of 6 inches.

3.07 SODDING NEW AREAS

When sodding new areas, the Contractor shall do the following:

- A. Before laying sod, contact the Engineer to observe soil preparation work. Lay sod within 24 hours of the time of stripping. Do not plant dormant sod or if the ground is frozen.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger to offset joints in adjacent courses. Employ installation methods to avoid damage to subgrade or sod. On slopes install the sod with an overlap that allows water to flow over the adjacent strip and not under it. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering adjacent grass.
- C. Anchor sod on slopes greater than 3:1 with wood pegs as required to prevent slippage.
- D. Immediately after installing the sod, the Contractor shall thoroughly water the sod with a fine spray.

3.08 RECONDITIONING SEEDED AND SODDED AREAS

The Contractor shall ensure that seeded and sodded areas are properly reconditioned by doing the following:

- A. Recondition seeded and sodded areas that are damaged by work operations, including storage of materials or equipment and movement of vehicles. Also recondition seeded and sodded areas where settlement or washouts occur or where minor regrading is required. Recondition other existing seeded and sodded areas where indicated.
- B. Provide fertilizer, topsoil, seed, or sod amendments as specified for new seeded and sodded areas and as required to provide satisfactory reconditioning. Provide new planting soil as required to fill low spots and meet new finish grades.

- C. Cultivate bare and compacted areas thoroughly to provide a good deep planting bed.
- D. Remove diseased or unsatisfactory seeded and sodded areas; do not bury into soil. Remove topsoil containing foreign materials resulting from operations including oil drippings, stone, gravel, and other construction materials. Replace with new topsoil.
- E. Where substantial seeding and sodding remains (but is thin), mow, rake, aerate if compacted, fill low spots, remove humps and cultivate soil, fertilize, and seed. Remove weeds before seeding or, if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.
- F. Water newly planted areas and keep moist until new grass is established.

3.09 PROTECTION

- A. The Contractor shall erect barricades, warning signs, and fencing to protect newly planted areas from traffic. Maintain barricade fencing and warning signs throughout the maintenance period until project is substantially completed.

3.10 MAINTENANCE

To maintain the seeded and sodded area, the Contractor shall do the following:

- A. Mow sod to a height of 2 inches as soon as there is enough top growth to cut with a mower. Remove no more than 40% of grass leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted.
- B. Maintain grass growth by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, re-grading, replanting as required to establish a smooth, acceptable seeding and sodding, free from eroded or bare areas.
- C. Remove weeds by pulling or chemical treatment.
- D. Perform maintenance until the date of final completion of project.
- E. Apply the second fertilizer application after the first mowing and when grass is dry. Use fertilizer which will provide not less than 1.0 pound of actual nitrogen per 1,000 square feet of seeded and sodded areas.
- F. Replant bare areas using the same materials specified for seeded and sodded areas.

- G. Watering: Provide and maintain temporary piping, hoses, and watering equipment as required to convey water from water sources and to keep seeded and sodded areas uniformly moist as required for proper growth. Do not apply more than 1 inch (25 mm) of water per week to sustain grass growth.
- H. Lay out temporary watering system and arrange watering schedule to avoid walking over muddy areas. Use equipment and water to prevent puddling and water erosion and displacing seed or mulch (if any).
- I. Apply water in sufficient quantities and as often as seasonal conditions require to keep the grassed areas moist.
- J. Provide supplemental water and irrigation to sod areas when the rainfall is not adequate to maintain soil moisture necessary for growth of the grass. The Contractor is responsible for determining the quantities of water required and when to irrigate. This obligation shall remain in full force and effect until final acceptance of the work by the Owner and shall be provided at no additional cost to the Owner.
- K. The Owner, at its discretion, may relieve the Contractor of this obligation at such time as the Owner is able to provide irrigation if available. This action, however, does not relieve the Contractor of the provisions and guarantees set forth in the Contract Documents.

3.11 ACCEPTANCE OF SEEDED OR SODDED AREAS

- A. When seeding or sodding work, including maintenance, is substantially complete, the Engineer and the Owner will, upon request, observe to determine satisfactory growth and acceptability:
 - 1. The term "Satisfactory Growth" as used in this Section is defined as even plant growth in healthy condition without bare spots larger than 1 square foot in seeded areas and without bare spots in sodded areas. Bare spots in sodded areas shall be resodded. The Contractor shall maintain all grassed and sodded areas until satisfactory growth has been demonstrated at project final completion. If the subsequent stand of grass is found contaminated with weeds or other obnoxious or undesirable growth, the Contractor shall eliminate such undesirable growth at the Contractor's own expense.
- B. The Contractor shall re-plant rejected work and continue specified maintenance until the work is accepted by the Engineer and the Owner and found to be acceptable.

- C. Sodded areas will be acceptable provided requirements, including maintenance, have been complied with and a healthy, well-rooted, even-colored, viable seeded or sodded area is established, free of weeds, open joints, bare areas, and surface irregularities.

3.12 CLEANUP

- A. The Contractor shall promptly remove soil and debris created by seeding and sodding work from paved areas. Clean wheels of vehicles before they leave the site to avoid tracking soil onto surfacing of roads, walks, or other paved areas.

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03100 CONCRETE FORMWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to design, install, and remove formwork for cast-in-place concrete complete as shown on the Drawings and specified herein.
- B. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts, and other items furnished under other sections and required to be cast into concrete or approved in advance by the Engineer.

1.02 RELATED WORK

- A. Section 03200, Concrete Reinforcement.
- B. Section 03250, Concrete Joints and Joint Accessories.
- C. Section 03300, Cast-In-Place Concrete.
- D. Section 03600, Grout.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit shop drawings and product data showing materials of construction and details of installation for:
 - 1. Form release agent.
 - 2. Form ties.
- B. Samples
 - 1. Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not adversely affect concrete surfaces to be painted, coated, or otherwise finished and will not affect the forming materials.

C. Certificates

1. Statement of qualification for the formwork designer retained by Contractor. Formwork designer shall be a professional engineer registered in the same state as the project site. Designer shall at a minimum 5 years of experience designing the required formwork and falsework systems.
2. Certify that form release agent is suitable for use in contact with potable water after 30 days (non-toxic and free of taste and odor).

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to herein shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Concrete Institute (ACI)

1. ACI 301—Standard Specification for Structural Concrete.
2. ACI 318—Building Code Requirements for Reinforced Concrete.
3. ACI 347—Formwork for Concrete.

B. American Plywood Association (APA)

1. Material grades and designations as specified.

C. NSF International (NSF) / American National Standards Institute (ANSI)

1. NSF/ANSI 61—Drinking Water System Components – Health Effects.

1.05 SYSTEM DESCRIPTION

- A. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete. Design forms and ties to withstand concrete pressures without budging, spreading, or lifting forms.
- B. Architectural Concrete is wall, slab, beam, or column concrete which will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of walls to 2 feet below the normal water surface in open tanks and basins.

PART 2 PRODUCTS

2.01 GENERAL

- A. The usage of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.02 MATERIALS

- A. General: Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the Engineer and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.
- B. Wall Forms
 - 1. Forms for all exposed exterior and interior concrete walls shall be "Plyform" exterior grade plywood panels manufactured in compliance with the APA and bearing the trademark of that group, or equal acceptable to the Engineer. Provide B grade or better veneer on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.
 - 2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging.
 - 3. Circular Structures: Use forms conforming to the circular shape of the structure. Straight panels may be substituted for circular form provided panels do not exceed 2 feet in horizontal width and angular deflection is no greater than 3-1/2 degrees per joint.
- C. Column Forms
 - 1. Rectangular Columns: As specified for walls.
 - 2. Circular Columns: Fabricated steel or fiber reinforced plastic with bolted together sections or spirally wound laminated fiber form internally treated with form release agent for height of columns.
- D. Rustication strips shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material,

compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.

E. Form Release Agent

1. Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste or odor and meet the requirements of NSF/ANSI 61. Form release agent shall be Farm Fresh by Unitex or Engineer approved equal.

F. Form Ties

1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1-1/2 inches of the face of the concrete. The part of the tie to be removed shall be at least 1/2 inch diameter or be provided with a wood or metal cone at least 1/2 inch diameter and 1-1/2 inches long. Form ties in concrete exposed to view shall be the cone washer type.
2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be of approved wood or plastic.
3. Flat bar ties for panel forms, if used, shall have plastic or rubber inserts having a minimum depth of 1-1/2 inches and sufficient dimensions to permit proper patching of the tie hole.
4. Ties for liquid containment structures shall have an integral waterstop that is tightly welded to the tie.
5. Common wire shall not be used for form ties.
6. Alternate form ties consisting of tapered through-bolts at least 1 inch in diameter at smallest end or through-bolts that use a removable tapered sleeve of the same minimum size may be used at the Contractor's option. Obtain Engineer's acceptance of system and spacing of ties before ordering or purchase of forming. Clean, fill, and seal form tie hole with non-shrink cement grout. A vinyl plug shall be inserted into the hole to serve as a waterstop. The Contractor shall be responsible for water-tightness of the form ties and any repairs needed.

PART 3 EXECUTION

3.01 GENERAL

- A. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings.
- B. Forms for walls shall have removable panels at the bottom for cleaning, inspection, and joint surface preparation. Forms for walls of considerable height (15 feet or greater) shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, to prevent segregation, and to prevent the accumulation of hardened concrete on the forms above the fresh concrete.
- C. Molding, bevels, or other types of chamfer strips shall be placed to produce block outs, rustications, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 3/4-inch chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the Drawings. Sizes of moldings shall conform to the sealants manufacturer's recommendations.
- D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms so that the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for the adequacy of the forming system.
- E. Before form material is re-used, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn, and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like new" condition of the form is maintained.

3.02 FORM TOLERANCES

- A. Forms shall be surfaced, designed, and constructed in accordance with the recommendations of ACI 301 and ACI 347 and shall meet the following additional requirements for the specified finishes:
 - 1. Formed Surface Exposed to View: Edges of all form panels in contact with concrete shall be flush within 1/16 inch and forms for plane surfaces shall be such that the concrete will be plane within 3/16 inch in 4 feet. Forms shall be tight to prevent the passage of mortar, water, and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4 inch from the intended surface as shown on the Drawings. Form panels

shall be arranged symmetrically and in an orderly manner to minimize the number of seams.

2. Formed surfaces not exposed to view or buried shall meet requirements of Class "C" Surface in ACI 301 and ACI 347.
3. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement, and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1 inch.

3.03 FORM PREPARATION

- A. Wood forms in contact with the concrete shall be coated with an effective release agent before form installation.
- B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms, except those used for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.

3.04 REMOVAL OF FORMS

- A. The Contractor shall be responsible for all damage resulting from removal of forms. Forms and shoring for structural slabs or beams shall remain in place in accordance with ACI 301. Form removal shall conform to the requirements specified in Section 03300, Cast-In-Place Concrete, including curing requirements.
- B. Repair all damages resulting from removal of forms.
- C. Clean, fill, and seal form tie hole with non-shrink cement grout. The Contractor shall be responsible for the watertightness of the form ties holes and any repair necessary to maintain watertightness of tie holes.

3.05 INSPECTION

- A. The Engineer on site shall be notified when the forms are complete and ready for inspection at least 6 hours before the proposed concrete placement.

- B. Failure of the forms to comply with the requirements specified herein or to produce concrete complying with the requirements of Section 03300, Cast-In-Place Concrete, shall be grounds for rejection of that portion of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner. Such repair or replacement shall be subject to the requirements of this Section and approval of the Engineer.

END OF SECTION

SECTION 03200
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Section 03100, Concrete Formwork.
- B. Section 03300, Cast-In-Place Concrete.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit shop drawings and product data showing materials of construction and details of installation for:
 - 1. Reinforcing steel. Placement Drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and ACI SP-66. All reinforcement in a concrete placement shall be included on a single Placement Drawing or cross-referenced to the pertinent main Placement Drawing. The main Drawing shall include the additional reinforcement (around openings, at corners, etc.) shown on the standard detail sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified. For all cast-in-place concrete tanks, retaining walls, building stem walls, wall sections shall be included in the Drawings.
 - 2. All splice and joint locations shall be indicated on Placement Drawings. Splice lengths shall be clearly dimensioned.
 - 3. Reinforcement cover shall be clearly indicated.
 - 4. Submit reinforcement shop drawing for each structure as a complete package. Submittal showing portions of a structure will not be acceptable, unless accepted by the Engineer in advance.
 - 5. Submittals consisting of schedules without accompanying Placement Drawings will not be acceptable, unless accepted by the Engineer in advance.

6. Bar bending details. The bars shall be referenced to the same identification marks shown on the Placement Drawings and shipping tags. Schedules shall be located on the same sheet where the bar marks are referenced. Schedule of all placements to contain synthetic reinforcing fibers. The amount of fibers per cubic yard to be used for each of the placements shall be noted on the schedule. The name of the manufacturer of the fibers and the product data shall be included with the submittal.

B. Test Reports

1. Certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.
2. Mechanical Reinforcing Bar Couplers: Current Evaluation Report prepared by ICC-ES or by other approved testing agency.

C. Certificates

1. Welder's certification. The certification shall be in accordance with AWS D1.4 when welding of reinforcement is required.
2. Weld Procedures: Provide procedure for each type of welded reinforcing splice in accordance with AWS D1.4 when welding of reinforcing is required.

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to herein shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Concrete Institute (ACI)

1. ACI 301—Standard Specification for Structural Concrete.
2. ACI 315—Details and Detailing of Concrete Reinforcement.
3. ACI 318—Building Code Requirements for Structural Concrete.
4. ACI SP-66—ACI Detailing Manual.

B. American Society for Testing and Materials (ASTM)

1. ASTM A82—Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A184—Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.
3. ASTM A615—Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

4. ASTM A616—Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
5. ASTM A617—Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.
6. ASTM A704—Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
7. ASTM A706—Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
8. ASTM A767—Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
9. ASTM A775—Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
10. ASTM A884—Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
11. ASTM A934—Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
12. ASTM A1064—Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

C. American Welding Society (AWS)

1. AWS D1.4—Structural Welding Code Reinforcing Steel.

D. Concrete Reinforcing Steel Institute (CRSI)

1. Manual of Standard Practice.

E. International Code Council (ICC)

1. ICC-ES—ICC Evaluation Service.

1.05 QUALITY ASSURANCE

- A. Provide services of a manufacturer's representative, with at least 2 years of experience in the use of the reinforcing fibers for a preconstruction meeting and assistance during the first placement of the material.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.
- B. Reinforcing steel shall be shipped and stored with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted Placement Drawings.

- C. Reinforcing steel shall be stored off the ground and kept free from dirt, oil, or other injurious contaminants

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials shall be new, of domestic manufacture, and shall comply with the following material specifications.
- B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.
- C. Concrete Reinforcing Bars required on the Drawings to be Welded: ASTM A706.
- D. Welded Steel Wire Fabric: ASTM A1064. Provide in flat sheets.
- E. Welded Deformed Steel Wire Fabric: ASTM A497. Provide in flat sheets.
- F. Welded Plain Bar Mats: ASTM A704 and ASTM A615 Grade 60 plain bars.
- G. Fabricated Deformed Steel Bar Mats: ASTM A184 and ASTM A615 Grade 60 deformed bars.
- H. Reinforcing Steel Accessories:
 - 1. Plastic Protected Bar Supports: CRSI Bar Support Specifications, Class 1 - Maximum Protection.
 - 2. Stainless Steel Protected Bar Supports: CRSI Bar Support Specifications, Class 2 - Moderate Protection.
 - 3. Precast Concrete Block Bar Supports: CRSI Bar Support Specifications, Precast Blocks. Blocks shall have equal or greater strength than the surrounding concrete.
 - 4. Steel Protected Bar Supports: #4 Steel Chairs with plastic or rubber tips.
- I. Tie Wire: Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire or stranded wire.
- J. Mechanical Reinforcing Bar Couplers:
 - 1. General: Use only at locations indicated on the Drawings or where written approval has been obtained from the Engineer.
 - 2. Mechanical reinforcing steel butt splices shall be positive connecting taper threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products Inc., Solon, OH or equal. They shall

meet all ACI 318 Building Code requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement.

3. Bar couplers shall be torqued to manufacturer's recommended value.
4. Unless otherwise noted on the Drawings, mechanical tension splices shall Type 2 and be designed to produce a splice strength in tension or compression of not less than ultimate strength of the rebar being spliced.
5. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar and shall be capable of developing the ultimate strength of the rebar in compression.
6. Form saver type mechanical couplers shall have flanges with nailing holes to positively attach coupler to formwork.

- K. Fiber Reinforcement: Synthetic reinforcing fiber for concrete shall be 100 percent polypropylene collated, fibrillated fibers as manufactured by Fibermesh Company of Synthetic Industries Inc., Chattanooga, TN - Fibermesh or equal. Fiber length and quantity for the concrete mix shall be in strict compliance with the manufacturer's recommendations as approved by the Engineer.

2.02 FABRICATION

- A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice and ACI SP-66.
- B. Bars shall be cold bent. Bars shall not be straightened or rebent.
- C. Bars shall be bent around revolving collar having a diameter of not less than that recommended by the ACI SP-66.
- D. Bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded, shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Surface condition, bending, spacing and tolerances of placement of reinforcement shall comply with the CRSI Manual of Standard Practice and ACI SP-66. The Contractor shall be solely responsible for providing and adequate number of bars and maintaining the spacing and clearances shown on the Drawings.

- B. Except as otherwise indicated on the Drawings, the minimum concrete cover of reinforcement shall be as follows:
1. Concrete cast against and permanently exposed to earth: 3 inches.
 2. Concrete exposed to soil, water, sewage, sludge, and/or weather: 2 inches (including bottom cover of slabs over water or sewage).
 3. Concrete not exposed to soil, water, sewage, sludge, and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells and folded plate members: 3/4 inch.
 - b. Beams and columns (principal reinforcement, ties, spirals, and stirrups): 1-1/2 inches.
- C. Reinforcement which will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.
- D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall comply with AWS D1.4.
- E. Reinforcing steel interfering with the location of other reinforcing steel, conduits, or embedded items, may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacement of bars to avoid interference shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings, or other items without the prior approval of the Engineer.
- F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- G. Reinforcing steel bars shall not be field-bent except where shown on the Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold-bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld, or otherwise repair. Do not bend reinforcement after it is embedded in concrete unless specifically shown otherwise on the Drawings.

3.02 REINFORCEMENT AROUND OPENINGS

- A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one-half of the cross-sectional area of the reinforcing steel interrupted by an opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.03 SPLICING OF REINFORCEMENT

- A. Splices designated as compression splices on the Drawings, unless otherwise noted, shall be 30-bar diameters, but not less than 12 inches. The lap splice length for column vertical bars shall be based on the bar size in the column above.
- B. Tension lap splices shall be provided at all laps in compliance with ACI SP-66. Splices in adjacent bars shall be staggered. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.
- C. Splicing of reinforcing steel in concrete elements noted to be "tension members" on the Drawings shall be avoided whenever possible. However, if required for constructability, splices in the reinforcement subject to direct tension shall be welded to develop, in tension, at least 125% of the specified yield strength of the bar. Splices in adjacent bars shall be offset the distance of a Class B splice.
- D. Install wire fabric in as long lengths as practicable. Wire fabric from rolls shall be rolled flat and firmly held in place. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI SP-66 but not less than 12 inches. The spliced fabrics shall be tied together with wire ties spaced not more than 24 inches on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.
- E. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30-bar diameters. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the Engineer.

3.04 ACCESSORIES

- A. Determine, provide, and install accessories such as chairs, chair bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.

- B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.
- C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use of galvanized or plastic tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.
- D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

3.05 INSPECTION

- A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement, has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished his/her observations of the reinforcing steel.

END OF SECTION

SECTION 03250
CONCRETE JOINTS AND JOINT ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Section 03100, Concrete Formwork.
- B. Section 03200, Concrete Reinforcement.
- C. Section 03300, Cast-In-Place Concrete.
- D. Section 03360, Concrete Finishes.
- E. Section 03600, Grout.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit shop drawings and product data. Submittals shall include at least the following:
 - 1. Standard Waterstops: Product data including catalogue cut, technical data, storage requirements, splicing methods, and conformity to ASTM standards.
 - 2. Special Waterstops: Product data including catalogue cut, technical data, location of use, storage requirements, splicing methods, installation instructions, and conformity to ASTM standards.
 - 3. Premolded Joint Fillers: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.
 - 4. Bond Breaker: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.
 - 5. Expansion Joint Dowels: Product data on the complete assembly including dowels, coatings, lubricants, spacers, sleeves, expansion caps, installation requirements, and conformity to ASTM standards.
 - 6. Compressible Joint Filler: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.

7. Bonding Agents: Product data including catalogue cut, technical data, storage requirements, product life, application requirements, and conformity to ASTM standards.

B. Certifications

1. Certification that all materials used within the joint system is compatible with each other.
2. Certifications that materials used in the construction of joints are suitable for use in contact with potable water 30 days after installation.

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to herein shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM A675—Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
2. ASTM C881—Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
3. ASTM C1059—Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
4. ASTM D570—Standard Test Method for Water Absorption of Plastics.
5. ASTM D624—Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
6. ASTM D638—Standard Test Method for Tensile Properties of Plastics.
7. ASTM D746—Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
8. ASTM D747—Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
9. ASTM D792—Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
10. ASTM D1751—Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
11. ASTM D1752—Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

B. US Army Corps of Engineers (CRD)

1. CRD-C572—Specification for Polyvinylchloride Waterstops.

C. Federal Specifications (FS)

1. FS SS-S-210A—Sealing Compound for Expansion Joints.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and product to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.
- C. All chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used on similar structures for more than 5 years.

2.02 MATERIALS

A. Standard Waterstops

1. PVC Waterstops: The waterstop shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1,750 psi. The waterstop shall conform to CRD-C572. The waterstop shall be Greenstreak Group, Inc. Model No. 679 or approved equal for construction joints. The waterstop shall be Sika Greenstreak model No. 732 or approved equal for control joints, and Sika Greenstreak Model No. 738 for expansion joints. Provide grommets or pre-punched holes spaced at 12 inches on center along length of waterstop.
2. Factory Fabrications: Provide factory made waterstop fabrications for all changes of direction, transitions, and intersections, leaving only straight butt joints of sufficient length for splicing in the field.

B. Special Waterstops

1. Preformed adhesive waterstops: The waterstop shall be a rope type preformed plastic waterstop meeting the requirements of FS SS-S-210A. The rope shall have a cross-section of approximately 1 square inch unless otherwise specified or shown on the Drawings. The waterstop shall be

Synko-Flex waterstop as manufactured by Henry Company, Lockstop by Sika Greenstreak, or equal. Primer and surface preparation for the material shall be as recommended by the waterstop manufacturer.

C. Expansion Joint Material

1. Joint Material at structures: Self-expanding cork, expansion joint material shall conform to ASTM D1752, Type III. The thickness shall be 3/4 inch unless shown otherwise on the Drawings.
2. Joint Material at sidewalk and roadway concrete pavements or where fiber joint filler is specifically noted on the Drawings: The joint filler shall be asphalt-impregnated fiber board conforming to ASTM D1751. Thickness shall be 3/4 inch unless otherwise shown on the Drawings.

D. Bond Breaker

1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will satisfactorily adhere to the expansion joint material or concrete surface as required. The tape shall be the same width as the joint.
2. Except where tape is specifically called for on the Drawings, bond breaker for concrete shall be either bond breaker tape or a nonstaining type bond prevention coating such as Maxi-Tilt with Dye by Dayton Superior, Inc.; Silcoseal 77, by SCA Construction Supply Division, Superior Concrete Accessories or equal.

E. Expansion Joint Dowels

1. Dowels shall be smooth steel conforming to ASTM A675, Grade 70. Dowels must be straight and clean, free of loose flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04 inch on the diameter of the dowel and extends no more than 0.04 inch from the end. Bars shall be coated with a bond breaker on the expansion end of the dowel. Expansion caps shall be provided on the expansion end. Caps shall allow for at least 1-1/2 inches of expansion.
2. Dowel Bar Sleeves: Provide two component Speed Dowel System by Sika, to accept 1-inch-diameter x 12-inch-long slip dowels. Speed Dowel System is comprised of a reusable base and a plastic sleeve. Both pieces shall be manufactured from polypropylene plastic.

F. Bonding Agent

1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The

bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation of Lyndhurst, N.J.; MasterEmaco ADH 326 by BASF or equal. Acrylic may be used if approved by the Engineer.

G. Compressible Joint Filler

1. The joint filler shall be a non-extruded watertight strip material use to fill expansion joints between structures. The material shall be capable of being compressed at least 40% for 70 hours at 68 degrees F and subsequently recovering at least 20% of its original thickness in the first 1/2 hour after unloading. Compressible Joint filler shall be Wabo®Evasote, by BASF, Inc., or equal.

H. Joint Sealant

1. The joint sealant shall be a one-component, polyurethane-based, non-sag elastomeric sealant. Joint sealant shall be Sikaflex-1a or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Standard Waterstops

1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Provide factory made waterstop fabrications for all changes in direction, intersections, and transitions leaving only straight butt joints splices for the field.
2. Horizontal waterstops in slabs shall be clamped in position by the bulkhead (unless previously set in concrete).
3. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete. All waterstops shall be tied to reinforcement with reinforcing tie wire through the factory provided grommets.
4. Waterstops shall be terminated 3 inches below the exposed top of walls. Expansion joint waterstop center bulbs shall be plugged with foam rubber, 1 inch deep, at point of termination.

B. Special Waterstops

1. Install special waterstops at joints where specifically noted on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Provide factory made

waterstop fabrications for all changes in direction, intersections, and transitions leaving only straight butt joints splices for the field.

2. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of connections or splices. Connections and splices shall conform to the manufacturer's recommendations and as specified herein.
3. Waterstops shall be terminated 3 inches below the exposed top of walls.

C. Construction Joints

1. Make construction joints only at locations shown on the Drawings or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor must be submitted to the Engineer for written approval. Joints shall be spaced at a maximum of 40 feet o.c. unless noted otherwise on the Drawings.
2. Additional or relocated joints should be located where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams, and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams, or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.
3. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings. When joints in beams are allowed, provide a shear key and inclined dowels as approved by the Engineer.
4. Provide sealant grooves for joint sealant where indicated on the Drawings.
5. At all construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 1/4 inch to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water-blasting or sandblasting and prepare for bonding.
6. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.
7. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the Engineer.

D. Expansion Joints

1. Do not extend through expansion joints, reinforcement, or other embedded metal items that are continuously bonded to concrete on each side of joint.

2. Position premolded joint filler material accurately. Secure the joint filler against displacement during concrete placement and compaction. Place joint filler over the face of the joint, allowing for sealant grooves as detailed on the Drawings. Tape all joint filler splices to prevent intrusion of mortar. Seal expansion joints as shown on the Drawings.
3. Expansion joints shall be 3/4 inch in width unless otherwise noted on the Drawings.
4. Where indicated on Drawings, install smooth dowels at right angles to expansion joints. Align dowels accurately with finished surface. Rigidly hold in place and support during concrete placement. Unless otherwise shown on the Drawings, apply oil or grease to one end of all dowels through expansion joints. Provide plastic expansion caps on the lubricated ends of expansion dowels.
5. Provide center bulb type waterstops in all wall and slab expansion joints in liquid containment structures and at other locations shown on the Drawings.

E. Control Joints

1. Provide sealant grooves, sealants, and waterstops at control joints in slabs on grade or walls as detailed. Provide waterstops at all wall and slab control joints in water containment structures and at other locations shown on the Drawings.
2. Control joints may be sawed if specifically approved by the Engineer. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during sawcutting.
3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Where specifically noted on the Drawings, coat the concrete surface with a bond breaker before placing new concrete against it. Avoid coating reinforcement or waterstops with bond breaker at these locations.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor and materials required and install cast-in-place concrete complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Section 01330, Submittals and Acceptance.
- B. Section 03100, Concrete Formwork.
- C. Section 03200, Concrete Reinforcement.
- D. Section 03250, Concrete Joints and Joint Accessories.
- E. Section 03360, Concrete Finishes.
- F. Section 03600, Grout.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit shop drawings and product data including the following:
 - 1. Sources of cement, pozzolan, and aggregates.
 - 2. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
 - 3. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.
 - 4. Water-reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.
 - 5. High-range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range, and conformity to ASTM standards. Identify proposed locations of use.

6. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, concrete slump, type, and manufacturer of cement. Provide either a. or b. below for each mix proposed.
 - a. Standard deviation data for each proposed concrete mix based on statistical records.
 - b. The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory tests. The cylinder strength shall be the average of the 28-day cylinder strength test results for each mix. Provide results of 7- and 14-day tests if available.
7. Sheet curing material. Product data including catalogue cut, technical data and, conformity to ASTM standard.
8. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate, and conformity to ASTM standards. Identify proposed locations of use.

B. Samples

1. Fine and coarse aggregates if requested by the Engineer.

C. Test Reports

1. Fine aggregates: Sieve analysis, physical properties, and deleterious substance.
2. Coarse aggregates: Sieve analysis, physical properties, and deleterious substances.
3. Cements: Chemical analysis and physical properties for each type.
4. Pozzolans: Chemical analysis and physical properties.
5. Proposed concrete mixes: Compressive strength, slump, and air content.

D. Certifications

1. Certify admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certify admixtures are suitable for use in contact with potable water after 30 days of concrete curing.
3. Certify curing compound is suitable for use in contact with potable water after 30 days (non-toxic and free of taste or odor).

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to herein shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Concrete Institute (ACI)

1. ACI 301—Standard Specification for Structural Concrete.
2. ACI 304.1—Guide for the Use of Preplaced Aggregate Concrete for Structural and Mass Concrete Applications.
3. ACI 305.1—Standard Specification for Hot Weather Concreting.
4. ACI 306.1—Standard Specification for Cold Weather Concreting.
5. ACI 318—Building Code Requirements for Structural Concrete and Commentary.

B. American Society for Testing and Materials (ASTM)

1. ASTM C31—Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33—Standard Specification for Concrete Aggregates.
3. ASTM C39—Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42—Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94—Standard Specification for Ready-Mixed Concrete.
6. ASTM C143—Standard Test Method for Slump of Hydraulic-Cement Concrete.
7. ASTM C150—Standard Specification for Portland Cement.
8. ASTM C171—Standard Specification for Sheet Materials for Curing Concrete.
9. ASTM C173—Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
10. ASTM C231—Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
11. ASTM C260—Standard Specification for Air-Entraining Admixtures for Concrete.
12. ASTM C309—Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
13. ASTM C494—Standard Specification for Chemical Admixtures for Concrete.
14. ASTM C618—Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
15. ASTM C989—Standard Specification for Slag Cement for Use in Concrete and Mortars.

16. ASTM C1017—Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

C. National Ready Mixed Concrete Association (NRMCA)

1.05 QUALITY ASSURANCE

- A. Reinforced concrete shall comply with specifications and standards noted above. The most stringent requirement of the specifications, standards, and this Section shall apply when conflicts exist.
- B. Only one source of cement and aggregates shall be used on any one structure. Concrete shall be uniform in color and appearance.
- C. Well in advance of placing concrete, discuss with the Engineer the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops, and curing. Propose methods of hot and cold weather concreting as required. Before the placement of any concrete containing a high-range water-reducing admixture (plasticizer), the Contractor, accompanied by the plasticizer manufacturer, shall discuss the properties and techniques of batching and placing plasticized concrete.
- D. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the Contractor's expense.
- E. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, the Contractor shall, at his/her expense, make new acceptance tests of aggregates and establish new design mixes.
- F. Testing of the following materials shall be furnished by the Contractor to verify conformity with this Section and the stated ASTM Standards.
 1. Fine aggregates for conformity with ASTM C33: Sieve analysis, physical properties, and deleterious substances.
 2. Coarse aggregates for conformity with ASTM C33: Sieve analysis, physical properties, and deleterious substances.
 3. Cements for conformity with ASTM C150: Chemical analysis and physical properties.
 4. Pozzolans for conformity with ASTM C618: Chemical analysis and physical properties.
 5. Proposed concrete mix designs: Compressive strength, slump and air content.

G. Field testing and inspection services will be provided by the Owner. The cost of such work, except as specifically stated otherwise, shall be paid by the Owner. Testing of the following items shall be by the Owner to verify conformity with this Section.

1. Concrete placements: Compressive strength (cylinders), compressive strength (cores), slump, and air content.
2. Other materials or products that may come under question.

H. All materials incorporated in the work shall conform to accepted samples.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Cement: Store in weathertight buildings, bins, or silos to provide protection from dampness and contamination and to minimize warehouse set.

B. Aggregate: Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding 3 feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.

C. Sand: Arrange and use stockpiles to avoid contamination. Allow sand to drain to uniform moisture content before using. Do not use frozen or partially frozen aggregates.

D. Admixtures: Store in closed containers to avoid contamination, evaporation, or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions that tend to separate. Protect liquid admixtures from freezing and other temperature changes that could adversely affect their characteristics.

E. Pozzolan: Store in weathertight buildings, bins, or silos to provide protection from dampness and contamination.

F. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.

G. Liquid Curing Compounds: Store in closed containers.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Cement: U.S. made Portland cement complying with ASTM C150. Air entraining cements shall not be used. Cement brand shall be subject to approval by the Engineer and one brand shall be used throughout the work.

2.02 MATERIALS

- A. Materials shall comply with this Section and any applicable State or local requirements.
- B. Cement: The following cement type(s) shall be used:
 - 1. All Classes – Type I/II or Type II.
- C. Fine Aggregate: Washed inert natural sand conforming to the requirements of ASTM C33.
- D. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in ASTM C33 Table 2 for the specified coarse aggregate size number. Limits of Deleterious Substances and Physical Property Requirements shall be as listed in ASTM C33 Table 3 for severe weather regions. Size numbers for the concrete mixes shall be as shown in Table 1 herein.
- E. Water: Potable water free from injurious amounts of oils, acids, alkalis, salts, organic matter, or other deleterious substances.
- F. Admixtures: Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures and shall be suitable for use in contact with potable water after 30 days of concrete curing.
 - 1. Air-Entraining Admixture: The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 2. Water-Reducing Agent: The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

3. High-Range Water-Reducer (Plasticizer): The admixture shall comply with ASTM C494, Type F and shall result in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations. Where walls are 14 inches thick or less and the wall height exceeds 12 feet, a mix including a plasticizer must be used.
 4. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the Engineer. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.
- G. Pozzolan (Fly Ash): Pozzolan shall be Class C or Class F fly ash complying with ASTM C618 except the Loss on Ignition (LOI) shall be limited to 3% maximum.
- H. Ground-Granulated Blast Furnace Slag: Ground-granulated blast furnace slag shall conform to the following:
1. ASTM C989.
 2. Slag activity classification: Grade 100 or 120.
- I. Sheet Curing Materials. Waterproof paper, polyethylene film, or white burlap-polyethylene sheeting all complying with ASTM C171.
- J. Liquid Curing Compound. Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309, Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil. Curing compound shall be approved for use in contact with potable water after 30 days (non-toxic and free of taste or odor). Curing compound shall comply with Federal, State, and local VOC limits.

2.03 MIXES

- A. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the Engineer engaged by and at the expense of the Contractor.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance, and other required properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

- C. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory, acceptable to the Engineer, engaged by and at the expense of the Contractor. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between water cementitious ratio and 7- and 28-day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16% greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.
- D. Compression Tests: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the specified design strength requirements in conformity with the above paragraph.
- E. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
1. If the air-entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.
- F. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducer (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 5 to 8 inches.
- G. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

TABLE 1 CONCRETE MIX REQUIREMENTS						
Class	Design Strength (1)	Cement (2)	Fine Aggregate (2)	Coarse Aggregate (3)		Cementitious Content (4)
A	2,500	C150 Type II	C33	57		440 minimum
B	3,000	C150 Type II	C33	57		480 minimum
C	4,000	C150 Type II	C33	57		560 minimum
D	5,000	C150 Type II	C33	57		600 minimum
Class	W/cm Ratio (5)	Fly Ash	AE Range (6)	WR (7)	HRWR (8)	Slump Range Inches
A	0.63 maximum	--	3.5 to 5	Yes	*	1-4
B	0.54 maximum	--	3.5 to 5	Yes	*	1-3
C	0.44 maximum	25% maximum	3.5 to 5	Yes	*	3-5
D	0.40 maximum	--	3.5 to 5	Yes	*	3-5

NOTES:

- (1) Minimum compressive strength in psi at 28 days.
- (2) ASTM designation.
- (3) Size number in ASTM C33.
- (4) Cementitious content in pounds/cubic yard.
- (5) W/Cm is water-cementitious ratio by weight.
- (6) AE is percent air-entrainment.
- (7) WR is water-reducer admixture.
- (8) HRWR is high-range water-reducer admixture.
- * HRWR used at the Contractor's option except where walls are 14 inches thick or less and the wall height exceeds 12 feet, a mix including a plasticizer must be used.

PART 3 EXECUTION

3.01 MEASURING MATERIALS

- A. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and shall be produced by a plant acceptable to the Engineer. All constituents, including admixtures, shall be batched at the plant except a high-range water-reducer may also be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within 1 year of use.
- C. Measure the amount of free water in fine aggregates within 0.3% with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as-batched on printed batching tickets.

- D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.02 MIXING AND TRANSPORTING

- A. Batch plants shall have a current NRMCA Certification or equal.
- B. Concrete shall be ready-mixed concrete produced by equipment acceptable to the Engineer. No hand-mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- C. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.
- D. Keep the water tank valve on each transit truck locked at all times. Any addition of water above the appropriate W/Cm ratio must be approved by the Engineer. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket.
- E. All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.
- F. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Metal or metal-lined non-aluminum discharge chutes shall be used and shall have slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 feet long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- G. Retempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar which has reached initial set will not be permitted.
- H. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.

- I. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement, and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer.
- J. Temperature and Mixing Time Control
1. In cold weather, do not allow the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms to drop below 40 degrees F.
 2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
 3. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. If necessary, substitute well-crushed ice for all or part of the mixing water.
 4. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the values shown in Table 2.

TABLE 2 MAXIMUM TIME TO DISCHARGE OF CONCRETE	
Air or Concrete Temperature (whichever is higher)	Maximum Time
80 to 90 Degree F (27 to 32 Degree C)	45 minutes
70 to 79 Degree F (21 to 26 Degree C)	60 minutes
40 to 69 Degree F (5 to 20 Degree C)	90 minutes

5. If an approved high-range water-reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

3.03 CONCRETE APPEARANCE

- A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:
 1. The gradation of aggregate.
 2. The proportion of fine and coarse aggregate.
 3. The percentage of entrained air, within the allowable limits.
- B. Concrete for the work shall provide a homogenous structure which, when hardened, will have the required strength, durability, and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete, when viewed in good lighting from 10 feet away, shall be pleasing in appearance, and at 20 feet shall show no visible defects.

3.04 PLACING AND COMPACTING

- A. Placing
 1. Verify that all formwork completely encloses concrete to be placed and is securely braced before concrete placement. Remove ice, excess water, dirt, and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent workman at the location of the placement who can assure that reinforcing steel and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Seal extremely porous subgrades in an approved manner.
 2. Deposit concrete as near its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate which ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section

cannot be placed continuously, place construction joints as specified or as approved.

3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping and submit for approval.
4. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.
5. Do not place concrete for supported elements until concrete previously placed in the supporting element (columns, slabs and/or walls) has reached adequate strength.
6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms with a suitable tool to bring the full surface of the mortar against the form. Prevent the formation of excessive surface voids.
7. Slabs
 - a. After suitable bulkheads, screeds, and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.
 - b. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.
 - c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow 1 hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist so as to prevent cold joints.
8. Formed Concrete
 - a. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to

drop freely more than 4 feet. Place concrete for walls in 12- to 24-inch lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 4 feet.

9. Underwater concreting shall be performed in conformity with the recommendations of ACI 304.1. The tremie system shall be used to place underwater concrete. Tremie pipes shall be in the range of 8 to 12 inches in diameter and be spaced at not more than 16 feet on centers nor more than 8 feet from an end form. Where concrete is being placed around a pipe, there shall be at least one tremie pipe on each side of each pipe. Where the tremie system is not practical, direct pumped concrete for underwater placement may be used subject to approval of the system including details by the Engineer.

B. Compacting

1. Consolidate concrete by vibration, puddling, spading, rodding, or forking so that concrete is thoroughly worked around reinforcement, embedded items and openings, and into corners of forms. Puddling, spading, etc., shall be continuously performed along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
2. All concrete shall be placed and compacted with mechanical vibrators. The number, type, and size of the units shall be approved by the Engineer in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job.
3. A minimum frequency of 7,000 rpm is required for mechanical vibrators. Insert vibrators and withdraw at points from 18 to 30 inches apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over-vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.
4. Concrete Slabs: Concrete for slabs less than 8 inches thick shall be consolidated with vibrating screeds; slabs 8 to 12 inches thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.
5. Walls and Columns: Internal vibrators (rather than form vibrators) shall be used unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down the batch at the point of discharge, one or

more additional vibrators must be used to densify, homogenize, and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.

6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until:
 - a. Frequency returns to normal.
 - b. Surface appears liquefied, flattened, and glistening.
 - c. Trapped air ceases to rise.
 - d. Coarse aggregate has blended into surface but has not disappeared.

3.05 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

- B. Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Curing methods to be used are as follows:
 - a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling, or covered with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.
 - b. Sheet Material Curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing: Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.

2. Specified applications of curing methods:
 - a. Slabs for Water Containment Structures: Water curing only.
 - b. Slabs on Grade and Footings (not used to contain water): Water curing, sheet material curing, or liquid membrane curing.
 - c. Structural Slabs (other than water containment): Water curing or liquid membrane curing.
 - d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout, or Other Material that Requires Bond to the substrate: Water curing.
 - e. Formed Surfaces: None if nonabsorbent forms are left in place for 7 days. Water cure if absorbent forms are used. Water cure if forms are removed before 7 days. Exposed horizontal surfaces of formed walls or columns shall be water cured for 7 days or until next placement of concrete is made.
 - f. Surfaces of Concrete Joints: Water cured or sheet material cured.
3. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

C. Cold Weather Concreting:

1. *Cold weather* is defined as a period when for more than 3 successive days, the average daily outdoor temperature drops below 40 degrees F. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight.
2. Cold weather concreting shall conform to ACI 306.1 and the additional requirements specified herein. Temperatures at the concrete placement shall be recorded at 12-hour intervals (minimum).
3. Discuss a cold weather work plan with the Engineer. The discussion shall encompass the methods and procedures proposed for use during cold weather including the production, transportation, placement, protection, curing, and temperature monitoring of the concrete. The procedures to be implemented upon abrupt changes in weather conditions or equipment failures shall also be discussed. Cold weather concreting shall not begin until the work plan is acceptable to the Engineer.

4. During periods of cold weather, concrete shall be protected to provide continuous warm, moist curing (with supplementary heat when required) for a total of at least 350 degree-days of curing.
 - a. Degree-days are defined as the total number of 24-hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g.: 5 days at an average 70 degrees F = 350 degree-days).
 - b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
5. Salt, manure, or other chemicals shall not be used for protection.
6. The protection period for concrete being water cured shall not be terminated during cold weather until at least 24 hours after water curing has been terminated.

D. Hot Weather Concreting

1. *Hot weather* is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation estimated in accordance with ACI 305.1, approaching or exceeding 0.2 lbs/sq ft/hr).
2. Concrete placed during hot weather shall be batched, delivered, placed, cured, and protected in compliance with the recommendations of ACI 305.1 and the additional requirements specified herein.
 - a. Temperature of concrete being placed shall not exceed 90 degrees F and every effort shall be made to maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set, or cold joints.
 - b. All necessary precautions shall be taken to promptly deliver, to promptly place the concrete upon its arrival at the job, and to provide vibration immediately after placement.
 - c. The Engineer may direct the Contractor to immediately cover plastic concrete with sheet material.
3. Discuss with the Engineer a work plan describing the methods and procedures proposed to use for concrete placement and curing during hot

weather periods. Hot weather concreting shall not begin until the work plan is acceptable to the Engineer.

3.06 REMOVAL OF FORMS

- A. Except as otherwise specifically authorized by the Engineer, forms shall not be removed before the concrete has attained a strength of at least 70% of its specified design strength for beams and slabs and at least 30% of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 3 MINIMUM TIME TO FORM REMOVAL	
Forms for	Degree Days
Beams and Slabs	500
Walls and Vertical Surfaces	100

NOTE: See definition of degree-days in Paragraph 3.05D above.

- B. Shores shall not be removed until the concrete has attained at least 70% of its specified design strength and sufficient strength to support safely its own weight and construction live loads.

3.07 INSPECTION AND FIELD TESTING

- A. The batching, mixing, transporting, placing, and curing of concrete shall be subject to the inspection of the Engineer at all times. The Contractor shall advise the Engineer of his/her readiness to proceed at least 24 hours before each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete; the reinforcing steel; and the alignment, cleanliness, and tightness of formwork. No placement shall be made without the inspection and acceptance of the Engineer.
- B. Sets of field control cylinder specimens will be taken by the Engineer (or inspector) during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 150 cubic yards of concrete nor less than one set for each 5,000 square feet of surface area for slabs or walls.
1. A "set" of test cylinders consists of five cylinders: one to be tested at 7 days and two to be tested and their strengths averaged at 28 days. The fourth may be used for a special test at 3 days or to verify strength after 28 days if the 28-day test results are low. The fifth is to be used at 28 days or 56 days where test results are low.

2. When the average 28-day compressive strength of the cylinders in any set falls below the specified design strength or below proportional minimum 7-day strengths (where proper relation between 7- and 28-day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve the required strengths.
- C. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations, and furnish material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Owner. Curing boxes shall be acceptable to the Engineer.
 - D. Slump tests will be made in the field immediately before placing the concrete. Such tests shall be made in accordance with ASTM C143. If the slump is greater than the specified range, the concrete shall be rejected.
 - E. Air Content: Test for air content shall be made on fresh concrete samples. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173.
 - F. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection, or determining the continuation of concrete work.
 - G. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Repair all core holes. The work of cutting and testing the cores will be at the expense of the Owner.

3.08 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer shall have the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens that failed. The cost of such additional curing shall be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure that fail to develop the required strength. The cost of all such core borings and/or

load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In such cases of failure to meet strength requirements, the Contractor and Engineer shall confer to determine what adjustment, if any, can be made in compliance with sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the Contractor in this Section.

- B. When the tests on control specimens of concrete fall below the specified strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the Engineer, in addition to other recourses, may require, at the Contractor's expense, load tests on any one of the slabs, beams, piles, caps, and columns in which such concrete was used. Tests need not be made until concrete has aged 60 days.
- C. Should the strength of test cylinders fall below 60% of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

3.09 PATCHING AND REPAIRS

- A. It is the intent of this Section to require quality work including adequate forming, proper mixture and placement of concrete, and curing so completed concrete surfaces will require no patching.
- B. Defective concrete and honeycombed areas as determined by the Engineer shall be repaired as specified by the Engineer.
- C. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed; recesses left by the removal of form ties shall be filled; and surface defects that do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.
- D. Immediately after removal of forms remove plugs and break off metal ties as required by Section 03100, Concrete Formwork. Promptly fill holes upon stripping as follows: Moisten the hole with water, followed by a 1/16 inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spiderweb. Trowel smooth with heavy pressure. Avoid burnishing.

- E. When patching exposed surfaces, the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary, by addition of proper amounts of white cement. Rub lightly with a fine Carborundum stone at an age of 1 to 5 days if necessary, to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

3.10 SCHEDULE

- A. Table 4 presents the general applications for the various concrete classes and design strengths:

TABLE 4 CONCRETE SCHEDULE		
Class	Design Strength (psi)	Description
A	2,500	Concrete fill and duct encasement
B	3,000	Concrete overlay slabs and pavements
C	4,000	Walls, slabs on grade, suspended slab and beam systems, columns, grade beams, and all other structural concrete
D	5,000	Prestressed concrete

END OF SECTION

SECTION 03360 CONCRETE FINISHES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required and finish cast-in-place concrete surfaces as shown on the Drawings and as specified in this Section.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Concrete sealer. Confirmation that the sealer is compatible with additionally applied coatings shall also be submitted.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be in accordance with the currently effective Florida Building Code (FBC). The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C33/C33M—Standard Specification for Concrete Aggregates.

1.04 QUALITY ASSURANCE

- A. Finishes
 - 1. For concrete which will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finishes are required and provide the proper finishes to receive these products.
 - 2. Changes in finishes made to accommodate products different from those specified shall be performed at no additional cost to the Owner. Submit the proposed new finishes and their construction methods to the Engineer for approval.

B. Services of Manufacturer's Representative

1. Upon 72 hours notification, make available at no extra cost to the Owner the services of a qualified field representative of the manufacturer of the curing compound, sealer, or hardener to instruct the user on the proper application of the product under prevailing job conditions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Chemical hardener shall be Lapidolith by Sonneborn; Hornolith by A.C. Horn; Penalith by W.R. Meadows; or equal fluosilicate-base material.
- B. Concrete sealer shall be "MasterKure CC 180 WB", by Master Builders Solutions, Shakopee, MN, or equal.

PART 3 EXECUTION

3.01 FORMED SURFACES

- A. Forms shall not be removed before the requirements of Section 03300, Cast-In-Place Concrete, have been satisfied.
- B. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications, or corners when removing the forms or performing any other work adjacent to such chamfers, rustications, or corners.
- C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- D. Rough Form Finish
 1. Immediately after stripping forms and before concrete has changed color, carefully remove all fins and projections.
 2. Promptly fill holes left by tie cones and defects as specified in Section 03300, Cast-In-Place Concrete.
- E. Rubbed Finish
 1. Immediately upon stripping forms and before the concrete has changed color, carefully remove all fins. While the wall is still damp, apply a thin coat of medium-consistency neat cement slurry by bristle brushes to

- provide a bonding coat within all pits, air holes, or blemishes in the parent concrete. Avoid coating large areas with the slurry at one time.
2. Before the slurry has dried or changed color, apply a dry (almost crumbly) grout proportioned by volume and consisting of 1 part cement to 1-1/2 parts of clean masonry sand having a fineness modulus of approximately 2.3 and complying with the gradation requirements of ASTM C33/C33M for such a material. Grout shall be uniformly applied by damp pads of coarse burlap approximately 6-inch square used as a float. Scrub grout into the pits and air holes to provide a dense mortar in all imperfections.
 3. Allow the mortar to partially harden for 1 or 2 hours depending on the weather. If the air is hot and dry, keep the wall damp during this period using a fine, fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel. (Note: Grout allowed to remain on the wall too long will harden and will be difficult to remove.)
 4. Allow the surface to dry thoroughly and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cut off with the trowel so it can be wiped off clean with the burlap.
 5. On the day after the repair of pits, air holes, and blemishes, the walls shall again be wiped off clean with dry, used pieces of burlap containing old hardened mortar which will act as a mild abrasive. After this treatment, there shall be no built-up film remaining on the parent surface. If, however, such a film is present, a fine abrasive stone shall be used to remove all such material without breaking through the surface film of the original concrete. Such scrubbing shall be light and sufficient only to remove excess material without changing the texture of the concrete.
 6. A thorough wash down with stiff bristle brushes shall follow the final bagging or stoning operation. No extraneous materials shall remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after the application of the repair grout.

F. Abrasive Blast Finish

1. Coordinate with Rubbed Finish application. Do not begin until Rubbed Finish operation is complete or before concrete has reached minimum 7-day strength. The Rubbed Finish application may be deleted by the Engineer if the unfinished concrete surface is of superior quality. Apply the abrasive blast finish only where indicated on the Drawings.

2. Prepare a sample area a minimum of 4 feet high by 16 feet wide. Blast Finish on a portion of new wall construction which will not be exposed in the final work. The sample area shall contain a variety of finishes obtained with different nozzles, nozzle pressures, grit materials, and blasting techniques for selection by the Engineer. Final accepted sample shall remain exposed until all Blast Finish operations are complete.
3. The Blast Finish operation shall meet all regulatory agency requirements. The Blast Finish contractor shall be responsible for obtaining all required permits and/or licenses.
4. Perform abrasive blast finishing in as continuous an operation as possible, using the same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns or variances in depths of blast as present on the accepted sample.
5. Use an abrasive grit of proper type and gradation as well as equipment and technique to expose aggregate and surrounding matrix surfaces as follows:
 - a. Medium: Generally expose coarse aggregate 1/4-inch to 3/8-inch reveal.
6. Abrade blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match the Architect's samples.
7. Upon completing the Blast Finish operation, thoroughly flush finished surfaces with clean clear water to remove residual dust and grit. Allow to air dry until curing of concrete is complete.
8. After the concrete has cured for a minimum of 28 days, apply a clear acrylic sealer as directed by the manufacturer.

3.02 FLOORS AND SLABS

A. Floated Finish

1. Machine Floating
 - a. Screed floors and slabs with straightedges to the established grades shown on the Drawings. Immediately after final screeding, sprinkle a dry cement/sand shake in the proportion of two sacks of Portland

cement to 350 pounds of coarse natural concrete sand evenly over the surface at the rate of approximately 500 pounds/1,000 square feet of floor. Do not sprinkle neat, dry cement on the surface.

- b. The application of the cement/sand shake may be eliminated at the discretion of the Engineer if the base slab concrete exhibits adequate fattiness and homogeneity and the need is not indicated. When the concrete has hardened sufficiently to support the weight of a power float without the float's digging into or disrupting the level surface, thoroughly float the shake into the surface with a heavy revolving disc-type power compacting machine capable of providing a 200-pound compaction force distributed over a 24-inch-diameter disc.
- c. Start floating along walls and around columns and then move systematically across the surface leaving a matte finish.
- d. The compacting machine shall be the "Kelly Power Float with Compaction Control" as manufactured by Kelley Industries of SSP Construction Equipment Inc., Pomona, CA, or equal. Troweling machines equipped with float (shoe) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades will not be permitted. The use of any floating or troweling machine which has a water attachment for wetting the concrete surface during finishing will not be permitted.

2. Hand Floating

- a. In lieu of power floating, small areas may be compacted by hand floating. The dry cement/sand shake previously specified shall be used unless specifically eliminated by the Engineer. Screed the floors and slabs with straightedges to the established grades shown on the Drawings. While the concrete is still green but sufficiently hardened to support a finisher and kneeboards with no more than 1/4-inch indentation, wood float to a true, even plane with no coarse aggregate visible. Use sufficient pressure on the wood floats to bring moisture to the surface.

3. Finishing Tolerances

- a. Level floors and slabs to a tolerance of plus or minus 1/8 inch when checked with a 10-foot straightedge placed anywhere on the slab in any direction. Where drains occur, pitch floors to drains such that no low spots are left undrained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other correction.

B. Broom Finish

1. Screed slabs with straightedges to the established grades indicated on the Drawings. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a stiff bristle broom lightly across the surface in the direction of drainage or, in the case of walks and stairs, perpendicular to the direction of traffic to provide a non-slip surface.

C. Steel Trowel Finish

1. Finish concrete as specified in Article 3.04. Then, hand steel trowel to a perfectly smooth hard even finish free from high or low spots or other defects.

D. Concrete Sealer

1. Prepare and seal surfaces indicated on the room finish schedule to receive a sealer as follows:
 - a. Finish concrete as specified in the preceding paragraphs and in accordance with the Schedule in Article 3.05.
 - b. Newly Placed Concrete: Surface must be sound and properly finished. Surface is application ready when it is damp but not wet and can no longer be marred by walking workmen.
 - c. Newly Cured Bare Concrete: Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt, and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that the surface is no more than damp and not wet.
 - d. Aged Concrete: Restore surface soundness by patching, grouting, filling cracks and holes, etc. Surface must also be free of any dust, dirt, and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required following the procedure indicated under cured concrete.
 - e. Methods: Apply sealer to form a continuous, uniform film by spray, soft bristle pushbroom, long nap roller, or lambswool applicator. Ordinary garden-type sprayers, using neoprene hose, are recommended for best results.
 - f. Applications: For curing only, apply the first coat evenly and uniformly as soon as possible after final finishing at the rate of 200 to 400 square feet per gallon. Apply the second coat when all trades are completed and the structure is ready for occupancy at the rate of 400 to 600 square feet per gallon.

- g. To meet guarantee and to seal and dustproof, two coats are required. For sealing new concrete, both coats shall be applied full strength. On aged concrete, when renovating, dustproofing, and sealing, the first coat should be thinned 10 to 15% with reducer in accordance with the manufacturer's directions.

3.03 CONCRETE RECEIVING CHEMICAL HARDENER

- A. After 28 days minimum concrete cure, apply chemical hardener in three applications to a minimum total coverage of the undiluted chemical of 100 square feet per gallon and in accordance with the manufacturer's recommendations as reviewed.

3.04 APPROVAL OF FINISHES

- A. All concrete surfaces, when finished, will be inspected by the Engineer.
- B. Surfaces which in the opinion of the Engineer are unsatisfactory shall be refinished or reworked.
- C. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03300, Cast-In-Place Concrete.

3.05 SCHEDULE OF FINISHES

- A. Concrete shall be finished as specified either to remain as natural concrete or to receive an additional applied finish or material under another section.
- B. Concrete for the following conditions shall be finished as noted on the Drawings and as further specified in this Section:
 - 1. Concrete to Receive Dampproofing: Rough form finish. See Paragraph 3.01D.
 - 2. Concrete Not Exposed to View and Not Scheduled to Receive an Additional Applied Finish or Material: Rough form finish. See Paragraph 3.01D.
 - 3. Exterior Vertical Concrete Above Grade Exposed to View: Rubbed finish. See Paragraph 3.01E.
 - 4. Interior Vertical Concrete Exposed to View Except in Water Containment Areas: Rubbed finish. See Paragraph 3.01E.
 - 5. Vertical Concrete in Water Containment Areas. Rubbed finish on exposed surfaces and extending to 2 feet below normal operating water

level: Rough form finish on the remainder of submerged areas. See Paragraphs 3.01E and 3.01D.

6. Interior and Exterior Underside of Concrete Exposed to View: Rubbed finish. See Paragraph 3.01E.
7. Exterior surfaces exposed to view and indicated to have an abrasive blast finish. See Paragraph 3.01F.
8. Interior or Exterior Horizontal Concrete not Requiring Floor Hardener or Sealer: Floated finish. See Paragraph 3.02A.
9. Concrete for Exterior Walks and Interior and Exterior Stairs: Broomed finish perpendicular to direction of traffic. See Paragraph 3.02B.
10. Concrete Slabs On Which Process Liquids Flow or In Contact with Sludge: Steel trowel finish. See Paragraph 3.02C.
11. Concrete to Receive Hardener: See Paragraph 3.02D.
12. Concrete tank bottoms to be covered with grout: See Section 03600, Grout.

END OF SECTION

SECTION 03420
PRECAST, PRESTRESSED CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required and install the precast, prestressed concrete and accessories as shown on the Drawings and as specified in this Section.
- B. The work of this Section includes but is not limited to:
 - 1. All inserts, weld plates, strand anchors, bolts, anchor bolt, slip angles, bearing plates, pipe sleeves, and reinforcing bars which are cast into the prestressed concrete members as indicated on Drawings.
 - 2. Furnish and place all anchors, weld plates, inserts, reinforcing bars, and other accessories in cast-in-place concrete as required installing the work under this Section.
 - 3. Erection including all necessary shimming and welding and removing lifting hooks.
 - 4. Grouting between all roof slabs.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. The shop drawings and calculations shall be prepared and stamped by a registered professional engineer. Fabrication of members shall not proceed until shop drawings are approved by the Engineer. Submit installation and handling literature and requirements for drilling and cutting openings in the field.
- B. All inserts, hangers, openings, pipe sleeves, blockouts, etc., required by various trades or as indicated, located, and detailed on the final approved drawings will be cast as such and any omission or changes in location or details or various trades shall be done at the expense of the Contractor.
- C. The manufacturer of the prestressed structural concrete elements shall submit a record of his/her work for the past 5 years to substantiate that he/she has been manufacturing prestressed members.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be in accordance with the currently effective Florida Building Code (FBC). The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Concrete Institute (ACI)
 - 1. ACI 318—Building Code Requirements for Structural Concrete.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A36/A36M—Standard Specification for Carbon Structural Steel.
 - 2. ASTM A307—Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - 3. ASTM A416/A416M—Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete.
 - 4. ASTM A615/A615M—Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
 - 5. ASTM C33/C33M—Standard Specification for Concrete Aggregates.
 - 6. ASTM C150/C150M—Standard Specification for Portland Cement.
- C. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. AASHTO HB 17—Standard Specifications for Highway Bridges.
- D. American Welding Society (AWS)
 - 1. AWS D1.1/D1.1M—Structural Welding Code Steel.

1.04 QUALITY ASSURANCE

- A. All prestressed structural concrete elements shall be manufactured at an existing plant and satisfactory evidence shall be given the Engineer to substantiate that the fabricator is capable of and has the organization and plant for performing the work and of maintaining the schedule required. The manufacturer of these elements must also submit a record of his\her work for the past 5 years to substantiate that he\she has been manufacturing prestressed members.

1.05 DESIGN CRITERIA

- A. The design and construction of prestressed members shall conform to ACI 318.

- B. Furnish two copies of design calculations to the Engineer for approval. Calculations shall indicate all assumptions and cover all phases of design. All elements shall be designed to support their own weight plus the superimposed loads shown on the Drawings. Calculations shall also include the amount of camber produced, together with the dead and live load deflections. Fabrication shall not be started until the Engineer's written approval of the design calculations has been received.
- C. The thickness of the elements has been established and is indicated on the Drawings. All steel, mild or strand, shall have a minimum of 2 inches of concrete cover. All concrete elements shall have shear keyways on the sides of the members which will be placed adjacent to other elements.
- D. The precast prestressed members shall be designed for the following superimposed loads:
 - 1. Concrete topping at a density of 150 pcf to the thickness indicated on the Drawings.
 - 2. Dead load and live load as indicated on the Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All cement, sand, and gravel used in this Section, including patching of members, shall be obtained from one single source to ensure as uniform a texture as possible.
- B. Cement shall be Portland cement conforming to ASTM C150/C150M, Type III.
- C. Aggregates shall consist of sand and gravel conforming to ASTM C33/C33M. The size of coarse aggregate shall meet spacing requirements of prestressing steel and/or reinforcing steel. The aggregate shall be no larger than 1 inch.
- D. Reinforcing steel shall be intermediate grade, new billet steel and deformed in accordance with ASTM A615/A615M, Grade 60. Cast-in anchor plates, weld plates, and angle headers with clips shall conform to ASTM A36/A36M. Prestressing strand shall conform to the ASTM A416/A416M, Grade 250K.
- E. Nonshrink grout shall be Masterflow 713 by Master Builders Company; Euco N S by Euclid; Five Star Grout by US Grout Corp, or equal.

PART 3 EXECUTION

3.01 CONCRETE STRENGTH

- A. All prestressed concrete members shall have a minimum 28-day compressive strength of 5,000 psi using Type III cement.
- B. Unless otherwise specified by the Engineer, concrete shall have a minimum compressive strength of 3,500 psi at transfer of prestressing force, as determined by test.

3.02 FABRICATION

- A. All exposed surfaces shall be steel formed and tops of roof members shall have a wood float finish. All members shall be steam cured at 130 to 160°F. All corners shall have minimum 1/2-inch chamfer.
- B. Sizes of all members shall conform to those shown on the Drawings with the following dimensional tolerances:
 - 1. Cross-sectional tolerance for all members shall be plus 1/4-inch minus 0 inch.
 - 2. Length of members shall be plus or minus 3/8 inch.
 - 3. Ends of members out of square shall be plus or minus 1/4 inch.
 - a. Deviation from straight line shall be not greater than 1/8 inch per 10 feet of length measured by a light line stretched from end to end of the unit.
 - b. Difference in camber between two adjacent slabs in place after welding shall not be more than 1/2 inch.
- C. Hollow Core Slabs
 - 1. Cross-sectional tolerance for all members shall be plus 1/4 inch minus 0 inch.
 - 2. Length of members shall be plus or minus 3/8 inch.
 - 3. Ends of members out of square shall be plus or minus 1/4 inch.
 - a. Deviation from straight line shall be not greater than 1/8 inch per 10 feet of length measured by a light line stretched from end to end of unit.

- b. Difference in camber between two adjacent slabs in place after welding shall not be more than 1/2 inch.

D. Double Tee Members

- 1. Cross-sectional tolerance for all members:
 - a. For depth and width up to 3 feet shall be plus 1/4 inch minus 0 inch.
 - b. For depth and width above 3 feet shall be plus 3/8 inch minus 0 inch.
- 2. Length of members:
 - a. Up to 50 feet shall be plus or minus 3/8 inch.
 - b. Up to 75 feet shall be plus or minus 5/8 inch.
 - c. Above 75 feet length shall be plus or minus 3/4 inch.
- 3. Ends of members out of square:
 - a. Members up to 2 feet in depth or width shall be plus or minus 1/4 inch/foot.
 - b. Members over 2 feet in depth or width shall be plus or minus 1/4 inch, plus or minus 1/16-inch per foot depth or width in excess of 2 feet.
 - c. Deviation from a straight line shall be not greater than 1/8 inch per 10 feet of length measured by a light line stretched from end to end of unit.
 - d. Difference in camber between two adjacent slabs in place after welding in a structure shall not be more than 1/2 inch for members up to a 50-foot span, 3/4 inch for a 60-foot span, 1 inch for an 80-foot span, and 1-1/4 inches for a 100-foot span.

3.03 HANDLING AND ERECTION

- A. All prestressed units shall be carefully loaded and hauled on trucks and erected to prevent damage. They shall be erected by experienced workmen, true to line and grade in proper sequence, and welded and/or anchored as indicated on the Drawings. All members superficially damaged during shipment or erection shall be rejected until they are repaired by experienced workmen. Units badly damaged shall be rejected until they are replaced. The Engineer shall be the sole judge of this damage. No holes shall be cut or drilled in the field without written approval of the Engineer.

- B. Connections between roof slabs shall be as required on the Drawings. Seal all longitudinal joints before placing grout. All welding shall be in accordance with AWS D1.1/D1.1M. Bolts shall be low-carbon steel conforming to ASTM A307.

3.04 TESTS

- A. At least three standard test specimens for each production line shall be prepared in accordance with Section 4.7 of ACI 318 at the time the concrete is deposited to determine the concrete strength at different ages.
- B. All testing of products or concrete strength tests to be done by the outside testing laboratory selected by the Engineer will be done at the expense of the Owner except testing of specimens for strength at transfer of prestressing force (refer to Article 3.01) shall be made and observed by the laboratory if so desired.

END OF SECTION

SECTION 03480
PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, and equipment required to install precast concrete structures as shown on the Drawings and as specified in this Section, including wet wells, valve vaults, manholes, and accessories. The work shall include the required inlet and outlet pipe connections; frames and covers; masonry; concrete; reinforcing steel; special pipe fittings; precast units; and all other materials, tools, and equipment necessary to produce complete structures.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submittals shall include at least the following:
1. Base sections, riser sections, eccentric and concentric conical top sections, flat slab tops, and grade rings with notarized certificate indicating compliance with ASTM C478.
 2. Location and elevation of all penetrations.
 3. Applicable lifting and installation details or instructions.
 4. Frames and covers with notarized certificate indicating compliance with specified standards (ASTM A48/A48M, Class 30; etc.).
 5. Method of repair for minor damage to precast concrete sections.
 6. Delivery, unloading, and receiving instructions.
- B. Design Data
1. All precast structures shall be designed by an engineer registered in Florida. Calculations and design drawings shall be signed, sealed, and submitted for review before fabrication. Design drawings shall demonstrate that the applicable industry design standards listed in this Section have been met.
 2. Precast concrete structures:
 - a. Sectional plans and elevations showing dimensions and reinforcing steel placement.

- b. Structural calculations including assumptions.
- c. Concrete design mix.

C. Test Reports

1. Precast concrete structures:

- a. Concrete test cylinder reports from an approved testing laboratory certifying conformance with this Section.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be in accordance with the currently effective Florida Building Code (FBC). The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Association of State Highway and Transportation Officials (AASHTO)

- 1. AASHTO HB 17—Standard Specifications for Highway Bridges.

B. American Concrete Institute (ACI)

- 1. ACI 318—Building Code Requirements for Structural Concrete and Commentary.
- 2. ACI 350/350R—Code Requirements for Environmental Engineering Concrete Structures and Commentary.

C. American Society for Testing and Materials (ASTM)

- 1. ASTM A48/A48M—Standard Specification for Gray Iron Castings.
- 2. ASTM A536—Standard Specification for Ductile Iron Castings.
- 3. ASTM A615/A615M—Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- 4. ASTM C14—Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
- 5. ASTM C33/C33M—Standard Specification for Concrete Aggregates.
- 6. ASTM C150/C150M—Standard Specification for Portland Cement.
- 7. ASTM C207—Standard Specification for Hydrated Lime for Masonry Purposes.
- 8. ASTM C443—Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- 9. ASTM C478—Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.

10. ASTM C497—Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C923—Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
12. ASTM C1244—Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
13. ASTM D4101—Standard Specification for Polypropylene Injection and Extrusion Materials.

D. Occupational Safety and Health Administration (OSHA)

1.04 QUALITY ASSURANCE

- A. All material shall be new and unused.
- B. The quality, manufacturing process, and finished sections of the materials are subject to inspection and approval by the Engineer or other representative of the Owner. Inspection may be at the place of manufacture, at the work site following delivery, or both.
- C. Materials may be examined for compliance with ASTM standards, this Section, and approved manufacturer's drawings. Additional inspection criteria shall include appearance, dimensions, blisters, cracks, and soundness. The surface shall be dense and close textured.
- D. Materials shall be rejected for failure to meet any requirements specified in this Section. Materials may be rejected at the place of manufacture, at the work site, or following installation. Mark rejected materials for identification and remove them from the work site immediately. Rejected materials shall be replaced at no cost to the Owner.
- E. If the Engineer authorizes repair, repair minor damage to precast concrete sections by the approved method. Epoxy mortar may be used for minor repairs subject to the approval of the Engineer.

PART 2 PRODUCTS

2.01 GENERAL

- A. Precast reinforced concrete structures shall be produced in a plant approved by the Engineer.

- B. To provide standardization for appearance, operation, maintenance, spare parts, and manufacturer's service, like items of materials/equipment shall be the end products of one manufacturer.
- C. Provide lifting lugs or holes in each precast section for proper handling.

2.02 CONCRETE

- A. Concrete and aggregate shall conform to the requirements of Section 03300, Cast-In-Place Concrete, unless otherwise specified in this Section. Portland cement shall be ASTM C150/C150M, Type II. Compressive strength shall be not less than 4,000 psi at 28 days. Maximum size of aggregate shall conform to ASTM C33/C33M and shall not exceed one-fifth the narrowest dimension between sides of forms, nor three-quarters the minimum clear spacing between individual reinforcing bars or wires. Water-to-cement ratio shall not exceed 0.45. Slump shall be between 2 and 4 inches, unless otherwise approved by the Engineer. The concrete proportions shall be developed using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for this project. Accelerators containing calcium chloride shall not be used in precast concrete.

2.03 PRECAST WET WELLS

- A. Precast wet well sections shall be sized as shown on the Drawings and shall conform to the requirements of ACI 350 and ASTM C478. Precast structures shall meet permeability requirements of ASTM C14.
- B. Minimum wall thickness shall be $\frac{1}{12}$ the wet well internal length in inches plus 1 inch unless otherwise shown on the Drawings. The top and bottom of all sections shall be parallel (straight sections).
- C. Sections shall be cured as specified in Section 03300, Cast-In-Place Concrete, and shall not be shipped until at least 10 days after casting. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the outside of each precast section.
- D. All pipe openings and access accessories shall be cast in at the precast plant. Drilled openings shall not be permitted.
- E. The wet well shall be designed for the applicable backfill, surcharge, and dead loads. Minimum live load shall be an equivalent lateral fluid pressure of 100 psf per foot of depth. Minimum surcharge live load shall be as stipulated by FDOT H20 highway loading.

- F. The wet well base sections shall have the slab integral with sidewalls with slab reinforcing tied to wall steel, unless indicated otherwise on the Drawings. Wet well foundation shall be as detailed on the Drawings.
- G. Wetwell Access Covers
 - 1. Wet well access covers shall be furnished by the pump supplier and all embedded items shall be shipped to the precast manufacturer to be cast into the structures. All coordination shall be the Contractor's responsibility. Access covers, access hatches, and accessories shall be as specified in Section 05500, Metal Fabrications, and Section 11535, Submersible Non-Clog Centrifugal Pumps.

2.04 PRECAST VALVE VAULTS

- A. Precast vaults shall be sized as shown on the Drawings and shall conform to the requirements of ACI 318. The vaults shall also meet the permeability requirements specified by ASTM C14.
- B. The units shall be cured as specified in Section 03300, Cast-In-Place Concrete, and shall not be shipped until at least 10 days after casting. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the outside of each precast section.
- C. All pipe openings and access accessories shall be cast in at the precast plant.
- D. The manufacturer shall reinforce the vaults to meet all applicable codes. Alternatively, the vaults may be redesigned using the applicable backfill, surcharge, and dead loads. Minimum live load shall be an equivalent lateral fluid pressure of 100 psf per foot of depth. Minimum surcharge live load shall be as stipulated by FDOT H20 highway loading.
- E. Access covers shall be as specified in Section 05500, Metal Fabrications.
- F. The vault base shall be integral with the sidewalls with slab reinforcing tied to wall steel.

2.05 JOINTING PRECAST SECTIONS

- A. Seal tongue-and-groove joints of precast manhole sections with either rubber O-ring gaskets or preformed flexible joint sealant. O-ring gaskets shall conform to ASTM C443. Preformed flexible joint sealant shall be Kent Seal No. 2 by Hamilton-Kent, Ram-Nek by Henry, or equal.

- B. After the joints are assembled the gap between sections shall be packed on the inside and outside with Anti-Hydro "Axpandaretes," Masterflow 713 by Master Builders or Five Star Grout by US Grout Corp., and shall be troweled smooth so that no projections remain on the inside.
- C. The completed joint shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.

2.06 PIPE CONNECTIONS TO MANHOLES

- A. Connect pipe to manholes in the following ways:
 - 1. Flexible sleeve—Integrally cast the sleeve in a precast manhole section or install the sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve, Kor-N-Seal connector, or equal.
 - 2. Compression gasket—Integrally cast the compression gasket in a precast manhole section. Insert pipe into compression gasket. The compression gasket shall be A-Lok or equal.
 - 3. At the discretion of the Engineer the following procedure may be allowed: Grout in place – Precast manhole sections shall have a formed, tapered circular opening larger than the pipe outside diameter. Grout shall be non-shrink and waterproof equal to Hallemite, Waterplug, or Embeco. Plastic pipe shall have a waterstop gasket secured to the pipe with a stainless-steel clamp before grouting.

2.07 DAMPPROOFING

- A. Apply two coats of bituminous waterproofing material to the exterior surfaces of precast concrete structures by brush or spray and in accordance with the manufacturer's recommendations. Dampproofing shall be Hydrocide 648 by Sonneborn Building Products, Dehydratine 4 by A.C. Horn Inc, RIW Marine Liquid by Toch Brothers, or equal.

PART 3 EXECUTION

3.01 PRECAST STRUCTURE INSTALLATION

- A. Precast section ends shall be clean of foreign materials and carefully inspected for chips or cracks. Any sections with damaged joint tongue shall not be used. Preformed plastic gaskets and joint sealant shall be installed in strict conformance

with the manufacturer's recommendations. Only primer furnished by the gasket manufacturer will be approved.

- B. Invert elevations shall be in strict conformance with the Drawings. All sharp edges or rough sections that obstruct flow shall be removed.
- C. Access door framing shall be cast in top slabs in methods approved by the Engineer and shall be flush and level with the top of concrete. Reference Section 05500, Metal Fabrications, for additional criteria.
- D. Set precast concrete sections vertical and in true alignment. Install O-ring rubber gasket in the recess in the base of previously set section or prime and double seal joint surfaces with "RAM-NEK" premolded plastic joint sealer or Engineer-approved equal.

Completely plug, seal, and smooth all holes in sections used for their handling and the annular space between the wall and entering pipes with non-shrink grout. Finish grout smooth and flush with the adjoining interior and exterior manhole wall surfaces and make watertight.

- E. All structures shall be installed plumb.
- F. Dampproofing
 - 1. Paint outer surfaces of precast structures with two coats of bituminous dampproofing at the rate of 30 to 60 square feet per gallon, in accordance with the manufacturer's instructions.

3.02 LEAKAGE TESTS

- A. Test each structure for leakage in accordance with Section 01810, Watertightness Test for Structures.

3.03 CLEANING

- A. The Contractor shall thoroughly clean all precast structures of all silt, debris, and foreign matter of any kind before final inspections.

END OF SECTION

SECTION 03485
PRECAST CONCRETE BUILDING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. A factory-built precast concrete building shall be supplied for the Recharge Pump Building and Recharge Well Building in accordance with Project Drawings and Specifications. The interior dimensions of the structure at a minimum shall be as indicated on the Drawings but must be coordinated with all equipment to ensure proper installation and maintenance of the equipment can be performed.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit to the Engineer shop drawings and material data showing dimensions, sizes, thickness, materials, finishes, and methods of assembly. Submit manufacturer's technical data for all building hardware and equipment. All work shall be fabricated and erected in accordance with the manufacturer's drawings.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to herein shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Concrete Institute (ACI)
 - 1. ACI 318—Building Code Requirements for Structural Concrete.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A615—Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 2. ASTM A1064—Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 3. ASTM C33—Standard Specification for Concrete Aggregates.
 - 4. ASTM C150—Standard Specification for Portland Cement.
 - 5. ASTM C260—Standard Specification for Air-Entraining Admixtures for Concrete.

6. ASTM C494—Standard Specification for Chemical Admixtures for Concrete.

C. Concrete Reinforcing Steel Institute (CRSI)

1.04 QUALITY ASSURANCE

- A. The precast concrete building manufacturer shall have a minimum of 5 years' experience in building fabrication. In addition, the manufacturer shall have made no less than 10 buildings similar to the one on this project. Evidence must be submitted to verify that these requirements are met before being deemed an acceptable manufacturer.
- B. The Engineer shall have the right to inspect or test any material during fabrication in the factory. At the option of the Engineer, certified test of materials may be accepted in lieu of field test.

1.05 WARRANTIES

- A. The manufacturer shall warrant the building and its components for 1 year from the date of installation this includes water tightness.
- B. The precast concrete structure shall endure and not deteriorate for a period of 10 years.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. The building shall be stored on dunnage placed at the proper locations to prevent cracking, distortion, or any other physical damage.
- B. The building shall be shipped by the manufacturer. It shall be provided with lifting fixtures for lifting and setting the building without incurring damage to the walls or roof.

1.07 DESIGN CRITERIA

- A. Structural design calculations for the building shall be prepared and signed and sealed by a registered professional engineer in the State of Florida and shall be submitted for approval before fabrication.
- B. The building shall be designed to meet the following minimum loading requirements:
 1. Roof Live Load: 60 psf.

2. Floor Live Load: 250 psf.
 3. Wall Wind Load: As indicated on the Drawings.
- C. The building shall be constructed of steel-reinforced precast concrete.
 - D. The precast concrete building shall be such that the roof and walls are cast at manufacture. The floor shall be permanently attached to the walls by welded connections, where applicable.
 - E. The building shall have a minimum roof thickness of 4 inches, minimum floor thickness of 6 inches and minimum wall thickness of 4 inches.
 - F. If the dimensions allow, the building shall be entirely factory assembled and shipped as one-piece unit.
 - G. The building exterior finish shall be a painted smooth trowel finish.
 - H. The exterior surface of the building body shall be form lined stained as shown in the Drawings. Color shall be chosen by the Owner.
 - I. The exterior building trim may be form lined stained or may receive two coats of MasterProtect HB 400 acrylic coating which shall be an alternate color chosen by the Owner.
 - J. The interior building finish shall be painted with Carbocrylic 3359 by Carboline or approved equal. Color shall be selected by the Owner.
 - K. The Contractor or Subcontractor shall coordinate the location of all penetrations and openings with the manufacturer as shown on the Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete
 1. Concrete used in the manufacture of the various structural components of the precast concrete building shall be factory batched and shall meet the following requirements:
 - a. Portland cement shall be Type I, II, or III conforming to ASTM C150.
 - b. Coarse aggregate shall consist of 1/2 inch maximum well graded crushed stone conforming to ASTM C33.

- c. Fine aggregate shall consist of natural sand conforming to ASTM C33.
- d. Air entrainment admixture shall conform to ASTM C260. The air-entrained content shall be not less than 4% or greater than 7%.
- e. A superplasticizer shall be used and shall conform to ASTM C494 Type F or G. Concrete shall be placed at a slump of between 5 and 8 inches.
- f. The concrete used for the structural components shall attain a minimum 28-day compressive strength of 5,000 psi.

B. Steel Reinforcing

- 1. Welded wire fabric shall conform to ASTM A1064. Reinforcing steel shall be new billet steel meeting the requirements of ASTM A615.
- 2. All reinforcement shall be free from loose rust, oil, and contaminants which reduce bond. Any foreign material shall be removed by suitable means before installation.
- 3. Provide supports for reinforcement including chairs, bolster bars, and other devices for spacing and securing reinforcement in accordance with CRSI requirements. Legs of all supports in contact with exposed-to-view surfaces shall be plastic coated in accordance with CRSI, Class I.

C. Joints

- 1. Sealant shall be an exterior grade, elastomeric sealant such as Sikaflex 1a or approved equal.
- 2. Joint filler shall be a foamed polyurethane strip saturated with polybutylene waterproofing material such as Polytite by Sandell Manufacturing Company.
- 3. Backer rod shall be closed cell compressible foam sized 1/4 inch larger than joint width.

D. Manufacturers

- 1. Precast Concrete Building shall be as manufactured by one of the following:
 - a. Leesburg Concrete Company, Inc. Leesburg, FL
 - b. Concrete Modular Systems, Inc. St. Petersburg, FL
 - c. Old Castle Precast, Inc. Spring Hill, FL
 - d. Or Engineer-Approved Equal.

PART 3 EXECUTION

3.01 JOINTS

- A. Seal all joints at wall panel to wall panel as required by the building manufacturer.
Seal all openings for doors, windows, equipment penetrations, etc.

END OF SECTION

SECTION 03600 GROUT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required and install grout complete as shown on the Drawings and as specified in this Section.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:
 - 1. Commercially manufactured nonshrink cementitious grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Material Safety Data Sheet.
 - 2. Commercially manufactured nonshrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Material Safety Data Sheet.
 - 3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures, and the proposed mix of the grout.
 - 4. Concrete grout. The submittal shall include data as required for concrete as delineated in Section 03300, Cast-In-Place Concrete, and for fiber reinforcement as delineated in Section 03200, Concrete Reinforcement. This includes the mix design, constituent quantities per cubic yard, and the water/cement ratio.
- B. Laboratory Test Reports: Submit laboratory test data as required under Section 03300, Cast-In-Place Concrete, for concrete to be used as concrete grout.
- C. Certifications: Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with potable water after 30 days curing.
- D. Qualifications: Grout manufacturers shall submit documentation that they have at least 10 years of experience in the production and use of the proposed grouts which they will supply.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be in accordance with the currently effective Florida Building Code (FBC). The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM C33/C33M—Standard Specification for Concrete Aggregates.
2. ASTM C150/C150M—Standard Specification for Portland Cement.
3. ASTM C531—Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
4. ASTM C579—Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
5. ASTM C827/C287M—Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
6. ASTM C1107/C1107M—Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
7. ASTM D695—Standard Test Method for Compressive Properties of Rigid Plastics.

B. US Army Corps of Engineers Standard (CRD)

1. CRD C621—Corps of Engineers Specification for Non-Shrink Grout.

1.04 QUALITY ASSURANCE

A. Pre-installation Conference

1. Well in advance of grouting, the Contractor shall hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing, and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days before its scheduled date.

B. Services of Manufacturer's Representative

1. A qualified field technician of the nonshrink grout manufacturer, specifically trained in installing the products, shall attend the pre-installation conference and shall be present for the initial installation of

each type of nonshrink grout. Additional services shall also be provided as required to correct installation problems.

C. Field Testing

1. All field testing and inspection services required shall be provided by the Owner. The Contractor shall assist in the sampling of materials and shall provide any ladders, platforms, etc., for access to the work. The methods of testing shall comply in detail with the applicable ASTM Standards.
2. The field testing of Concrete Grout shall be as specified for concrete in Section 03300, Cast-In-Place Concrete.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.
- B. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.
- C. Store materials in full compliance with the manufacturer's recommendations. Total storage time from the date of manufacture to the date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.
- D. Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the Owner.
- E. Nonshrink-cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.
- F. Nonshrink epoxy grouts shall be delivered as premeasured, prepackaged, three-component systems requiring only blending as directed by the manufacturer.

1.06 QUALIFICATIONS

- A. The grout manufacturer shall have a minimum of 10 years of experience in the production and use of the type of grout proposed for the work.

1.07 DEFINITIONS

- A. Nonshrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state, and bonds to a clean base plate.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and product or catalog number is to establish the standard of quality desired.
- B. To standardize appearance, like materials shall be the products of one manufacturer or supplier.

2.02 MATERIALS

- A. Nonshrink Cementitious Grout
 - 1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107/C1107M, Grades B or C and CRD C-621. Grouts shall be Portland-cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents, and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827/C827M.
 - a. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Set Grout by Master Builders, Inc.; Gilco Construction Grout by Gifford Hill & Co.; Euco NS by The Euclid Chemical Co.; NBEC Grout by U. S. Grout Corp.; or equal.
 - b. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders, Inc.; Hi Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Supreme Grout by Gifford Hill & Co.; Five Star Grout by U. S. Grout Corp.; or equal.
- B. Nonshrink Epoxy Grout
 - 1. Nonshrink epoxy-based grout shall be a pre-proportioned, three-component, 100% solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in

7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30×10^{-6} when tested in conformity with ASTM C531. The grout shall be Ceilcote 648 CP by Master Builders Inc.; Five Star Epoxy Grout by US Grout Corp.; Sikadur 42 Grout Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co.; or equal.

C. Cement Grout

1. Cement grouts shall be a mixture of 1 part Portland cement conforming to ASTM C150/C150M, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33/C33M with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout

1. Concrete grout shall conform to the requirements of Section 03300, Cast-In-Place Concrete, except as specified in this Section. It shall be proportioned with cement, coarse and fine aggregates, water, water reducer, and an air-entraining agent to produce a mix having an average strength of 2,900 psi at 28 days, or 2,500 psi nominal strength. Coarse aggregate size shall be 3/8 inch maximum. Slump should not exceed 5 inches and should be as low as practical yet still retain sufficient workability.
2. Synthetic reinforcing fibers as specified in Section 03200, Concrete Reinforcement, shall be added to the concrete grout mix at the rate of 1.5 pounds of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

E. Water

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

- A. Grout shall be placed over cured concrete which has attained its full design strength unless otherwise approved by the Engineer.

- B. Concrete surfaces to receive grout shall be clean and sound, free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints, and free of all loose material or foreign matter which may affect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance, and firmly embedded into the parent concrete.
 - 1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.
- D. Remove all loose rust, oil, or other deleterious substances from metal embedments or bottom of baseplates before installing the grout.
- E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours before the placing of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, using a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24-hour period, visible water shall be removed from the surface before grouting. An adhesive bonding agent should only be used in lieu of surface saturation when approved by the Engineer for each specific location of grout installation.
- F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- G. Construct grout forms or other leak-proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place, and shored to resist the forces imposed by the grout and its placement.
 - 1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- H. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks, or other approved means. The shims, wedges, and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.02 INSTALLATION—GENERAL

- A. The Contractor shall mix, apply, and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90°F during grouting and for at least 24 hours after or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.
- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90°F range.
- E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or contraction joint.
- F. Reflect all existing underlying expansion, contraction, and construction joints through the grout.

3.03 INSTALLATION—CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

- A. Mix in accordance with the manufacturer's recommendations. Do not add cement, sand, pea gravel, or admixtures without prior approval by the Engineer.
- B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
- C. Placements greater than 3 inches deep shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.

- D. Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45° angle from the lower edge of the bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.
- G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding, or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION—NONSHRINK EPOXY GROUTS

- A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Mix full batches only to maintain proper proportions of resin, hardener, and aggregate.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90°F.
- C. Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

- F. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.05 INSTALLATION—CONCRETE GROUT

- A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of concrete grout.
- B. Remove the debris and clean the surface by sweeping and vacuuming all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing debris into tank drain lines will not be permitted.
- C. Saturate the concrete surface for at least 24 hours before placing the concrete grout. Saturation may be maintained by ponding, by the use of soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just before placing the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16- to 1/8-inch-thick cement paste.
- D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure that high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.
- E. Provide grout contraction joints as indicated on the Drawings.
- F. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.06 SCHEDULE

- A. The following list indicates where the particular types of grout are to be used:
 - 1. General purpose nonshrink cementitious grout: Use at all locations where nonshrink grout is called for on the plans except for base plates greater than 3 feet wide by 3 feet long and, except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.
 - 2. Flowable nonshrink cementitious grout: Use under all base plates greater in area than 3 feet by 3 feet. Use at all locations indicated to receive flowable nonshrink grout by the Drawings. The Contractor, at his/her

option and convenience, may also substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.

3. Nonshrink epoxy grout: Use for setting anchor rods, anchor bolts, and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.
4. Cement grout: Cement grout may be used for grouting incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting primary structural steel members such as columns and girders.
5. Concrete grout: Use for overlaying the base concrete under scraper mechanisms of clarifiers to allow more control in placing the surface grade.

END OF SECTION

DIVISION 5

METALS

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes the following:
 - 1. Miscellaneous framing and supports.
 - 2. Gratings.
 - 3. Access hatches.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Product Data: For the following:
 - 1. Non-slip aggregates and non-slip-aggregate surface finishes.
 - 2. Prefabricated building columns.
 - 3. Metal nosings and treads.
 - 4. Paint products.
 - 5. Grout.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 2. Provide templates for anchors and bolts specified for installation under other sections.
 - 3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Verification: For each type and finish of extruded nosing.

- D. Mill Certificates: Signed by the manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
- E. Welding certificates.
- F. Qualification Data: Florida Professional Engineering Registration certificate.

1.03 WORK SEQUENCE

- A. The Contractor shall coordinate the installation of anchorages for metal fabrications. 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 the Project site in time for installation.
- B. The Contractor shall coordinate the installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another section. Deliver such items to the Project site in time for installation.

1.04 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be in accordance with the currently effective Florida Building Code (FBC). The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American National Standards Institute (ANSI)
 - 1. ANSI A14.3—Ladders – Fixed – Safety Requirements.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A27/A27M—Standard Specification for Steel Castings, Carbon, for General Application.
 - 2. ASTM A36/A36M—Standard Specification for Carbon Structural Steel.
 - 3. ASTM A47/A47M—Standard Specification for Ferritic Malleable Iron Castings.
 - 4. ASTM A48/A48M—Standard Specification for Gray Iron Castings.
 - 5. ASTM A53/A53M—Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 6. ASTM A123/A123M—Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 7. ASTM A153/A153M—Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

8. ASTM A276/A276M—Standard Specification for Stainless Steel Bars and Shapes.
9. ASTM A307—Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
10. ASTM A489—Standard Specification for Carbon Steel Lifting Eyes.
11. ASTM A500/A500M—Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
12. ASTM A563—Standard Specification for Carbon and Alloy Steel Nuts.
13. ASTM A653/A653M—Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
14. ASTM A666—Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
15. ASTM A780/A780M—Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
16. ASTM A786/A786M—Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
17. ASTM B108/B108M—Standard Specification for Aluminum-Alloy Permanent Mold Castings.
18. ASTM B209—Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
19. ASTM B221—Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
20. ASTM B633—Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
21. ASTM C1107/C1107M—Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
22. ASTM D1187/D1187M—Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
23. ASTM E488/E488M—Standard Test Methods for Strength of Anchors in Concrete Elements.
24. ASTM F436/F436M—Standard Specification for Hardened Steel Washers.
25. ASTM F593—Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
26. ASTM F594—Standard Specification for Stainless Steel Nuts.
27. ASTM F836M—Standard Specification for Style 1 Stainless Steel Metric Nuts (Metric).
28. ASTM F879—Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.
29. ASTM F1554—Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
30. ASTM F3125/F3125M—Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa)

and 150 ksi (1,040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

C. American Society of Mechanical Engineers (ASME)

1. ASME B18.2.1—Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
2. ASME B18.2.3.8M—Metric Hex Lag Screws.
3. ASME B18.6.1—Wood Screws (Inch Series).
4. ASME B18.6.3—Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series).
5. ASME B18.6.7M—Metric Machine Screws.
6. ASME B18.21.1—Washes: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).
7. ASME B18.21.2M—Lock Washers (Metric Series).
8. ASME B18.22.1—Plain Washers.
9. ASME B18.22M—Metric Plain Washers.

D. American Welding Society (AWS)

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.

E. Environmental Protection Agency (EPA)

1. EPA Method 24—Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings.

F. Federal Regulations (FR)

1. 40 CFR 59—National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

G. National Association of Architectural Metal Manufacturers (NAAMM)

1. NAAMM MBG 531—Metal Bar Grating Manual.

H. Society for Protection Coatings (SSPC)

1. SSPC-PA1—Shop, Field, and Maintenance Painting of Steel.
2. SSPC-SP6/NACE No. 3—Commercial Blast Cleaning.
3. SSPC-SP10/NACE No. 2—Near-White Blast Cleaning.

4. SSPC-Paint 20—Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic).
5. SSPC-Paint 29—Zinc Dust Sacrificial Primer, Performance-Based.
6. SSPC-Zone 1A—Interior, Normally Dry.
7. SSPC-Zone 1B—Exterior, Normally Dry.

1.05 QUALITY ASSURANCE

A. Welding: 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.

1.06 PROJECT REQUIREMENTS

- ### A. Structural Performance of Ladders: The Contractor shall provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- ### B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120°F, ambient; 180°F, material surfaces.

1.07 PROJECT CONDITIONS

A. Field Measurements: The Contractor shall verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on shop drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 Articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include but are not limited to products specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.
 - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to manufacturers specified.
 - 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.03 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
 - 1. Unless noted otherwise, steel that is not stainless steel shall be galvanized with a G90 coating conforming to ASTM A123/A123M.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 316L.
- C. Stainless-Steel Bars and Shapes: ASTM A276/A276M, Type 316L.
- D. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- E. Steel Pipe: ASTM A53/A53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.04 ALUMINUM ALLOY PRODUCTS

- A. Aluminum Sheet Plates: Conforming to ASTM B209.

- B. Aluminum Extrusions: Conforming to ASTM B221.
- C. Aluminum Castings: Conforming to ASTM B108/B108M.

2.05 FASTENERS

- A. General: For all exterior applications and where fastening aluminum, provide Type 304 stainless-steel fasteners. Provide hot-dipped galvanized fasteners in all other applications in accordance with ASTM A153/A153M unless noted otherwise on the Drawings. Select fasteners for type, grade, and class required.
- B. High-Strength Bolts and Nuts: ASTM F3125/F3125M with heavy hex nuts ASTM A563 and hardened carbon-steel washers ASTM F436/F486M.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.
- D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group A4.
- E. Stainless Steel Socket Button and Flat Countersunk Head Cap Screws: ASTM F879.
- F. Anchor Bolts: ASTM F 1554, Grade 36.
- G. Eyebolts: ASTM A489.
- H. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
- I. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- J. Wood Screws: Flat head, ASME B18.6.1.
- K. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
- L. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).

- M. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining without failure a load equal to four times the load imposed, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized in accordance with ASTM A153/A153M.
- N. Expansion Anchors: Anchor bolt and sleeve assembly with ability to sustain, 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 E488/E488M conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633, Class Fe/Zn 5.
 - 2. Material for Anchors in Exterior Locations: Alloy Group (A4) stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594 (ASTM F836M).

2.06 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 9, Finishes.
- C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
 - 1. Use primer with a VOC content of 3.5 pounds/gallon or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Available Products:
 - a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.
 - b. Carboline Company; Carbozinc 621.
 - c. ICI Devoe Coatings; Catha-Coat 313.
 - d. International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.
 - e. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.

- f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.
 - g. Tnemec Company, Inc.; Tneme-Zinc 90-97.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- F. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C1107/C1107M, specifically recommended by the manufacturer for heavy-duty loading applications.
- G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

2.07 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to the greatest extent possible. 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 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.
- C. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work true to line and level with accurate angles, surfaces, and straight edges.
- E. Weld corners and seams continuously 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather so as to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of the type indicated and coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
 1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 inch by 1-1/2 inches with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.08 GRATINGS

Design floor gratings to withstand a live load of 250 pounds per square foot for the span indicated, with a maximum deflection of $L/240$.

- A. Gray Cast Iron-Gratings: Conforming to ASTM A48/A48M.
- B. Metal Plank Gratings: Non-slip type, aluminum conforming to ASTM B209, 6061 T6, and steel conforming to ASTM A653/A653M, G90 galvanized.
- C. Metal Bar Gratings: Conforming to NAAMM MBG 531.

2.09 ACCESS HATCHES

- A. Access hatches shall have single- or double-leaf doors as indicated in the design drawing. The door shall be 1/4-inch aluminum diamond pattern plate with welded stiffeners able to withstand a live load of 300 pounds per square foot with a maximum deflection of $L/240$. The hatch shall have a 1/4-inch aluminum channel frame with perimeter anchor flange or strap anchors for concrete embedment.

Hardware shall be of stainless steel throughout. Provide removable lock handle. Hatch shall be watertight and have a 1-1/2-inch drainage coupling to the channel frame.

2.10 MISCELLANEOUS METAL FABRICATIONS

A. Miscellaneous Framing and Supports:

1. Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.
2. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
3. Galvanize miscellaneous framing and supports in all locations.

2.11 FINISHES, GENERAL

- A. Comply with NAAMM's *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.12 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 1. ASTM A123/A123M, for galvanizing steel and iron products.
 2. ASTM A153/A153M, for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Interiors (SSPC Zone 1A): SSPC-SP 10 "Near White Metal Blast Cleaning."
- C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete,

sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, *Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel*, for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.13 STAINLESS STEEL FINISHES

- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Dull Satin Finish: No. 6.
- C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. 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.

3.02 ADJUSTING AND CLEANING

The Contractor shall do the following:

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9, Finishes.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09900
PAINTING AND COATING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes materials for and application of painting and coating systems for the following surfaces:
 - 1. Submerged metal.
 - 2. Exposed metal.
 - 3. Buried metal.
 - 4. Concrete and masonry.
 - 5. Polyvinyl Chloride (PVC).
 - 6. Metal in contact with concrete.
 - 7. Exterior architectural coatings and finishes.
- B. It does not include coating steel water tanks and reservoirs.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. Submit manufacturer's data sheets showing the following information:
 - 1. Percent solids by volume (sbv).
 - 2. Minimum and maximum recommended dry-film thickness per coat for prime, intermediate, and finish coats.
 - 3. Recommended surface preparation.
 - 4. Recommended thinners.
 - 5. Statement verifying that the specified prime coat is recommended by the manufacturer for use with the specified intermediate and finish coats.
 - 6. Application instructions including recommended equipment and temperature limitations.
 - 7. Curing requirements and instructions.
- C. Submit color swatches.
- D. Submit certificate identifying the type and gradation of abrasives used for surface preparation.

- E. Submit material safety data sheets for each coating.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM A780/A780M—Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
2. ASTM C501—Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
3. ASTM D520—Standard Specification for Zinc Dust Pigment.
4. ASTM D522/D522M—Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
5. ASTM D1002—Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal).
6. ASTM D2240—Standard Test Method for Rubber Property—Durometer Hardness.
7. ASTM D2697—Standard Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings.
8. ASTM D2794—Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
9. ASTM D3734—Standard Specification for High-Flash Aromatic Naphthas.
10. ASTM D4060—Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
11. ASTM D4138—Standard Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means.
12. ASTM D4258—Standard Practice for Surface Cleaning Concrete for Coating.
13. ASTM D4260—Standard Practice for Liquid and Gelled Acid Etching of Concrete.
14. ASTM D4261—Standard Practice for Surface Cleaning Concrete Masonry Units for Coating.
15. ASTM D4263—Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
16. ASTM D4787—Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.

17. ASTM D6386—Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
 18. ASTM D7091—Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
 19. ASTM E84—Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. American Water Works Association (AWWA)
1. AWWA C203—Coal-Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied.
 2. AWWA C209—Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections, and Fittings.
- C. International Concrete Repair Institute (ICRI)
1. ICRI CSP 3-5—Light to Medium-Heavy Shotblast.
 2. ICRI CSP 5—Medium-Heavy Shotblast.
- D. National Association of Corrosion Engineers International (NACE)
1. NACE SP0188—Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
- E. NSF International (NSF)
1. NSF 61—Drinking Water System Components – Health Effects.
- F. Steel Structure Painting Council (SSPC)
1. SSPC PA-1—Shop, Field, and Maintenance Painting of Steel.
 2. SSPC PA-2—Procedure for Determining Conformance to Dry Coating Thickness Requirements.
 3. SSPC SP-1—Solvent Cleaning.
 4. SSPC SP-2—Hand Tool Cleaning.
 5. SSPC SP-3—Power Tool Cleaning.
 6. SSPC SP-5/NACE No. 1—White Metal Blast Cleaning.
 7. SSPC SP-6/NACE No. 3—Commercial Blast Cleaning.
 8. SSPC SP-7/NACE No. 4—Brush-Off Blast Cleaning.
 9. SSPC SP-8—Pickling.
 10. SSPC SP-10/NACE No. 2—Near-White Blast Cleaning.

11. SSPC SP-11—Power Tool Cleaning to Bare Metal.
12. SSPC SP-13—Surface Preparation of Concrete.
13. SSPC SP WJ-1—Waterjet Cleaning of Metals – Clean to Bare Substrate.
14. SSPC SP WJ-2—Waterjet Cleaning of Metals – Very Thorough Cleaning.
15. SSPC SP WJ-3—Waterjet Cleaning of Metals – Thorough Cleaning.
16. SSPC SP WJ-4—Waterjet Cleaning of Metals – Light Cleaning.

G. U.S. Department of Defense (MIL)

1. MIL-C-5541—Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
2. MIL-C-18480B—Coating Compound, Bituminous, Solvent, Coal-Tar Base.
3. MIL-DTL-24441—General Specification for Paint, Epoxy-Polyamide.
4. MIL-P-21035—Paint High Zinc Dust Content, Galvanizing Repair.

PART 2 MATERIALS

2.01 PAINTING AND COATING SYSTEMS

The following index lists the various painting and coating systems by service and generic type:

PAINT COATINGS SYSTEM INDEX		
No.	Title	Generic Coating
Submerged Metal Coating Systems		
1.	Submerged Metal, Raw Water (Nonpotable) or Raw Sewage	
2.	Submerged Metal, Raw Water (Nonpotable), Raw Sewage, or Chemical Waste Immersion	
3.	Submerged Metal, Raw Water (Nonpotable) or Raw Sewage	Urethane
4.	Submerged Metal, Raw Sewage or Raw Water (Nonpotable)	Polyurethane
7.	Submerged Metal, Potable or Nonpotable Water	Epoxy
Exposed or Submerged Metal Coating Systems		
8.	Exposed or Submerged Metal	Phenolic epoxy
Exposed Metal Coating Systems		
10.	Exposed Metal, Corrosive Environment	High-build epoxy (two-coat system)
11.	Exposed Metal, Corrosive Environment	Epoxy (four-coat system)
12.	Exposed Metal, Corrosive Environment	Epoxy (three-coat system)
13.	Exposed Metal, Corrosive Environment	Epoxy with urethane topcoat
14.	Exposed Metal, Atmospheric Environment	Urethane
15.	Exposed Metal, Atmospheric Weathering Environment	Acrylic

PAINT COATINGS SYSTEM INDEX		
No.	Title	Generic Coating
18.	Exposed Metal, Organic Zinc Primer for Shop Coating and Field Touch-Up	Organic zinc
19.	Exposed/Immersed Metal	Epoxy
Buried Metal Coating Systems		
21.	Buried Metal	Epoxy
22.	Buried Metal	Polyurethane
23.	Buried Metal	Thixotropic coal-tar pitch
24.	Buried Metal	Corrosion-resisting grease
25.	Buried Metal Piping and Tubing	Coal-tar, wax, and polyethylene tape wrap or extruded polyethylene
Concrete and Masonry Coating Systems		
31.	Exposed Concrete and Masonry, Corrosive Environment	Epoxy
31A.	Exposed Concrete and Masonry, Anti-Graffiti Coating	Epoxy with polyurethane topcoat
31B.	Exposed Concrete and Masonry, Anti-Graffiti Coating	Modified wax emulsion
32.	Exposed Concrete and Masonry, Atmospheric Weathering Environment	Acrylic
33.	Submerged Concrete, Raw Water or Raw Sewage	Vinyl ester
34.	Concrete Floors, Wet Environment	Epoxy
36.	Exposed Concrete and Masonry, Corrosive Environment	High-build epoxy with polyurethane topcoat
37.	Exposed Masonry or Concrete, Atmospheric Weathering Environment	Cement-based grouting
PVC Coating Systems		
41.	PVC, Ultraviolet Exposure, or Color Coding	Polyurethane
42.	PVC, Ultraviolet Exposure, or Color Coding	Acrylic latex
Coating Systems for Miscellaneous Metals		
51.	Insulate Aluminum (Insulation) from Concrete and Carbon Steel	Bituminous
52.	Exposed Metal, Galvanized Steel and Aluminum	Synthetic resin
53.	Coating for Thermally Sprayed Aluminum and Zinc Coatings	Epoxy
54.	Aluminum Insulation from Concrete and Carbon Steel	Epoxy
55.	Repair of Galvanized Steel Surfaces	Cold galvanizing compound
Exterior Architectural Coatings and Finishes		
71.	Flat Finish on Exterior Concrete and Cement Plaster	Acrylic latex
73.	Clear Sealer on Exterior Concrete and Masonry	Silane

These systems are specified in detail in the following paragraphs. For each coating, the required surface preparation, prime coat, intermediate coat (if required), topcoat, and coating thicknesses are described. Mil thicknesses shown are minimum dry-film thicknesses.

A. Submerged Metal Coating Systems

1. System No. 1—Submerged Metal—Raw Water (Nonpotable) or Raw Sewage:
 - a. Type: Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat with a minimum 71% sbv.
 - b. Service Conditions: For use with metal pipes or structures (such as scum troughs, sluice gates, or piping) alternately submerged in raw sewage or raw water (nonpotable) and exposed to a moist saturated hydrogen sulfide atmosphere, as in raw sewage wet wells. Minimum temperature resistance of the coating shall be 140°F for moist heat conditions.
 - c. Surface Preparation: Average blast profile to be 1.5 to 2.5 mils. Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Prime Coat: ICI Devoe Bar-Rust 233H, 8 mils; Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat; Sherwin Williams Tank Clad HSB62-80 Series/B60V80 Series at 5.0 to 8.0 mils DFT.
 - e. Finish Coat: ICI Devoe Bar-Rust 233H, 8 mils; Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat; Sherwin Williams Tank Clad HS B62-80 Series/B60V80 Series at 5.0 to 8.0 mils DFT.
2. System No. 2—Submerged Metal, Raw Water (Nonpotable) Raw Sewage, or Chemical Waste Immersion:
 - a. Type: Polyamide-cured epoxy prime, intermediate, and finish coats. Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat and with a minimum 71% sbv.
 - b. Service Conditions: For use with metal pipes or structures (such as tanks, clarifier mechanisms, scum troughs, slide gates) immersed in raw water (nonpotable), raw sewage, or alkaline wastes or acidic wastes having a pH range of 5 to 11.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.

- d. Prime Coat: Ameron 400, 7 mils; Devoe Bar-Rust 233H, 7 mils; Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat at 6.0 to 8.0 mils; International Interline 785HS, 5 mils; Carboline 890, 5 mils; PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series, 5 mils; or equal. Sherwin Williams Macropoxy 646 B58-600 Series/B58VX600 at 5.0 to 10.0 mils DFT.
 - e. Intermediate/Finish Coats: One coat of Ameron 400, 8 mils; Devoe Bar-Rust 233H, 8 mils; Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat; two coats of International Interline 785HS, 5 mils per coat; two coats of Carboline 890, 5 mils per coat; two coats of PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series, 5 mils dry-film thickness per coat; Sherwin Williams Macropoxy 646 B58-600 Series/B58VX600 at 5.0 to 10.0 mils DFT; or equal.
 - f. Total system thickness of prime, intermediate, and finish coats shall be 15 mils minimum.
3. System No. 3—Submerged Metal, Raw Water (Nonpotable) or Raw Sewage:
- a. Type: Tnemec Series 446 Perma-Shield MCU, Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat with a minimum 71% sbv.
 - b. Service Conditions: For use with metal pipes or structures (such as scum troughs, sluice gates, clarifier mechanisms, or piping) continuously submerged in raw water or raw sewage having a pH of 3.5 to 11 or alternately immersed in raw water or raw sewage and exposed to a moist saturated hydrogen sulfide atmosphere as in raw sewage wet wells.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface; abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Prime Coat: Single-component, zinc-rich, moisture-cured urethane having a minimum zinc content of 80% in the dry film. Apply one coat of Wasser MC-Zinc or Sherwin-Williams Corothane I Galva Pac Zinc Primer B65G11 at 3.0 to 4.0 mils DFT; Tnemec Series 1 modified aromatic polyurethane primer containing a proprietary blend of micaceous iron oxide (MIO) and zinc. Can be used as a shop or field primer. Apply at 2.5 to 4.0 mils DFT.
 - e. Finish Coats: Coal tar epoxies are not acceptable. Apply two coats of Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat; equal by Sherwin Williams Macropoxy 646 B58-600 Series/B58VX600 at 5.0 to 10.0 mils DFT.

4. System No. 4—Submerged Metal—Raw Water (Nonpotable) or Raw Sewage:
 - a. Type: Tnemec Series 446 Perma-Shield MCU, Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat with a minimum 71% sbv.
 - b. Service Conditions: For use with metal pipes or structures (such as scum troughs, sluice gates, clarifier mechanisms) immersed in raw water (nonpotable) or raw sewage.
 - c. Surface Preparation: SSPC SP-10/NACE No. 2. Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Prime Coat: ICI Devoe Bar-Rust 233H, 8 mils; Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat; Sherwin Williams Tank Clad HSB62-80 Series/B60V80 Series at 5.0 to 8.0 mils DFT.
 - e. Finish Coat: ICI Devoe Bar-Rust 233H, 8 mils; Tnemec Series 446 Perma-Shield MCU Modified Aromatic Polyurethane at 8.0 to 10.0 mils per coat; Sherwin Williams Tank Clad HS B62-80 Series/B60V80 Series at 5.0 to 8.0 mils DFT.
5. System No. 7—Submerged Metal, Potable or Nonpotable Water:
 - a. Type: Epoxy: 100% sbv Polyamine Epoxy with near “0” VOC.
 - b. Service Conditions: For use with structures, valves, piping, or equipment immersed in potable or nonpotable water.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Coating System: Apply the manufacturer’s recommended number of coats to attain the specified minimum coating thickness. Products: Devoe Bar-Rust 233H; Tnemec N140; Sherwin-Williams Tank Clad HS B62-80 Series/B60V80; PPG AQUAPON® LT NSF Low Temperature Epoxy Coatings 95-172; Carboline Super Hi-Gard 891; Ameron 395; International Interline 785HS; Wisconsin Protective Coating Corp. Plasite 7133 or 9133, Keysite 740, Scotchkote 306, or equal; at least 16 mils total. Color of topcoat: white. Each coat shall be a different color than the one preceding it. Tnemec Series N140 Pota-Pox Plus Polyamidoamine epoxy at 6.0 to 8.0 mils/coat. Apply two coats. Total system should not exceed 17 mils.

B. Exposed or Submerged Metal Coating Systems

1. System No. 8—Exposed or Submerged Metal:

- a. Type: Baked, thermosetting, phenolic epoxy.
- b. Service Conditions: For use with metal immersed in raw sewage or raw water (such as the interior of pulsation dampeners and water softeners) and with metal exposed to moist hydrogen sulfide gas (such as the impellers and casing interiors of centrifugal blowers) having a maximum continuous temperature of 400°F
- c. Surface Preparation: SSPC SP-5/NACE No. 1.
- d. Coating System: Apply at least four coats (including prime coat) of Heresite P-403 to a minimum dry-film thickness of 1.0 to 1.5 mils per coat, at least two coats of Devoe Devchem 550 to a minimum dry-film thickness of 2.5 mils per coat, or at least three coats of Plasite 3070 or 3070L to a minimum dry-film thickness of 1.5 to 2.0 mils per coat. Total minimum dry-film thickness shall be 5 mils.

C. Exposed Metal Coating Systems

1. System No. 10—Exposed Metal, Corrosive Environment:

- a. Type: High-build epoxy intermediate coat having a minimum volume solids of 60%, with an inorganic zinc prime coat
- b. Service Conditions: For use with metal structures or pipes subjected to water condensation, chemical fumes such as hydrogen sulfide, salt spray, and chemical contact.
- c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
- d. Prime Coat: Self-curing, two-component inorganic zinc-rich coating recommended by the manufacturer for overcoating with a high-build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of 3 mils. Products: Tnemec Series 90-97; Devoe Catha-Coat 304 or 304V; International Interzinc 180HS; Ameron 9HS; Carboline 11 HS; Sherwin-Williams Zinc-Clad II Plus, B69VZ12/B69VZ13/B69D11 at 2.5 to 4.0 mils DFT; PPG METALHIDE® 28 Inorganic Zinc-Rich Primer 97-672, or equal.
- e. Intermediate Coat: Tnemec Series 104; ICI Devoe Devran 224 HS; International Interguard 760HS; Ameron 385; Carboline 888 or 890; Sherwin-Williams Macropoxy 646 B58-600/B58V600 at 4.0 to 8.0 mils DFT; PPG PITT-GUARD®

Direct-to-Rust Epoxy Mastic Coating 97-145 Series, or equal; 5 mils. Film thickness 5.0 to 8.0 mils/coat. Minimum sbv should be 82%.

- f. Finish Coat: Two-component pigmented acrylic or aliphatic polyurethane, minimum 70% sbv recommended by the manufacturer for overcoating a high-build epoxy coating. Apply to a thickness of at least 2 mils. Products: Tnemec Series 1075; ICI Devoe Devthane 379; International Interline 990HS; Ameron 450 HS; Carboline 134 HG; Sherwin-Williams Hi-Solids Polyurethane B65-300 Series/B60V30 at 2.5 to 4.0 mils DFT; PPG PITTHANE® Ultra-Gloss Urethane Enamel 95-812 Series; or equal.

2. System No. 11—Exposed Metal, Corrosive Environment:

- a. Type: Polyamidoamine Epoxy finish and intermediate coat and primer as Aromatic urethane zinc rich coating. Minimum sbv is 70%.
- b. Service Conditions: For use with metal structures or pipes subjected to water condensation or splashing, salt spray, chemical fumes such as hydrogen sulfide, and chemical contact.
- c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
- d. Prime Coat: Two-component inorganic zinc pigmented coating recommended by the manufacturer to be coated with polyamide epoxy paint finish coating. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of 3 mils. Products: Tnemec 90-97, a two-package aromatic zinc rich polyurethane; ICI Devoe Catha-Coat 304 or 304V; International Interzinc 180HS; Ameron 9 HS; Carboline 11 HS; Sherwin-Williams Zinc-Clad II Plus, B69VZ13/B69VZ13/B69D11 at 2.5 to 4.0 mils; DFT PPG METALHIDE® 28 Inorganic Zinc-Rich Primer 97-672; or equal.
- e. Intermediate Coat: Apply to a thickness of 4.0 to 6.0 mils. Products: Tnemec N69; ICI Devoe Devran 224 HS; International Interguard 760HS; Ameron 385; Carboline 888 or 893; Sherwin-Williams Macropoxy 646 B58-600/B58V600 at 4.0 to 8.0 mils DFT; PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series; or equal.
- f. Finish Coats: Apply two coats to a thickness of 4.0 to 6.0 mils each. Products: Apply only one coat of Tnemec N69; ICI Devoe Devran 224 HS; International Interguard 760HS; Ameron 385; Carboline 890; Sherwin-Williams Macropoxy 646 B58-600; PPG

PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating
97-145 Series; or equal.

3. System No. 12—Exposed Metal, Corrosive Environment:
 - a. Type: Gloss polyamidoamine epoxy having a minimum volume solids content of 67% with epoxy prime coat.
 - b. Service Conditions: For use with metal structures or pipes subjected to water condensation and chemical fumes, such as hydrogen sulfide.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Prime Coat: Polyamide-cured epoxy primer having minimum volume solids content of 67% (ASTM D2697). Products: Carboline 893; ICI Devoe Devran 224 HS; Tnemec N69; International Interguard 750HS; Ameron 385; Sherwin-Williams Macropoxy 646 B58-600/B58V600 at 4.0 to 8.0; PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series; or equal. Apply to a minimum dry-film thickness of 4.0 to 6.0 mils.
 - e. Finish Coat: Two coats of Carboline 890 or 893; two coats of ICI Devoe Devran 224 HS; two coats Tnemec N69; two coats of International Interguard 760HS; two coats of Ameron 385; two coats of Sherwin-Williams Macropoxy 646 B58-600/B58V600 at 4.0 to 8.0 mils DFT/coat; two coats of PPG Tile-8™ Gloss Epoxy 95-674; or equal. Apply to a thickness of 4.0 to 6.0 mils per coat.
4. System No. 13—Exposed Metal, Corrosive Environment:
 - a. Type: High-build self-priming Cycloaliphatic Amine epoxy minimum 82% sbv prime coat with a pigmented high-build aliphatic with a minimum 71% sbv.
 - b. Service Conditions: For use with metal structures or pipes subjected to water condensation, chemical fumes such as hydrogen sulfide, salt spray, and chemical contact.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Prime Coat: Two-component high-build epoxy. Apply to a thickness of 8 mils. Products: Ameron 400; ICI Devoe 235; Tnemec Series 104; International Interseal 670HS; Carboline 890LT; Sherwin-Williams Macropoxy 646

- B58-600/B58V600 at 4.0 to 8.0 mils DFT; PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series; or equal.
- e. Finish Coat: Two-component pigmented high-build Aliphatic Acrylic polyurethane. Apply one or more coats to a total thickness of 5 mils. Products: Ameron “Amershield”; ICI Devco Devthane 359; Tnemec Series 1075; International Interthane 990HS; Carboline 133 HB; Sherwin-Williams Hi-Solids Polyurethane B65-300 Series/B60V30 at 2.5 to 4.0 mils DFT/coat; PPG PITTHANE® Ultra Gloss Urethane Enamel 95-812 Series; or equal.

5. System No. 14—Exposed Metal, Atmospheric Environment:

- a. Type: Single component, moisture-cured urethane having a minimum volume solids of 61%, with a zinc-rich primer and a moisture cured aliphatic acrylic urethane topcoat.
- b. Service Conditions: For use with exposed metal structures or piping subjected to continuous water condensation.
- c. Prime Coat: Single-component, zinc-rich, moisture cured urethane having a minimum zinc content of 80% in the dry film. Apply one coat of Wasser MC-Zinc or Sherwin-Williams Corothane I Galva Pac Zinc Primer B65A11 at 3.0 to 4.0 mils DFT to a minimum thickness of 3 mils. Tnemec Series 1 Aromatic Polyurethane primer.
- d. Intermediate Coats: Apply one coat of Wasser MC-Ferrox B or Sherwin-Williams Corothane I Ironox B B65A11 at 3.0 to 5.0 mils DFT and one coat of Wasser MC-CR or Sherwin-Williams Corothane I MIO-Aluminum B65S14 at 2.0 to 3.0 mils DFT to a minimum dry-film thickness of 4 mils per coat. Color of first coat: brown/gray. Color of second coat: white. Apply two coats of Wasser MC-CR to a minimum dry-film thickness of 4 mils per coat. Color of first coat: red oxide. Color of second coat: white.
- e. Finish Coat: Single-component, moisture-cured, aliphatic urethane having a minimum volume solids of 50%. Apply one coat of Wasser MC-Shieldcoat or Sherwin-Williams Aliphatic, B65-10 Series at 2.5 to 3.5 mils DFT. Ferrox A to a minimum thickness of 3 mils. Tnemec Series 1074 or Tnemec Series 1075, catalyzed Aliphatic Acrylic polyurethane.

6. System No. 15—Exposed Metal, Atmospheric Weathering Environment:

- a. Type: Gloss alkyd enamel having a minimum volume solids content of 46% with alkyd primer.

- b. Service Conditions: For use on exterior metal and piping subject to sunlight and weathering.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-6/NACE No. 3.
 - d. Prime Coat: Carboline Shop Primer No. 1; ICI Devoe 4140; Ameron 5105; International Interlac 260HS; Sherwin-Williams Kem-Bond HS B50NZ Series at 2.0 to 4.0 mils DFT; PPG SPEEDHIDE® Int/Ext Rust Inhibitive Steel Primer 6-208 Series; or equal, applied to minimum dry-film thickness of 2 mils. Tnemec Series 10 primer at 2.0 to 3.5 mils DFT with 56% sbv.
 - e. Finish Coat: Two coats of Carboline Carbocoat 139; two coats of ICI Devoe 4348; two coats of Tnemec Series 2H; two coats of Ameron 5401 HS; two coats of International Interlac 820; two coats of Sherwin-Williams Industrial Enamel B54Z Series at 2.0 to 3.0 mils DFT/coat; two coats of PPG MetalMax Int/Ext Gloss Alkyd 7-914 Series, or equal. Apply to a minimum dry-film thickness of 1.5 to 3.5 mils DFT/coat.
7. System No. 18—Exposed Metal Organic Zinc Primer for Shop Coating and Field Touch-Up:
- a. Type: Organic zinc primer having a minimum zinc content of 14 pounds per gallon.
 - b. Service Conditions: For use as a shop-applied primer or field touch-up primer over inorganic zinc prime coatings on exposed metal.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Coating: Coating shall be of the two- or three-component converted epoxy, epoxy phenolic, or urethane type. Products: Tnemec 90-97; International Interzinc 308; Ameron 68HS; ICI Devoe 313; Carboline 859; Sherwin-Williams Zinc-Clad III HS B69A100/B69D11/B69D11 at 3.0 to 5.0 mils DFT; PPG Durethane™ MCZ 97-679; or equal. Applied to a minimum dry-film thickness of 3 mils. Organic zinc primer shall be manufactured by the prime coat manufacturer.
8. System No. 19—Exposed/Immersed Metal:
- a. Type: Cycloaliphatic Amine Epoxy with a minimum sbv of 82%.

- b. Service Conditions: For use with metal (steel, iron) such as canal gates, slide gates, and dam gates alternately immersed in raw water and exposed to an atmospheric weathering environment.
- c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
- d. Prime Coat: Apply Ameron 90 (gray); International Interline 785HS (aqua); ICI Devoe 235 (gray); Tnemec Series 104; Carboline 890 (gray); Sherwin-Williams Macropoxy 646 B58-600 Series/B58V600 at 4.0 to 8.0 mils DFT (gray); PPG PITT-GUARD® All Weather Direct-to-Rust 97-948 (gray); or equal, to a minimum dry-film thickness of 5 mils.
- e. Finish Coat: Apply Ameron 90 (white); International Interline 785HS (white); ICI Devoe 235 (white); Tnemec Series 104; Carboline 890 (white); Sherwin-Williams Macropoxy 646 B58-600 Series/B58V600 at 4.0 to 8.0 mils DFT (white); PPG PITT-GUARD® All Weather Direct-to-Rust 97-946 (white); or equal, to a minimum dry-film thickness of 5 mils.

D. Buried Metal Coating Systems

1. System No. 21—Buried Metal:

- a. Type: High solids Cycloaliphatic Amine epoxy or phenolic epoxy having minimum volume solids of 80% (ASTM D2697).
- b. Service Conditions: Buried metal, such as valves, flanges, bolts, nuts, structural steel, and fittings.
- c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
- d. Coating System: Apply three or more coats of Ameron 400; Tnemec 104 HS (6.0 to 8.0 mils per coat); ICI Devoe Bar-Rust 233H; Carboline 890LT; Sherwin-Williams Tank Clad HS B62-80 Series/B60V80 Series at 5.0 to 8.0 mils/coat or equal; 30 mils total. Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

2. System No. 22—Buried Metal:

- a. Type: Two-component polyurethane having the following characteristics:
 - (1) Coatings shall contain no tar or hydrocarbon additives or solvent.

- (2) Hardness (ASTM D2240, Shore “D”): 65 to 85.
 - (3) Abrasion Resistance (ASTM D4060, Taber CS-17): 25 mg (maximum) loss per 1,000 cycles or a maximum loss of 65 mg in accordance with ASTM C501.
 - b. Service Conditions: Buried metal, such as valves, flanges, bolts, nuts, structural steel, and fittings.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Coating System: Madison Chemical Industries, Inc., Corrocote II TX or Futura Coatings, Inc., Futura-Thane 527, Corrocote Plus (CM), or equal. Apply to a total thickness of 40 to 100 mils. Tnemec Series 400 Elasto-Shield FC polyurea Elastomer at 40 to 100 mils total DFT.
3. System No. 23—Buried Metal:
- a. Type: Thixotropic, coal-tar pitch having minimum volume solids of 68% and complying with MIL-C-18480B.
 - b. Service Conditions: Buried metal, such as flanges, nuts and bolts, fittings, and structural steel especially subjected to corrosive conditions such as acidic groundwater.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP-10/NACE No. 2.
 - d. Prime Coat: Not required.
 - e. Finish Coat: Apply two coats of Carboline Bitumastic 50, 15 mils each; two or more coats of Tnemec 46-465, to a total thickness of 30 mils; or equal. Apply two to three coats.
4. System No. 24—Buried Metal:
- a. Type: Corrosion-resisting grease.
 - b. Service Conditions: Buried metal, such as bolts, bolt threads, tie rods, and nuts.
 - c. Surface Preparation: Solvent clean in accordance with SSPC SP-1 to remove contaminants from the surface. Power tool clean in accordance with SSPC SP-3 as a minimum. Abrasive blasting in accordance with SSPC SP-6/NACE No. 3 is preferred.
 - d. Coating: NO-OX-ID GG-2 as manufactured by Sanchem, Inc. Apply to a minimum thickness of 1/4 inch.

5. System No. 25—Buried Metal Piping and Tubing:
- a. Type: Cold-applied coal-tar tape, hot-applied coal-tar tape, extruded polyethylene, cold-applied wax tape, or polyethylene tape.
 - b. Service Conditions: Buried ferrous and nonferrous piping and tubing.
 - c. Coat with one of the following systems:
 - (1) Wrap with cold-applied coal-tar tape conforming to AWWA C209. Minimum thickness of tape shall be 35 mils. Apply tape with manufacturer's prime coat. Tape shall be Tapecoat CT, Protecto-Wrap 200, or equal.
 - (2) Wrap with hot-applied coal-tar tape conforming to AWWA C203, Section 4.6. Minimum thickness of tape shall be 50 mils. Apply tape with manufacturer's recommended prime coat. Tape shall be Tapecoat 20, Protecto-Wrap 110, or equal.
 - (3) Coat with extruded polyethylene.
 - (4) Wrap with cold-applied wax tape.
 - (5) Wrap with polyethylene tape coating.
 - d. Use chloride-free primers with the above coatings when applying to stainless steel piping or tubing.
 - e. Coat field joints of buried piping that has a shop-applied coating with primer and tape conforming to AWWA C209. Use Type 1 tape of 35-mil thickness. Products: Protection Engineering Co. Protectowrap 200 GT, Tapecoat CT10/40W, Polyken 930-35, or equal.
 - f. Perform electrical inspection of shop and field coating in accordance with Section 5 of AWWA C209.
 - g. Install buried pipes with wrapped coatings by extending the wrapping to the first joint after entering a building, penetrating a slab, or 6 inches above finished grade. Wrap joints spirally with a minimum overlap of 50% of the tape width.

E. Concrete and Masonry Coating Systems

1. System No. 31—Exposed Concrete and Masonry, Corrosive Environment:

- a. Type: Polyamide-cured epoxy having a minimum volume solids of 53%. If the service is splash and spillage then use the existing updated system.
- b. Service Conditions: Concrete and masonry exposed to corrosive atmospheres, such as hydrogen sulfide gas, chlorine gas, or chlorinated effluent sprays in wastewater treatment plants.
- c. Surface Preparation: In accordance with Article 3.04. Clean to an ICRI CSP 5 standard. If using for splash and spillage surface, preparation can be brush off abrasive blasting.
- d. Prime Coat: Epoxy filler compound or epoxy masonry filler having a minimum solids volume of 60%. Apply one coat to fill voids, pores, and cracks. Products: Tnemec 54-660, International Intercryl 320WB, Amerlock 400 BF, ICI Devoe Devran 265 BHF, Sentry 610, Sherwin-Williams Kem Cati-Coat HS B42W400/B42V401 at 10.0 to 20.0 mils DFT, or equal. For surfacing, use Tnemec Series 218 MortarClad applied to 1/4 inch. For greater depressions use Tnemec Series 63-1500 or Tnemec Series 219 MortarCast.
- e. Intermediate Coat: One coat of Tnemec 104 (6.0 to 8.0 mils per coat); International InterGuard 760HS; Amerlock 400; ICI Devoe Bar-Rust 233 H; Carboline 890; Sherwin-Williams Macropoxy 646 B58-600 Series/B58V600 at 5.0 to 8.0 mils DFT; or equal.
- f. Finish Coat: Two coats of Tnemec 104 (use 6.0 to 8.0 mils per coat); International InterGuard 760HS; Amerlock 400; ICI Devoe Bar-Rust 233 H; Carboline 890; Sherwin-Williams Macropoxy 646 B58-600 Series/B58V600 at 4.0 to 8.0 mils DFT; or equal.

2. System No. 31A—Exposed Concrete and Masonry, Antigraffiti Coating:

- a. Type: Two-component aliphatic polyurethane topcoat with epoxy intermediate coat. Minimum volume solids of the polyurethane topcoat shall be 70%. The polyurethane finish coat shall be formulated to have the following characteristics:

Impact resistance
(ASTM D2794) 5 mils

Direct	140 in-lb minimum
Reverse	50 in-lb minimum

Taber abrasion

1 kg load/1,000 cycles	Weight loss:
CS-17 wheel	75 mg maximum
Elongation (ASTM D522/D522M)	32% minimum

- b. Minimum volume solids of the epoxy intermediate coating shall be 80%.
 - c. Service Conditions: Concrete and masonry subjected to spray paint and marker graffiti
 - d. Surface Preparation: In accordance with Article 3.04.
 - e. Prime Coat: Epoxy filler compound or epoxy masonry filler having a minimum solids volume of 60%. Apply one coat to fill voids, pores, and cracks. Products: Ameron Amerlock 400 BF; Tnemec Series 54-660; Sentry 610; or equal. Sherwin Williams Kem Cati-Coat HS Epoxy Filler/Sealer B42W400/B42V401 at 10.0 to 20.0 mils DFT.
 - f. Intermediate Coat: One coat of Ameron 400, Tnemec Series 104, Carboline 890LT, or equal; 6 mils. Sherwin Williams Macropoxy 626 B58-600 Series/B58V600 at 5.0 to 8.0 mils DFT.
 - g. Finish Coat: One coat of Ameron “Amershield”; Tnemec Series 1075; Carboline 134 HG, or equal; 5 mils. Sherwin Williams Hi-Solids Polyurethane B65-300 Series/B60V30 at 3.0 to 4.0 mils DFT.
3. System No. 31B—Exposed Concrete and Masonry, Anti-Graffiti Coating:
- a. Type: Modified wax emulsion that dries to a clear matte film.
 - b. Service Conditions: Concrete and masonry subjected to spray paint and marker graffiti.
 - c. Surface Preparation: Apply clear sealer, System No. 73. Surface must be clean and dry before applying Tnemec Series 626.
 - d. Prime Coat: Clear “Perma Shield” as manufactured by Monopole, Inc., Los Angeles, California, or equal. Apply with a saturating coat allowing for a 4-inch to 6-inch rundown.
 - e. Finish Coat: Clear “Perma Shield” or equal.

4. System No. 32—Exposed Concrete and Masonry, Atmospheric Weathering Environment:
- a. Type: Acrylic enamel or acrylic latex having a minimum volume solids of 36%.
 - b. Service Conditions: Exposed concrete or masonry exposed to normal sunlight and weathering.
 - c. Surface Preparation: In accordance with Article 3.04.
 - d. Prime Coat: Water-borne acrylic or cementitious acrylic emulsion having a minimum solids volume of 40%. Apply one coat of Carboline “Flexide” Masonry Block Filler to fill all voids, pores, and cracks; ICI Devoe Bloxfill 4000; Amerlock 400 BF; Tnemec 54-562 Masonry Filler single component epoxy; International Intercryl 320WB; Sherwin-Williams Heavy Duty Block Filler B42W46 at 10.0 to 18.0 mils DFT; PPG SPEEDHIDE® Int/Ext Acrylic Masonry Block Filler 6-15; or equal.
 - e. Finish Coat: Two coats of Carboline 3350, two coats of ICI Devoe 4208; two coats of Ameron 220; two coats Tnemec Series 6 at 2.0 to 3.0 mils per coat; two coats of International Intercryl 530WB 520; Sherwin-Williams Metalatex Semi-Gloss B42 Series at 2.0 to 4.0 mils DFT/coat; two coats of PPG Int/Ext Semi-Gloss Acrylic Metal Finish 7-374 Series; or equal. Apply to a thickness of 2 mils per coat.
5. System No. 33—Submerged Concrete, Raw Water or Raw Sewage:
- a. Type: Vinyl-ester-finish coat system, using Dow Derakane 411 or 470 resin, with epoxy or vinyl-ester prime coat. Minimum resin content in the finish coat system shall be 29% by weight. The vinyl-ester-finish coat system shall be formulated with an abrasion-resistant pigment to provide no more than an average 60 mg weight loss when run on a Taber Abraser using a CS-17 wheel, 1,000-gram weight on 1,000 cycles.
 - b. Service Conditions: Concrete submerged in raw water.
 - c. Surface Preparation: In accordance with Article 3.04.
 - d. Prime Coat - Surfacer:
 - (1) Apply epoxy or vinyl ester filler and surfacer to fill in depressions. Products: Plasite 9029; Tnemec Series 120-5003 (apply Tnemec 120-5002 primer at 10 to

- 15 mils wet to facilitate application of the 120-5003 surfacer); or Sherwin Williams Corobond Vinyl Ester Primer, B88C10/B88R99 at 3.5 to 4.5 mils DFT.
- (2) Apply prime coat with trowel or squeegee so that exposed aggregate is covered and the surface is level with the surrounding concrete.
- e. Finish Coats: Apply three or more coats to a total thickness of 40 mils minimum. Maximum thickness of any single coat shall not exceed 15 mils. Observe manufacturer's recommended recoating time between coats. Products: Plasite 4007; Tnemec 120-5001 Vinester; or Sherwin-Williams Magnalux 304, 921-W-304/531-0-006/970-C-949 at 14.0 to 16.0 DFT.
6. System No. 34—Concrete Floors, Wet Environment:
- a. Type: Cycloaliphatic Amine Epoxy higher solids material of no less than 80% sbv.
 - b. Service Conditions: Concrete floors subject to pedestrian traffic or exposure to water splashing from pump seal water, cleaning, etc.
 - c. Surface Preparation: In accordance with Article 3.04.
 - d. Coating System: Two coats of Ameron 400; two coats of ICI Devoe 233 H; two coats of Tnemec Series 104; two coats of International Interguard 760HS; two coats of Carboline 890; two coats of Sherwin-Williams Macropoxy 646 B58-600 Series/B58V600 at 5.0 to 8.0 mils DFT; PPG PITT-GUARD® Rapid Coat Direct-to-Rust Epoxy Coating 95-2400; or equal. Apply to a minimum dry-film thickness of 5 mils per coat. Broadcast glass beads, Tnemec Series 211-0212, into a finish for a non-slip finish.
7. System No. 36—Exposed Concrete and Masonry, Corrosive Environment:
- a. Type: High-build epoxy intermediate coat having minimum volume solids of 100% with an epoxy filler prime coat and a pigmented polyurethane finish coat.
 - b. Service Conditions: Concrete and masonry block exposed to corrosive atmospheres, such as hydrogen sulfide gas, chlorine gas, or chlorinated effluent sprays in wastewater treatment plants.
 - c. Surface Preparation: In accordance with Article 3.04. ICRI CSP 3-5.
 - d. Prime Coat: Epoxy filler compound or epoxy masonry filler having a minimum solids volume of 60%. Apply one coat to fill voids, pores, and cracks. Products: Amerlock 400 BF; Tnemec 54-660; International Intercryl 320WB; ICI Devoe Devran 265 BHF;

- Sentry 610; Sherwin-Williams Kem Cati-Coat HS B42 W400 Series/B42V401 at 10.0 to 20.0 mils DFT; or equal.
- e. Intermediate Coats: Ameron 385; Tnemec Series 434 Perma-Shield H₂S at 1/8 inch; International Interguard 760HS; ICI Devoe Devran 224 HS; Carboline 890LT; Sherwin-Williams Macropoxy 646 B58-600 Series/B60V80 at 5.0 to 8.0 mils DFT; or equal. Apply multiple coats to a total minimum thickness of 15 mils. Thickness of any single coat shall not exceed 6 mils.
 - f. Finish Coat: Two-component pigmented acrylic or aliphatic polyurethane recommended by the manufacturer for overcoating a high-build epoxy coating. Minimum volume of solids shall be 52%. Apply to a thickness of at least 2 mils. Products: Ameron 450 HS; Tnemec Series 435 Perma-Glaze at 15.0 to 20.0 mils DFT; International Interthane 990HS; ICI Devoe Devran 379; Carboline 134 HG; Sherwin-Williams Hi-Solids Polyurethane HS B65-300 Series/B60V30 at 3.0 to 4.0 mils DFT; or equal.
8. System No. 37—Exposed Masonry or Concrete, Atmospheric Weathering Environment:
- a. Type: Cement-base waterproofing grouting for concrete and masonry.
 - b. Service Conditions: For use in waterproofing concrete, block, brick, stone, and other masonry.
 - c. Surface Preparation: In accordance with Article 3.04. Dampen surface immediately ahead of application with clean water. Follow manufacturer's instructions on mixing and application.
 - d. Coatings: Apply two or more coats of Bonsal Sure-Coat to minimum total thickness of 1/16 inch or evenly distribute a base coat of Thoro Systems Products "Thoroseal" or equal, minimum 2 pounds per square yard. Then apply another coat at 2 pounds per square yard for a total of 4 pounds per square yard. Sherwin Williams SherCrete Waterproof Coat.

F. PVC, Coating System

1. System No. 41—PVC, Ultraviolet Exposure, or Color Coding:
- a. Type: Epoxy primer with minimum volume solids of 54% and a pigmented polyurethane enamel having a minimum volume solids of 66%.
 - b. Service Conditions: Color coding of PVC exposed to sunlight.

- c. Surface Preparation: Clean the surface in accordance with SSPC SP-1. Then, lightly abrade the surface with medium-grain sandpaper.
- d. Prime Coat: One coat of Tnemec Series, N69 Epoxoline; International 7510; Ameron 385; ICI Devoe Devran 224 HS; Sherwin-Williams Macropoxy 646 B58 Series/B58V600 at 5.0 to 8.0 mils DFT; Carboline 888 or 890; PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series; or equal. Apply to a minimum dry-film thickness of 4 mils.
- e. Finish Coat: One coat of Tnemec Series 1075; International Interthane 990HS; Ameron 450 HS; ICI Devoe Devran 379; Carboline 134 HG; Sherwin-Williams Hi-Solids Polyurethane B65-300 Series/B60V30 at 3.0 to 4.0 mils DFT; PPG PITTHANE® Ultra-Gloss Urethane Enamel 95-812 Series; or equal. Apply to a minimum dry-film thickness of 3 mils.

2. System No. 42—PVC, Ultraviolet Exposure or Color Coding:

- a. Type: Acrylic latex primer and topcoats with minimum volume solids of 35%.
- b. Service Conditions: Color coding of PVC exposed to sunlight.
- c. Surface Preparation: Clean the surface in accordance with SSPC SP-1. Then, lightly abrade the surface with medium-grain sandpaper.
- d. Prime Coat: One coat of Tnemec Series 1028 or Series 1029 at 2.0 to 3.0 mils DFT; Ameron 148; Carboline 3358; PPG PITT-TECH® Int/Ext Industrial DTM Primer/Finish Enamel 90-712 Series; or equal. Apply to a minimum dry-film thickness of 2 mils. Sherwin Williams DTM Primer/Finish B66W1 at 3.0 to 5.0 mils DFT.
- e. Finish Coat: Two coats of Tnemec Series 1028 or Series 1029 at 2.0 to 3.0 mils DFT; Ameron 220; Carboline 3359; two coats of PPG PITT-TECH® Int/Ext High Gloss DTM Industrial Enamel 90-374 Series; or equal. Apply to a minimum dry-film thickness of 2 mils each. Sherwin Williams DTM Gloss Acrylic B66 Series at 2.0 to 4.0 mils DFT/coat.

G. Coating Systems for Miscellaneous Metals

- 1. System No. 51—Insulate Aluminum (Insulation) from Concrete and Carbon Steel:
 - a. Type: Bituminous paint having a minimum volume solids of 68% coal-tar pitch based.

- b. Service Conditions: Coat areas of aluminum grating, stairs, structural members or aluminum fabrications, in contact with concrete or carbon steel with this system.
- c. Surface Preparation: Solvent or steam clean in accordance with SSPC SP-1; do not use alkali cleaning. Then dust blast.
- d. Prime Coat: Apply synthetic resin or epoxy primer to metal surface before finish coats. Products: International Intervinux VTA528/529, or equal. No primer required for Carboline or Tnemec.
- e. Finish Coat: Carboline Super Service Black; Tnemec 46-465; International Intertuf 100; or equal. Apply two coats to a minimum dry-film thickness of 8.0 to 12.0 mils/coat.

2. System No. 52—Exposed Metal, Galvanized Steel and Aluminum:

- a. Type: Synthetic resin or epoxy primer.
- b. Service Conditions: Coat galvanized steel and aluminum surfaces with this system before applying topcoat.
- c. Surface Preparation of Galvanized Steel: Surfaces shall be flat with no protrusions. Remove high spots and tears in the galvanizing with hand and power grinders. Comply with ASTM D6386, Paragraph 5.2.1. Do not remove the galvanized coating below the specified thickness. Solvent clean galvanized surfaces in accordance with ASTM D6386, Paragraph 5.3.2. Then sweep blast as in ASTM D6386, Paragraph 5.4.1. Use one of the abrasive materials described in ASTM D6386, Paragraph 5.4.1. Surface preparation for weathered and partially weathered galvanized steel shall be in accordance with ASTM D6386, Paragraphs 6 and 7. Apply prime coating within 1 hour of the surface preparation.
- d. Surface Preparation of Aluminum: Solvent clean or steam clean aluminum surfaces as specified in SSPC SP-1; do not use alkali cleaning. Then dust blast and follow with a chemical conversion coating in accordance with MIL-C-5541, Class 1A.
- e. Prime Coat: Tnemec Series N69 2.5 to 3.5 mils; Ameron 385; ICI Devoe Devran 224 HS; Carboline Rustbond Penetrating Sealer SG; Sherwin-Williams Macropoxy 646 B58-600 Series/B58V600 at 5.0 to 8.0 mils DFT; PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series; or equal. Apply to a minimum thickness of 4 mils.
- f. Intermediate and Finish Coats: Epoxy and polyurethane as described in System No. 10

3. System No. 53—Coating for Thermally Sprayed Aluminum and Zinc Coatings:
- a. Type: Two-component polyamide epoxy primer with polyamide epoxy intermediate coats and polyurethane topcoat.
 - b. Service Conditions: Seal coat for thermally sprayed aluminum and zinc coatings continuously exposed to sunlight, weathering, submerged in raw water, or continuously exposed to high humidity and water condensation.
 - c. Surface Preparation: Clean the surface in accordance with SSPC SP-1.
 - d. Prime Coat: Two-component polyamide epoxy conforming to MIL-DTL-24441, Formula 150, Type I thinned after the required period of induction with an equal volume of super-high-flash naphtha (ASTM D3734, Type I). The volatile organic content (VOC) of the prime coat shall not exceed local VOC limits. The prime coat shall be thin enough to penetrate into the body of the thermally sprayed coating and seal the porosity. Apply prime coat as soon after thermal spraying as possible but no later than 8 hours. Apply to a dry-film thickness of 0.50 to 0.75 mil.
 - e. Intermediate Coats: One coat of MIL-DTL-24441/20A Formula 150 epoxy green primer and one coat of MIL-DTL-24441/21A Formula 151 gray epoxy, applied to a dry-film thickness of 4 mils each. Apply the full intermediate coats over the prime coat within 6 hours of drying of the prime coat.
 - f. Finish Coat: Polyurethane finish coat as described in System No. 10.
 - g. Products that are commercial equivalents to the cited MIL-specification coatings are acceptable.
 - h. No more than 3 days shall elapse after applying the prime coat before the entire coating system is applied.
4. System No. 54—Aluminum Insulation from Concrete and Carbon Steel:
- a. Type: High-solids epoxy or phenolic epoxy having minimum volume solids of 80% (ASTM D2697).
 - b. Service Conditions: Coat areas of aluminum grating, stairs, structural members, or aluminum fabrications in contact with concrete or carbon steel with this system.
 - c. Surface Preparation: Solvent or steam cleaning as specified in SSPC SP-1; do not use alkali cleaning. Then dust blast.
 - d. Coating System: Apply three or more coats of Ameron 400; Tnemec 135; ICI Devoe Bar-Rust 233H; Sherwin-Williams Macropoxy B58-600 Series/B58V600 at 5.0 to 8.0 mils DFT; PPG

PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 Series; or equal; 30 mils total. Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

5. System No. 55—Repair of Galvanized Steel Surfaces:

- a. Type: Cold galvanizing compound consisting of paint containing oils, solvents, and zinc dust and complying with MIL-P-21035. Minimum metallic zinc content in the cured coating shall be 90%.
- b. Service Conditions: Repair of damaged galvanized coatings on steel surfaces.
- c. Surface Preparation: Clean damaged surfaces in accordance with SSPC SP-1 and SSPC SP-11.
- d. Coating System: Apply Z.R.C. Galvanizing Compound; RAMCO Specialty Products "Zinckit"; NuWave "Galv-Match-Plus"; Devcon "Cold Galvanizing"; Clearco "Cold Galvanizing Spray"; Tnemec Series 90-1K97; or equal; to a minimum dry-film thickness of 3 mils. Apply as specified in ASTM A780/A780M, Annex A2.

H. Exterior Architectural Coatings and Finishes

1. System No. 71—Flat Finish on Exterior Concrete and Cement Plaster:

- a. Type: Acrylic latex flat with minimum volume solids of 28% with an alkali-resistant soya-alkyd binder-type sealer prime coat.
- b. Surface Preparation: In accordance with Article 3.04.
- c. Prime Coat: Dunn-Edwards 42-52, Frazee 371; ICI Dulux acrylic primer; Sherwin-Williams Loxon A24W300; Tnemec Series 6 or equal; 2 mils.
- d. Finish Coat: Two coats, 1.4 mils dry each, of Dunn-Edwards W-705; Frazee 202; ICI Dulux 2200; Sherwin-Williams A-100 A6 Series; Tnemec Series 6; or equal.

2. System No. 73—Clear Sealer on Exterior Concrete and Masonry:

- a. Type: Silane with minimum solids of 22%.
- b. Surface Preparation: In accordance with Article 3.04.
- c. Prime Coat: One coat Hydrozo Enviroseal 7; two coats Okon Block Plugger; one coat Rainstopper 140; two coats Carbocrete Sealer WB. Apply at 80 square feet per gallon.

- d. Finish Coat: Two coats Hydrozo Enviroseal 7; one coat Okun W-2; one coat Rainstopper 140; one coat Carbocrete Sealer WB. Apply at 80 square feet per gallon.

I. Abrasives for Surface Preparation

1. Abrasives used for preparation of ferrous (excluding stainless steel) surfaces shall be one of the following:
 - a. 16- to 30- or 16- to 40-mesh silica sand or mineral grit.
 - b. 20- to 40-mesh garnet.
 - c. Crushed iron slag, 100% retained on No. 80 mesh.
 - d. SAE Grade G-40 or G-50 iron or steel grit.
2. Abrasives used for preparation of stainless steel surfaces shall be 20- to 40-mesh silicon carbide or aluminum oxide.
3. Abrasives used for preparation of aluminum surfaces shall be one of the following:
 - a. Crushed slag, 80 to 100 mesh.
 - b. Very fine silica sand, 80 to 100 mesh.
4. Abrasives used for preparation of concrete and masonry surfaces shall be 16- to 30- or 16- to 40-mesh silica sand.
5. In the above gradations, 100% of the material shall pass through the first stated sieve size and 100% shall be retained on the second stated sieve size.

PART 3 EXECUTION

3.01 WEATHER CONDITIONS

- A. Do not paint in the rain, wind, snow, mist, or fog or when steel or metal surface temperatures are less than 5°F above the dew point.
- B. Do not apply paint when the relative humidity is above 85%. For Systems Nos. 3 and 14, the relative humidity shall not exceed 95%.
- C. Do not paint when temperature of metal to be painted is above 120°F.

- D. Do not apply alkyd, inorganic zinc, silicone aluminum, or silicone acrylic paints if air or surface temperature is below 40°F or expected to be below 40°F within 24 hours. For Systems Nos. 3 and 14, the temperature shall not be below 25°F.
- E. Do not apply epoxy, acrylic latex, and polyurethane paints on an exterior or interior surface if air or surface temperature is below 60°F or expected to drop below 60°F in 24 hours.

3.02 SURFACE PREPARATION PROCEDURES

- A. Remove oil and grease from metal surfaces in accordance with SSPC SP-1. Use clean cloths and cleaning solvents and wipe dry with clean cloths. Do not leave a film or greasy residue on the cleaned surfaces before abrasive blasting. Power-washing with a biodegradable degreaser is also acceptable.
- B. Remove weld spatter and weld slag from metal surfaces and grind smoothly rough welds, beads, peaked corners, and sharp edges including erection lugs in accordance with SSPC SP-2 and SSPC SP-3. Grind 0.020 inch (minimum) off the weld caps on pipe weld seams. Grind outside sharp corners, such as the outside edges of flanges, to a minimum radius of 1/4 inch.
- C. Do not abrasive blast or prepare more surface area in 1 day than can be coated in 1 day; prepare surfaces and apply coatings the same day. Remove sharp edges, burrs, and weld spatter. Prime all areas before rust bloom forms and within the same day.
- D. Do not abrasive blast PVC piping or equipment.
- E. For carbon steel, do not touch the surface between the time of abrasive blasting and the time the coating is applied. Apply coatings within 2 hours of blasting or before any rust bloom forms.
- F. Surface preparation shall conform to the SSPC specifications as follows:

Solvent Cleaning	SP-1
Hand Tool Cleaning	SP-2
Power Tool Cleaning	SP-3
White Metal Blast Cleaning	SP-5
Commercial Blast Cleaning	SP-6
Brush-Off Blast Cleaning	SP-7
Pickling	SP-8
Near-White Blast Cleaning	SP-10

Power Tool Cleaning to Bare Metal	SP-11
Surface Preparation of Concrete	SP-13
Waterjet Cleaning of Metals – Clean to Bare Substrate	SP WJ-1
Waterjet Cleaning of Metals – Very Thorough Cleaning	SP WJ-2
Waterjet Cleaning of Metals – Thorough Cleaning	SP WJ-3
Waterjet Cleaning of Metals – Light Cleaning	SP WJ-4

- G. Wherever the words “solvent cleaning,” “hand tool cleaning,” “wire brushing,” or “blast cleaning” or similar words are used in these Specifications or in the paint manufacturer’s specifications, they shall be understood to refer to the applicable SSPC, surface preparation specifications listed above.
- H. *Dust blasting* is defined as cleaning the surface through the use of very fine abrasives, such as siliceous or mineral abrasives, 80 to 100 mesh. Apply a fine etch to the metal surface to clean the surface of any contamination or oxide and to provide a surface profile for the coating.
- I. *Brush-off blasting* of concrete and masonry surfaces is defined as opening subsurface holes and voids and etching the surface for a coating to bond.
- J. For carbon steel surfaces, after abrasive blast cleaning, the height of the surface profile shall be 2 to 3 mils. Verify the surface profile by measuring with an impresser tape acceptable to the Owner’s Representative. Perform a minimum of one test per 100 square feet of surface area. Testing shall be witnessed by the Owner’s Representative. The impresser tape used in the test shall be permanently marked with the date, time, and locations where the test was made. Test results shall be promptly presented to the Owner’s Representative.
- K. Do not apply any part of a coating system before the Owner’s Representative has reviewed the surface preparation. If coating has been applied without this review, if requested by the Owner’s Representative, remove the applied coating by abrasive blasting and reapply the coat in accordance with this Specification.

3.03 ABRASIVE BLAST CLEANING

- A. Use dry abrasive blast cleaning for metal surfaces. Do not use abrasives in automatic equipment that have become contaminated. When shop or field blast cleaning with handheld nozzles, do not recycle or reuse blast particles.
- B. After abrasive blast cleaning and before coating is applied, dry clean surfaces to be coated by dusting, sweeping, and vacuuming to remove residue from blasting. Apply the specified primer or touch-up coating within an 8-hour working day. Do

not apply coating over damp or moist surfaces. Reclean any blast-cleaned surface not coated within the 8-hour period before applying primer or touch-up coating.

- C. Keep the area of the work in a clean condition and do not permit blasting particles to accumulate and constitute a nuisance or hazard.
- D. During abrasive blast cleaning, prevent damage to adjacent coatings. Schedule blast cleaning and coating so that dust, dirt, blast particles, old coatings, rust, mill scale, etc., will not damage or fall upon wet or newly coated surfaces.

3.04 PREPARATION OF CONCRETE AND MASONRY SURFACES TO BE COATED

- A. Surface preparation of concrete and masonry surfaces shall be in accordance with SSPC SP-13/NACE No. 6 and the following.
- B. Do not apply coating until concrete has cured at least 30 days at 75⁰F and a minimum 50%. Finish concrete surfaces in accordance with Section 03360, Concrete Finishes. Do not use curing compound on surfaces that are to be coated.
- C. Concrete and masonry surfaces on which coatings are to be applied shall be of even color, gray or gray-white. The surface shall have no pits, pockets, holes, or sharp changes of surface elevation. Scrubbing with a stiff-bristle fiber brush shall produce no dusting or dislodging of cement or sand. Sprinkling water on the surface shall produce no water beads or standing droplets. Concrete and masonry shall be free of laitance and slick surfaces.
- D. Detergent clean the concrete or masonry surface with Trisodium Phosphate in accordance with ASTM D4258. Then sandblast surfaces (brush-off blast). Floor slabs may be acid etched as specified in ASTM D4260 in lieu of sandblasting. After sandblasting, wash surfaces with water to remove dust and salts in accordance with ASTM D4258 or ASTM D4261. The grain of the concrete surface to touch shall not be rougher than that of No. 10 mesh sand. Use ICRI standards for concrete and masonry surface preparation.
- E. Before coating concrete, plaster, and masonry determine the presence of capillary moisture in accordance with ASTM D4263, except as modified below. Tape a 4-foot-by-4-foot sheet of polyethylene plastic to the concrete surface to be coated. Allow the plastic sheet to remain in place at least 24 hours. After the specified time has elapsed, remove the plastic sheet and visually examine both the underside of the plastic sheet and the concrete surface beneath it. There shall be no indication of moisture on either surface. If moisture is indicated, allow additional curing time for the concrete and then retest. Provide one test sheet for every 300 square feet of concrete surface to be coated. For walls, provide one test

sheet for each 10 feet (or fraction thereof) of vertical rise in all elevations starting within 12 inches of the floor or base slab.

- F. Acceptance criteria for concrete surfaces (except for those coated with System No. 31B or 73) shall be in accordance with SSPC SP-13, Table 1, "Severe Service."
- G. Do not apply coatings to concrete when the concrete is outgassing. Apply coatings only when the concrete surface temperature is stable, not rising. Apply concrete coatings when the temperature is falling to reduce the potential of outgassing.

3.05 COATING STAINLESS STEEL

- A. Solvent clean in accordance with SSPC SP-1. Solvents and cleaning solutions shall contain less than 200 mg/l of halogens. Then abrasive blast to give a surface profile of 2.0 to 3.0 mils. Refer to the coatings for the correct surface profile. Use coatings that are low in chloride content.
- B. Do not apply inorganic zinc primers to stainless steel if such primers are specified in the painting system required. Apply only the intermediate and finish coats in such cases.

3.06 PROCEDURES FOR ITEMS HAVING SHOP-APPLIED PRIME COATS

- A. After applying primer to surfaces, allow coating to cure for a minimum of 2 hours before handling to minimize damage.
- B. When loading for shipment to the project site, use spacers and other protective devices to separate items to prevent damaging the shop-primed surfaces during transit and unloading. If wood spacers are used, remove wood splinters and particles from the shop-primed surfaces after separation. Use padded chains or ribbon binders to secure the loaded items and minimize damage to the shop-primed surfaces.
- C. Cover shop-primed items 100% with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.
- D. Handle shop-primed items with care during unloading, installation, and erection operations to minimize damage. Do not place or store shop-primed items on the ground or on top of other work unless the ground or work is covered with a protective covering or tarpaulin. Place shop-primed items above the ground upon platforms, skids, or other supports.

3.07 FIELD TOUCH-UP OF SHOP-APPLIED PRIME COATS

- A. Remove oil and grease surface contaminants on metal surfaces in accordance with SSPC SP-1. Use clean rags wetted with a degreasing solution, rinse with clean water, and wipe dry.
- B. Remove dust, dirt, salts, moisture, chalking primers, or other surface contaminants that will affect the adhesion or durability of the coating system. Use a high-pressure water blaster or scrub surfaces with a broom or brush wetted with a solution of Trisodium Phosphate, detergent, and water. Before applying intermediate or finish coats to inorganic zinc primers, remove any soluble zinc salts that have formed by scrubbing with a stiff bristle brush. Rinse scrubbed surfaces with clean water.
- C. Remove loose or peeling primer and other surface contaminants not easily removed by the previous cleaning methods in accordance with SSPC SP-7/NACE No. 4. Take care that the remaining primers are not damaged by the blast cleaning operation. The remaining primers shall be firmly bonded to the steel surfaces with blast-cleaned edges feathered.
- D. Remove rust, scaling, or primer damaged by welding or during shipment, storage, and erection in accordance with SSPC SP-10/NACE No. 2. Take care that the remaining primers are not damaged by the blast cleaning operation. Areas smaller than 1 square inch may be prepared in accordance with SSPC SP-11. The remaining primers shall be firmly bonded to the steel surfaces with cleaned edges feathered.
- E. Use repair procedures on damaged primer that protect adjacent primer. Blast cleaning may require the use of lower air pressure, smaller nozzles and abrasive particle sizes, short blast nozzle distance from surface, shielding, and/or masking.
- F. After abrasive blast cleaning of damaged and defective areas, remove dust, blast particles, and other debris by dusting, sweeping, and vacuuming; then apply the specified touch-up coating.
- G. Surfaces that are shop primed shall receive a field touch-up of the same primer used in the original prime coat.

3.08 PAINTING SYSTEMS

- A. All materials of a specified painting system, including primer, intermediate, and finish coats, shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the paint manufacturer for the particular coating system.

- B. Deliver paints to the jobsite in the original, unopened containers.

3.09 PAINT STORAGE AND MIXING

- A. Store and mix materials only in areas designated for that purpose by the Owner's Representative. The area shall be well ventilated, with precautionary measures taken to prevent fire hazards. Post "No Smoking" signs. Storage and mixing areas shall be clean and free of rags, waste, and scrapings. Tightly close containers after each use. Store paint at an ambient temperature from 50°F to 100°F.
- B. Prepare multiple-component coatings using all of the contents of the container for each component as packaged by the paint manufacturer. Do not use partial batches. Do not use multiple-component coatings that have been mixed beyond their pot life. Provide small quantity kits for touch-up painting and for painting other small areas. Mix only the components specified and furnished by the paint manufacturer. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

3.10 PROCEDURES FOR THE APPLICATION OF COATINGS

- A. Conform to the requirements of SSPC PA-1. Follow the recommendations of the coating manufacturer, including the selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
- B. Stir, strain, and keep coating materials at a uniform consistency during application. Power mix components. For multiple component materials, premix each component before combining. Apply each coating evenly, free of brush marks, sags, runs, and other evidence of poor workmanship. Use a different shade or tint on succeeding coating applications to indicate coverage where possible. Finished surfaces shall be free from defects or blemishes.
- C. Do not use thinners unless recommended by the coating manufacturer. If thinning is allowed, do not exceed the maximum allowable amount of thinner per gallon of coating material. Stir coating materials at all times when adding thinner. Do not flood the coating material surface with thinner before mixing. Do not reduce coating materials more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.
- D. Remove dust, blast particles, and other debris from blast cleaned surfaces by dusting, sweeping, and vacuuming. Allow ventilator fans to clean airborne dust to provide good visibility in working area before applying coating. Remove dust

from coated surfaces by dusting, sweeping, and vacuuming before applying succeeding coats.

- E. Apply coating systems to the specified minimum dry-film thicknesses as determined in accordance with SSPC PA-2.
- F. Apply primer immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Before applying coating, re-clean surfaces that have surface colored or become moist by blast cleaning.
- G. Apply a brush coat of primer on welds, sharp edges, nuts, bolts, and irregular surfaces before applying the primer and finish coat. Apply the brush coat before and in conjunction with the spray coat application. Apply the spray coat over the brush coat.
- H. Before applying subsequent coats, allow the primer and intermediate coats to dry for the minimum curing time recommended by the manufacturer. In no case shall the time between coats exceed the manufacturer's recommendation.
- I. Each coat shall cover the surface of the preceding coat completely and there shall be a visually perceptible difference in applied shade or tint of colors.
- J. Applied coating systems shall be cured at 75°F or higher for 48 hours. If temperature is lower than 75°F, curing time shall be in accordance with printed recommendations of the manufacturer, unless otherwise allowed by the Owner's Representative.
- K. Assembled parts shall be disassembled sufficiently before painting or coating to ensure complete coverage by the required coating.

3.11 SURFACES NOT TO BE COATED

- A. Do not paint the surfaces listed below unless otherwise noted in the drawings or in other Specification sections. Protect the following surfaces during the painting of adjacent areas:
 - 1. Concrete walkways.
 - 2. Mortar-coated pipe and fittings.
 - 3. Metal letters.
 - 4. Glass.
 - 5. Roofing.
 - 6. Fencing.
 - 7. Electrical fixtures except for factory coatings.

8. Nameplates.
9. Grease fittings.
10. Brass and copper, submerged.
11. Buried pipe, unless specifically required in the piping specifications.
12. Fiberglass items, unless specifically required in the FRP specifications.
13. Aluminum handrail, stairs, and grating.

3.12 PROTECTION OF SURFACES NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors to prevent paint and other materials from entering the motors.

3.13 SURFACES TO BE COATED

- A. The exact coating to be applied in any location is not designated by the descriptive phrases in the coating system titles such as “corrosive environment,” “buried metal,” or “submerged metal.” Coat surfaces with the specific coating systems as described below:
 1. Coat mechanical equipment, such as pumps, blowers, and clarifier mechanisms, as described in the various mechanical equipment specifications. The color of the finish coat shall match the color of the connecting piping.
 2. Coat aboveground and exposed piping or piping in vaults and structures as shown in the Piping Schedule in the drawings. The color of the finish coat shall be as shown in the Piping Schedule in the drawings.
 3. Coat submerged steel, ductile iron piping, and piping in wet wells as specified.
 4. Coat valves as described the same as the adjacent piping unless stated otherwise in the valve specification. Aboveground valves, or valves in vaults and structures, shall match the color of the connecting piping.

3.14 DRY-FILM THICKNESS TESTING

- A. Measure coating thickness specified for carbon steel surfaces with a magnetic-type dry-film thickness gauge in accordance with SSPC PA-2. Measure coating thickness specified for stainless steel, aluminum, and copper surfaces with an eddy-current type thickness gauge in accordance with ASTM D7091. Provide certification that the gauge has been calibrated by a certified laboratory within the

past 6 months. Provide dry-film thickness gauge as manufactured by Mikrotest or Elcometer.

- B. Test the finish coat of metal surfaces (except zinc primer and galvanizing) for holidays and discontinuities with an electrical holiday detector, low-voltage, wet-sponge type. Provide measuring equipment. Provide certification that the gauge has been calibrated by a certified laboratory within the past 6 months. Provide detector as manufactured by Tinker and Razor or K-D Bird Dog.
- C. Measure coating thickness specified for concrete or masonry surfaces in accordance with ASTM D4138. Test the finish coat of concrete and masonry surfaces in accordance with NACE SP0188 or ASTM D4787. Patch coatings at the points of thickness measurement or holiday detection.
- D. Check each coat for the correct dry-film thickness. Do not measure within 8 hours after application of the coating.
- E. For metal surfaces, make five separate spot measurements (average of three readings) spaced evenly over each 100 square feet of area (or fraction thereof) to be measured. Make three readings for each spot measurement of either the substrate or the paint. Move the probe or detector a distance of 1 to 3 inches for each new gauge reading. Discard any unusually high or low reading that cannot be repeated consistently. Take the average (mean) of the three readings as the spot measurement. The average of five spot measurements for each such 100-square-foot area shall not be less than the specified thickness. No single spot measurement in any 100-square-foot area shall be less than 80% nor more than 120% of the specified thickness. One of three readings which are averaged to produce each spot measurement may underrun by a greater amount as defined by SSPC PA-2.
- F. For concrete surfaces, make five separate spot measurements spaced evenly over each 100-square feet of area (or fraction thereof) to be measured. The average of five spot measurements for each such 100-square-foot area shall not be less than the specified thickness. No single spot measurement in any 100-square-foot area shall be less than 80% nor more than 120% of the specified thickness.
- G. Perform tests in the presence of the Owner's Representative.

3.15 REPAIR OF IMPROPERLY COATED SURFACES

- A. If the item has an improper finish color or insufficient film thickness, clean and topcoat the surface with the specified paint material to obtain the specified color and coverage. Sandblast or power-sand visible areas of chipped, peeled, or abraded paint, feathering the edges. Then prime and finish the coat in accordance

with the Specifications. The work shall be free of runs, bridges, shiners, laps, or other imperfections.

3.16 CLEANING

- A. During the work, remove discarded materials, rubbish, cans, and rags at the end of each day's work.
- B. Thoroughly clean brushes and other application equipment at the end of each period of use and when changing to another paint or color.
- C. Upon completion of painting work, remove masking tape, tarps, and other protective materials, using care not to damage finished surfaces.

END OF SECTION

DIVISION 11

EQUIPMENT

SECTION 11000 GENERAL EQUIPMENT REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies general work requirements regarding the products and execution services that are specified in the Division 11 Sections incorporated in the Contract Documents. The requirements specified shall apply to all of the Division 11 Sections, unless noted otherwise.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. The submittal contents for equipment, instrumentation, controls, and appurtenances specified in the Division 11 Sections shall contain the general information listed below. Additional submittal requirements are contained in the Division 11 Sections.
 - 1. A list and description of all deviations from the Contract Documents.
 - 2. A list of equipment and components on each drawing with each product identified by legend reference. Include product name, manufacturer, and model number.
 - 3. Completely dimensioned plans, elevations, and cross-sections of system equipment and sub-assemblies.
 - 4. Shop and erection drawings showing details, anchor bolt locations, and field connections.
 - 5. Manufacturers' equipment installation instructions.
 - 6. Descriptive literature, technical bulletins, and catalog data sheets for all equipment and purchased sub-components.
 - 7. Installation, operation, maintenance and start-up procedures.
 - 8. Total equipment weight (while operating).
 - 9. Drive mechanism torque rating and bearing life rating.
 - 10. Motor data and catalog information.
 - 11. Submit complete electrical drawings, schematics, and interconnecting wiring diagrams and schedules for the equipment control system, instrumentation, and control panel(s) showing numbered wiring terminals in the control panel conforming to NEMA ICS-1-101. Identify field device terminals, wire number, wire sizes, control and power wire types, and interfaced elements.

12. Control panel construction and panel layout drawings.
13. Complete technical literature for all factory-applied paint systems. Clearly indicate the components to be coated and the corresponding paint system.
14. Manufacturers' descriptive literature, product specifications, and published details.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. National Electrical Manufacturers Association (NEMA)

1. NEMA ICS-1—Industrial Control and Systems: General Requirements.

1.04 QUALITY ASSURANCE

- #### A. Requirements of Regulatory Agencies: The Contractor shall comply with construction requirements of State, County, and other local political subdivision specifications as may exceed the requirements of the codes, standards, and approving bodies referenced in this Section.
1. NFPA Standards: The Contractor shall comply with requirements of the National Fire Protection Association (NFPA) Standards referenced in the various Specifications Sections and as directly appropriate to the work and workmanship.
 2. Electrical Requirements: The Contractor shall comply with requirements for both the Underwriters' Laboratories, Inc. (UL) Listings, Labels, and Approvals and the NEMA Stamps or Seals as applicable to electrical equipment or apparatus forming parts of the Mechanical Equipment.
- #### B. Certificates and Permits: Upon completion of work and before final payment, the Contractor shall furnish to the Engineer formal certification of final inspections from authorities having jurisdiction over the work in this project and secure required permits, if any, from such authorities. Additionally, the Contractor shall prepare any detailed diagrams and drawings that are required by those authorities having jurisdiction over the work of this project at no additional cost to the Owner.
- #### C. Source Quality Control: Products used throughout these Specifications and as indicated on the Drawings shall be from companies having established reputations in the manufacture of the particular materials, equipment, or apparatus specified.

Such products may be of their own make or products of others for which they assume full responsibility when used in finished products which are not manufactured completely by them and with replacement parts available.

- D. Products: The equipment specified in the Division 11 Sections was based on the latest models that were available from the specified equipment manufacturers at the time the Contract Documents were developed. If any equipment models specified in the Division 11 Sections have been discontinued or will be discontinued within 1 year after the bid date, the Contractor shall furnish and install the latest and most recent equipment model at no additional cost to the Owner.
- E. For each category of materials and equipment (Products) specified in the Division 11 Sections, the Contractor shall provide Products of the same manufacturer and type.
- F. Equipment Selection: The Contractor may furnish equipment of higher electrical characteristics, physical dimensions, capacities, and ratings provided such proposed equipment is approved by the Engineer in writing. Upon receiving the Engineer's approval to provide such equipment, the Contractor shall furnish the connecting mechanical and electrical services including but not limited to circuit breakers, conduit, increased control panel enclosure size, motors, bases, and any other electrical equipment needed to accommodate the higher electrical characteristics at no additional cost to the Owner.
- G. If minimum energy ratings or efficiencies of equipment are specified in Division 11, Equipment, the Contractor shall furnish and install equipment that meets or exceeds the specified design and commissioning requirements (no exceptions) as determined by the Engineer.
- H. All the equipment specified in the Contract Documents shall be standard units of proven ability as manufactured by a competent organization that is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practice and methods and shall operate satisfactorily when installed.

1.05 QUALIFICATIONS

- A. The manufacturer of each piece of equipment described in the Division 11 Sections shall meet the following requirements, unless noted otherwise:
 - 1. Have a record of operation, manufacturing and servicing the items specified in the Division 11 Sections for a minimum of 10 years before the Bid Date.
 - 2. Have a minimum of five installations of equipment similar to that specified in this Section at municipal wastewater treatment facilities in Florida before the bid date.
 - 3. Have been in business for at least the 10 consecutive years before the Bid Date.
- B. If the equipment manufacturer that the Contractor proposes to furnish and install the equipment described in the Division 11 Sections does not meet these qualifications and is not specified in the Contract Documents, the Engineer reserves the right to reject the equipment from this manufacturer for use on this project. Any costs incurred by the Contractor as a result of providing equipment from a manufacturer that does not meet the qualifications described in this Section shall not be incurred by the Owner.
- C. The Contractor shall furnish documentation that the manufacturer meets these qualifications as part of the submittals specified in Section 01330, Submittals and Acceptance.

1.06 MAINTENANCE

- A. Spare Parts
 - 1. The Contractor shall furnish the spare parts specified in the Division 11 Sections. The Contractor shall also submit a list of recommended spare parts, special tools, and lubricants for each equipment item. The list shall include contact information for local sources for supply of all parts and professional service.

PART 2 PRODUCTS

2.01 MOTORS

- A. All motors identified in Division 11 Sections shall be furnished and installed under Division 11, Equipment, and in accordance with Division 16, Electrical.

2.02 CONTROLS

A. General

1. All control panels specified in the Division 11 Sections shall be furnished and installed under Division 11, Equipment, and in accordance with Division 13, Special Construction, and Division 16, Electrical.
2. The Contractor shall furnish and install controls designed to operate on 120-volt, single-phase, 60 Hertz electric service unless otherwise specified. The Contractor shall furnish and install 120-volt step-down voltage transformers as specified in Division 16, Electrical, in each control panel as required.
3. The Contractor shall furnish and install elapsed time meters in each control panel for each piece of motor-driven equipment being controlled by that control panel. All elapsed-time meters shall be furnished and installed in accordance with Division 16, Electrical.
4. All control panels shall be furnished with a main circuit breaker to enable/disable electric service to the panelboard.
5. All control panels that will annunciate a local and/or remote alarm shall be furnished with an ALARM ACKNOWLEDGE reset pushbutton switch (momentary contact) wired to each alarm contact.
6. All indicating lamps in each control panel shall be furnished in accordance with the color-coded scheme:
 - a. ON indicating lamps: Green.
 - b. OFF indicating lamps: Red.
 - c. Alarm indicating lamps: Amber.
 - d. POWER ON indicating lamp: White.
7. Provide a heater inside of each control panel enclosure to prevent condensation. Heater size shall be in accordance with the equipment manufacturer's recommendations.
8. The face of each control panel shall be installed so it is facing north whenever possible or provided with a sunshield when not possible.

2.03 FLOAT SWITCHES

- A. Float switches shall be of the suspended type with polypropylene or PVC body. Units shall have an integral electrical cable with two #19 AWG stranded conductors. Switches shall be pilot duty, normally open or normally closed, as required for application. Switches shall be suitable for use with intrinsically safe circuits. Each switch shall be supported from an AISI Type 316 stainless steel cable support bracket with individual stainless steel Kellems grip strain relief supports. Each switch shall be provided with sufficient cable length to extend from the float switch to the final termination point at the pump control panel with an additional 18 inches of looped cable. The float switch cables shall be bundled to an AISI Type 316 stainless steel cable with heavy-duty nylon strap wire ties. The upper end of the stainless steel cable shall be attached to the cable support bracket and the lower end attached to a 5-pound (minimum) cable weight. The cable weight shall be firmly attached to the cable and shall be constructed of noncorrosive metal and/or materials. Float switches and cables shall be intrinsically safe when used in classified locations.

2.04 EQUIPMENT ANCHORING SYSTEMS

- A. All anchoring systems including, but not limited to, expansion anchors, adhesive anchors, anchor bolts, cinch anchors, and screws that are required to install the equipment and appurtenances specified in the Division 11 Sections shall be AISI Type 316 stainless steel unless noted otherwise. The Contractor shall furnish and install all equipment anchoring systems in accordance with Section 05500, Metal Fabrications.

2.05 EQUIPMENT NAMEPLATES

- A. The Contractor shall provide engraved laminated phenolic nameplates with white legend and black field that provides the following information for each piece of equipment described in the Division 11 Sections.
 - 1. Equipment Description (i.e., Recharge Well Pump, Fine Screen Filter, etc.).
 - 2. Equipment Identification Label No.
- B. Letter height on each nameplate shall not be less than 3/4-inch. Nameplates shall be factory drilled for fasteners. Secure nameplates to equipment or nearby wall using AISI Type 304 stainless steel fasteners. The locations of each nameplate shall be coordinated with the Owner and approved by the Owner before their installation.

- C. The Contractor shall obtain the Engineer's approval for the nameplate information for each equipment item described in the Division 11 Sections before ordering these nameplates from the manufacturer.

2.06 PRESSURE GAUGE ASSEMBLIES – PUMPING UNITS

- A. General: The Contractor shall provide a pressure gauge assembly as specified in Section 15125, Piping Appurtenances, on the suction and discharge piping of the pumping units specified in the Division 11 Sections. The intent of the Drawings is not to show the locations of every pumping unit pressure gauge. Rather, the Contractor shall mount each pressure gauge as close to the pump suction and discharge connections as possible, but so as not to impede the operation and maintenance of the pressure gauge assembly, pumping unit, and valves installed on the pumping unit suction and discharge piping. Coordinate the location of all pressure gauge assemblies with the Owner before installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: The Contractor shall install the equipment in accordance with the manufacturer's instructions and recommendations and approved submittals at the locations shown on the Drawings. If the equipment locations shown on the Drawings are in conflict with the manufacturer's recommendations or will interfere with the installation or operation of any other item indicated in the Contract Documents, the Contractor shall relocate this equipment and provide the necessary appurtenances to install the equipment in accordance with the manufacturer's recommendations at no additional cost to the Owner. The Contractor shall not install any equipment at locations not in accordance with the Contract Documents or approved submittals.
- B. The Contractor shall install equipment, slabs, walls level and plumb, parallel and perpendicular to other building and components in exposed interior spaces, unless otherwise shown on the Drawings.
- C. The Contractor shall apply an anti-seize compound to threaded fasteners of equipment components that require removal, replacement, or adjustment as part of any maintenance or inspection procedure.
- D. The Contractor shall furnish and install the required oil and grease for initial operation in accordance with the manufacturer's recommendations.

- E. Provide means of oil lubrication for bearings and other metallic parts in sliding contact. Use alemite industrial-type fittings except where otherwise specified. The Contractor shall also perform the following work:
1. Locate lubrication points on equipment readily accessible without the necessity of removing covers, plates, housings or guards, or without creating safety hazards at installed equipment elevations.
 2. The Contractor shall exhaust pressure-lubricated units to the atmosphere to prevent excessive greasing.
 3. The Contractor shall extend grease fittings to locations that are readily accessible to the Owner. The Contractor shall coordinate the location of these grease fittings with the Owner before their installation.
- F. The Contractor shall furnish and apply touch-up paint to any equipment's factory painting finish that is chipped or damaged during installation. All factory-finish touch-up paint shall be mutually compatible with the factory finish on the equipment and shall be furnished by the manufacturer of the equipment to be touched up in the field.
- G. If equipment mounting heights are not shown on the Drawings, the Contractor shall install that piece of equipment to provide the maximum amount of headroom (defined as the distance from the bottom of the structure to the top of finished floor or grade), as possible. In such an instance, the Contractor shall obtain the Engineer's approval for this mounting location before installing that piece of equipment in the field.
- H. The Contractor shall furnish and install all mechanical equipment to facilitate service, maintenance, and repair or replacement of the equipment components. The Contractor shall connect equipment for ease of disconnecting, with minimum interference to other installations.

3.02 FIELD TESTING

- A. General: The Contractor shall provide services of a factory-authorized service representative to perform, approve, and certify the field testing specified in this Section. Field testing shall generally consist of performing the pre-startup and startup tests as specified in the Division 11 Sections and the final mechanical performance test specified in this Section. The Contract Documents may require the Contractor to perform factory testing on equipment items before the Engineer approves their use for this project. The Contractor shall refer to the Division 11 Sections regarding equipment shop testing requirements.

B. The Contractor shall adhere to the following requirements regarding the field testing to be provided for this project:

1. The service representative shall be employed by the manufacturer of the equipment specified at the time field testing is being performed. The service representative shall be authorized by the factory to perform the field testing specified in Division 11, Equipment. Upon request by the Engineer, the Contractor shall submit a letter from a company officer of the equipment manufacturer stating that the service representative performing the field testing is authorized by the manufacturer.
2. Before scheduling each field test with the equipment manufacturer, the Contractor shall coordinate with the Owner and Engineer to obtain a list of dates that both parties would be available to attend the testing. The Contractor shall notify the Owner and Engineer of the field-testing dates no less than 14 calendar days before the date of the field test.
3. If directed by the Engineer, the Contractor shall perform a second pre-startup and/or startup test, in accordance with the procedures specified in the Division 11 Sections, at no additional cost to the Owner if the original pre-startup and/or startup test did not pass because of any work that was deemed by the Engineer to be non-compliant with the Contract Documents and/or manufacturer's recommendations.
4. The Contractor shall only perform startup testing after the Contractor has reached Substantial Completion for the project as defined in the Agreement and General Conditions.
5. The Contractor shall furnish, install, and remove any temporary piping, valves, appurtenances, and equipment necessary to perform the pre-startup and startup testing to the Engineer's satisfaction.
6. All field testing shall be performed Monday through Friday at the project site, unless otherwise approved by the Owner.
7. The duration that the manufacturer's representative is required to be onsite to perform the pre-startup and startup training is specified in the Table 11000-1, Equipment Testing and Training Requirements.

C. Operating Costs

1. Costs for Pre-startup and Startup Testing: The Contractor shall include in the Contract Price the following operating costs for satisfactorily completing the Initial Mechanical Performance Tests on equipment being tested:
 - a. Lubricating grease.
 - b. Lubricating oils.
 - c. Such other materials or utilities not specifically identified in this Section but required to conduct the pre-startup and startup testing.

- d. Portable diesel power generation sets and diesel fuel as needed for lighting, portable tools, and furnishing electrical to any temporary pumping units used to transfer potable water, reclaimed water, or raw water to each treatment or storage structure for startup testing.
 - 2. Costs for Final Mechanical Performance Tests: The Owner will pay for the operating costs for the Final Mechanical Performance Test, except for the Contractor's personnel needed to perform and supervise this testing as specified in this Section.
- D. The intent of the field testing for each equipment item specified in the Division 11 Sections is provided in this Section. If the individual equipment field testing procedures specified in the Division 11 Sections are not sufficient to obtain a Manufacturer's Certification or to demonstrate compliance with the Contract Documents, the Contractor shall perform these additional field test procedures at no additional cost to the Owner.
 - 1. Pre-startup Testing: Upon the Contractor's completion of the installation and adjustment of the equipment; the Contractor, with his own forces and with the manufacturer's representative(s), shall demonstrate to the Engineer's satisfaction that the equipment has been furnished and installed in accordance with the Contract Documents and the manufacturer's recommendations.
 - a. The Contractor shall repair any equipment items that do not pass the pre-startup test, as identified by the Engineer and/or manufacturer's representative, to the satisfaction of the Engineer before performing the startup testing for that equipment.
 - 2. Startup Testing: Upon successful completion of the pre-startup testing, the Contractor shall demonstrate that the mechanical performance and controls of each equipment item, when operated in accordance with the design intent indicated by the Contract Documents, are satisfactory to the Owner and Engineer.
 - a. Startup testing shall be performed with each equipment item and associated treatment structure simulated under similar operating conditions as the final mechanical performance testing specified in this Section. For equipment that will operate while being submerged as shown on the Drawings, the Contractor shall fill the respective structure to its maximum water surface with water and perform startup testing while that equipment is submerged. The Contractor shall not use wastewater to fill any treatment structures for startup testing.

- b. After the startup testing procedures specified in the Division 11 Sections have been completed to the satisfaction of the Engineer, the Contractor shall operate that equipment for one successful continuous 72-hour period without assistance from the Owner as a condition of startup testing. If the equipment needs to be taken out of service for repair during this 72-hour period because it not operating in accordance with the intent of the Contract Documents, this operating period shall cease. A new operating period will not begin until the equipment has been operating in accordance with the Contract Documents and manufacturer's recommendations for at least 72 consecutive hours. The Contractor shall furnish any additional supervision or provisions necessary to verify that each equipment item was successfully operated during this 72-hour operating period.
 - c. Upon completion of the startup test, the Contractor shall dewater each treatment and storage structure in accordance with local and State regulations and in a manner that is satisfactory to the Owner and Engineer.
- 3. Final Mechanical Performance Testing: The Contractor shall perform final mechanical performance testing of the equipment specified in the Division 11 Sections once the following conditions have been satisfied:
 - a. The Contractor has successfully completed the pre-startup and startup testing requirements specified in the Division 11 Sections.
 - b. The Contractor has performed the training services specified in this Section.
 - c. The Contractor has procured all of the required permits for each building and treatment structure within the project site.
 - d. The Engineer has received and approved all of the manufacturer's certifications of compliance, warranties, and O&M manuals for all required items as specified in the Contract Documents.
 - e. The intent of the final mechanical performance test is for the entire facility to be operated by the Owner for a continuous 30-day period while the facility is receiving and injecting raw water. During this 30-day testing period the Contractor shall furnish personnel who shall be on-site as needed and available at all times 24 hours per day during the final mechanical performance test. Personnel shall be competent in the troubleshooting and repair of the equipment and related electrical and mechanical systems

specified in the Contract Documents. The Contractor's electricians and mechanical technicians shall be on-site as needed (minimum 8 hours/week) and available 24 hours per day to assist with this testing. If the final mechanical performance testing needs to be stopped and suspended due to equipment not operating in accordance with the design intent of the Contract Documents as determined by the Engineer, the following conditions shall apply:

- (1) The Contractor shall repair and troubleshoot these items immediately at no additional cost to the Owner.
 - (2) The 30-day period for the final mechanical performance testing will start over (i.e., be reset to zero hours).
- f. Upon restarting the final mechanical performance testing, the Contractor shall furnish the appropriate personnel defined above on-site as needed and available (minimum 8 hours/week) for 24 hours per day during the 30-day period at no additional cost to the Owner even though the total duration of the final mechanical performance testing (including restarts), may exceed 30 days.
- g. The final mechanical performance test shall end when the Engineer determines that all of the equipment and related systems are operating in accordance with the design intent of the Contract Documents and all deficiencies that hinder the normal day-to-day operation of the facility have been corrected to the satisfaction of the Engineer. The Engineer shall notify the Contractor in writing when the final mechanical performance testing has been successfully completed.

3.03 TRAINING SERVICES

- A. Upon completion of the pre-startup and startup testing and before the final mechanical performance testing, the manufacturer of the equipment specified in the Division 11, 13, and 15 Sections shall provide an authorized representative to train the Owner's personnel in the operation and maintenance of the equipment. The representative shall provide additional onsite startup and troubleshooting services during this training upon request by the Engineer or Owner while performing these training services. The duration of the training services for each equipment item are specified in the Table 11000-1, Equipment Testing and Training.

3.04 MANUFACTURER'S CERTIFICATIONS OF COMPLIANCE

- A. Upon successful completion of the pre-startup testing, startup testing, and training services specified in this Section, as required in Table 11000-1, Equipment Testing and Training Requirements, the Contractor shall obtain the equipment manufacturer's certification that the equipment specified in the respective Division 11 Sections has been installed, adjusted, and tested in accordance with the manufacturer's recommendations. The Contractor shall furnish the Engineer with Manufacturer's Certificates of Compliance and Equipment Manufacturer's Certificate of Installation Testing and Instruction for each specified equipment item before performing the final mechanical performance testing specified in this Section.

Table 11000-1 Equipment Testing and Training Requirements					
(Hours below stipulate the duration the manufacturer's representative is required be on site to perform the required pre-startup and starting testing, final mechanical performance testing, and training services specified in the listed sections. See Note 1.)					
Section	Equipment Name	Pre-Startup Testing ⁽³⁾	Startup Testing ⁽³⁾	Final Mechanical Performance Testing ⁽⁴⁾	Training ⁽⁴⁾
11400	Static Intake Screen	4 hours	4 hours	4 hours	8 hours
11450	Borehole Control Injection Valve System	16 hours	16 hours	8 hours	16 hours
11535	Submersible Non-Clog Pump	4 hours	4 hours	4 hours	8 hours
13300	Instrumentation Specification	16 hours	16 hours	8 hours	8 hours

Notes:

1. If difficulties occur in operating the equipment due to the manufacturer's fabrication or the Contractor's installation, additional service shall be provided at no change in Contract Price or Time.
2. All times listed above exclude travel time to and from the project site.
3. The Pre-Startup and Startup testing may be combined within a single trip if the manufacturer's representative determines that the equipment is properly installed by the Contractor in accordance with the Contract Documents and the manufacturer's recommendations. However, these services shall not be combined with the Final Mechanical Performance Testing and Training; a separate trip(s) shall be conducted to accomplish these services.
4. The Final Mechanical Performance Testing and Training may be combined within a single trip but shall not be combined with the Pre-Startup and Startup testing. Training shall be conducted in accordance with Section 01820, Training.

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER _____

EQPT SERIAL NO: _____

EQPT TAG NO: _____

EQPT/SYSTEM: _____

PROJECT NO: _____

SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

_____ Installed in accordance with Manufacturer's recommendations.

_____ Inspected, checked, and adjusted.

_____ Serviced with proper initial lubricants.

_____ Electrical and mechanical connection meet quality and safety standards.

_____ All applicable safety equipment has been properly installed.

_____ System has been performance tested, and meets or exceeds specified performance requirements (when complete system of one manufacturer).

Comments: _____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment, and (iii) authorize the make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20____

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

**EQUIPMENT MANUFACTURER'S CERTIFICATE OF
INSTALLATION TESTING AND INSTRUCTION**

OWNER

PROJECT

CONTRACT NO.

Jones Edmunds No.

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with Serial No.)

Installed for the subject project has have been installed in a satisfactory manner, has have been satisfactorily tested, is/are ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the units on Date:

_____ Time: _____.

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGEMENT OF MANUFACTURER'S INSTRUCTION

I/We the undersigned, authorized representatives of the _____
and/or Plant Operating Personnel have received classroom and hands on instruction on the
operation, lubrication, and maintenance of the subject equipment and am are prepared to assume
normal operational responsibility for the equipment:

_____ DATE: _____

_____ DATE: _____

_____ DATE: _____

END OF SECTION

SECTION 11400 STATIC INTAKE SCREENS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This Section of the specifications covers the furnishing and installation of the Static Intake Screen and appurtenances as shown on the drawings and specified herein.
- B. The following items are a part of this Section and shall be furnished by one manufacturer to ensure a properly designed and integrated intake system.
 - 1. One static intake screen assembly of all-welded continuous slot construction, for mounting in the intake screen wetwell.
 - 2. Airburst system for air flushing/removal of accumulated debris from screen surface consisting of integrated compressor, receiver tank, valves and control panel.
 - 3. Manufacturer's services.

1.02 RELATED SECTIONS

- A. Related specification sections conformed herein and listed below:
 - 1. Section 11000, General Equipment Requirements.
 - 2. Section 11535, Submersible Non-Clog Centrifugal Pumps.
 - 3. Section 13300, Instrumentation and Control for Process Systems.
 - 4. Section 15110, Manual, Check, and Process Valves.
 - 5. Division 16, Electrical.

1.03 REFERENCES

- A. The work shall conform to applicable provisions of the following standards, latest, editions, except as modified herein.
 - 1. American Water Works Association (AWWA)
 - a. AWWA C207—Steel Pipe Flanges for Waterworks Service- Sizes 4 through 144 inches.

2. International Organization for Standardization (ISO)

- a. ISO 9000—Quality Management Systems – Fundamentals and Vocabulary.

1.04 PERFORMANCE CONDITIONS

- A. Each Static Intake Screen assembly capacity shall be 2 million gallons per day (MGD) at a maximum through-slot velocity, as a result of water withdrawal, of 0.5 feet per second (ft/sec). The corresponding average through-slot velocity shall be 90% of the maximum velocity. At this flow rate the pressure drop through the clean screen surface shall be approximately 0.0031 pounds per square inch (psi).
- B.
- | | |
|-------------------------------|------------------|
| Number of Screens | 1 |
| Capacity (each/unit) | 2 MGD |
| Screen Slot Size | 0.04 inch (1 mm) |
| Headloss – Clean screen | 0.0031 psi |
| Headloss – Full assembly | 0.29 psi |
| Maximum Through-Slot Velocity | 0.5 ft/sec |
- C. Pressure drop through the entire intake assembly shall be less than 0.29 psi at the rated flow. The hydraulic design of this system is based on this maximum headloss – screens that exceed this headloss are not acceptable. The manufacturer's clean screen assembly headloss must be stated in the bid documents.
- D. Evidence of the intake assembly capacity and flow distribution shall be able to be provided by a Computational Fluid Dynamic (CFD) analysis, supplied by the manufacturer. The CFD Analysis Method must be verified by actual physical testing.
- E. The static screen supplier shall provide, as part of the overall static screen system, an air backwash system designed to remove debris from the screen surface by delivering a suitable volume of compressed air to the inside of the screen body. The exiting air shall scour the screen surface to maintain adequate design flow and through slot velocity characteristics.

1.05 QUALITY ASSURANCE

- A. The entire intake screen system shall be furnished by a single manufacturer who shall comply with the following:
1. The equipment manufacturer must maintain an ongoing quality assurance program, including ISO 9000 certification.

2. All welders must maintain certification to ASME Section IX. Copies of certifications shall be provided upon request.
3. The single manufacturer supplying this equipment must be able to furnish proof of over 50 installations and 10 years of manufacturing equipment of similar technology.
4. Supporting flow distribution data via a CFD analysis.

1.06 SUBMITTALS

- A. See Section 01330, Submittal and Acceptance.
- B. Provide piping and instrumentation diagram (P&ID) drawings documentation control functionality described in this and related specifications to provide a complete and operable system.
- C. Drawing(s) showing screen diameter, screen length, assembly length, interface dimension for outlet and air backwash dimensions, materials of construction, and assembly weight.
- D. Included in the static screen submittals shall be all associated airburst equipment catalog information, system sizing criteria, and drawings. All dimensional and operational information will be provided. All interconnecting wiring and piping information will be included and documented.
- E. Welder Certifications.
- F. Evidence of a statistical control program.
- G. Provide supporting flow distribution data where calculation methods are verified by physical flow distribution tests.

1.07 DELIVERY

- A. See Section 01650, Delivery, Storage, and Handling.

PART 2 PRODUCTS

2.01 GENERAL

- A. All system components and equipment utilized in the intake screen system, including the system described in Article 1.01 shall be furnished as a complete integrated system by one manufacturer; Johnson Screen, Model T18MFD, New Brighton, MN, or Hendrick Screen, Owensboro, KY.

2.02 STRENGTH

- A. The intake assembly shall be designed to a maximum withstand a differential hydrostatic collapse pressure of 4.3 psi (0.3 bar).
- B. Design stress used for determining strength of the assembly shall be no more than 90% of the published yield strength of the material used. Strength calculations verifying compliance with these criteria shall be provided upon request.

2.03 CONSTRUCTION

- A. The static screen surface wire shall be Johnson Screens Vee-Wire® Number 69 or Hendrick Screen 695.
- B. The surface wire, support beam, and stiffener structure shall be an all-welded matrix designed to provide the specific strength with minimal interference with the through screen flow pattern.
- C. End plates and tee body shall be a minimum of 0.15 inch thick. All structural butt welds shall be full penetration fillet welds and shall be the thickness of the thinner component.

2.04 SLOT OPENING SIZE

- A. The screen slot size shall be as shown in the Table in Article 1.04.B. The open area for this slot opening shall be a minimum of 35.67%.
 - 1. Slot size shall be controlled and continuously monitored during manufacture.
 - 2. For slot openings greater than 0.100 inch, the mean slot size shall be within +/- 0.003 inch with a standard deviation no greater than 0.003 inch throughout the entire assembly.

2.05 MATERIALS

- A. The static screen material shall be manufactured of Type 316L stainless steel material.
- B. The main outlet flange shall mate with a 16 -inch flange with a flange pattern equal to AWWA C207, Table 1, Class D.
- C. The air backwash connection shall be a minimum 1-inch flange suitable for mating with a Sch 40 stainless steel piping to connect screen to receiver tank.

2.06 AIRBURST BACKWASH SYSTEM

- A. The air backwash system shall consist of an integrated system of compressor, receiver tank, valves, and control panel.
 - 1. The compressor shall be a reciprocating type and shall be sized to recover from each backwash in 15 minutes. The compressor shall be no greater than 5 horsepower (hp) capable of producing 17.3 actual cubic feet per minute (ACFM) at 200 pounds per square inch gauge (psig).
 - 2. The receiver shall be a 60-gallon receiver, ASME coded for 200 psig, sized for the system piping, and to displace three screen volumes of air at the screen during a backwash to provide suitable debris removal and cleaning. Two of the three volumes shall be delivered in the first second of the backwash cycle.
 - 3. The receiver shall be equipped with a 4-inch isolated pressure gauge, safety valve, and automatic drain valve.
 - 4. The system shall include one butterfly valve rated at 200 psi with standard ANSI Class 125/150 flanges, sized to match the tank flange and backwash piping.
 - 5. Interconnecting piping and interconnecting wiring to automated valving and power connections between the intake screen assembly and the airburst system is by the General Contractor.

2.07 CONTROLS

- A. A NEMA 4 control panel shall be included that will contain as a minimum, the motor starter for the compressor, control power transformer, and relay logic to perform the specified control functions.
- B. The controls shall allow backwash based on differential level, timed automatic or manual initiated air cleaning cycles. The control system shall allow a full week duration of time and day programmed air burst cleaning cycles.
- C. The system default control will be timer-controlled operation which will allow the operator to schedule a routine air backwash based on an operator selectable time interval that may span several days or several weeks.
- D. In manual mode, the operator can initiate an airburst backwash.
- E. In differential level mode for backwash control, the system will receive a start signal from the facility PLC in CP1 to initiate a air burst backwash based on a selected differential level between the intake screen wetwell and the recharge pump wetwell.

- F. The control panel shall monitor and annunciate compressor run and failure modes and annunciate the operation mode – differential pressure, timer mode, or manual. The compressor run, failure status and the selected operation mode shall be monitored and annunciated by the facility PLC.

PART 3 EXECUTION

3.01 MANUFACTURER'S SERVICES AND CERTIFICATIONS

- A. The equipment manufacturer shall furnish the services of a qualified representative to provide installation, startup, and testing services in accordance with this Section, Section 01820, Training, and Table 11000-1, Equipment Testing and Training Requirements. Screens and airburst system shall be installed in accordance with the manufacturer's recommendation.
- B. Unless stated otherwise, the representative shall supervise and check the installation(s) for not less than 2 days, perform the final acceptance tests, and instruct the Owner's operators in the operation, proper maintenance, and repairs for not less than 3 additional days.

END OF SECTION

SECTION 11450
BOREHOLE INJECTION CONTROL VALVE SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This Section covers the furnishing and installation of the recharge well head, Borehole Injection Control Valve System, in-line check valve, interconnecting and appurtenances as shown on the Drawings and specified herein.
- B. The following items are a part of this Section and shall be furnished and coordinated to function as an integrated and complete system to ensure a properly designed aquifer recharge well and well purge system.
 - 1. Hydraulic power unit and control panel.
 - 2. Well head, 10-inch well column and interconnecting column pipes.
 - 3. One static borehole control valve.
 - 4. In-line check valve.
 - 5. Purge pump.
 - 6. Miscellaneous appurtenances.
 - 7. Manufacturer's services.

1.02 RELATED SECTIONS

- A. Related specification sections conformed herein and listed below:
 - 1. Section 11000, General Equipment Requirements.
 - 2. Section 11535, Submersible Non-Clog Centrifugal Pumps.
 - 3. Section 13300, Instrumentation and Control for Process Systems.
 - 4. Section 15110, Manual, Check, and Process Valves.
 - 5. Section 15276, Stainless Steel Pipe.
 - 6. Division 16, Electrical.

1.03 REFERENCES

- A. The work shall conform to applicable provisions of the following standards, latest, editions, except as modified herein.
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM D638—Standard Test Method for Tensile Properties of Plastic.

- b. ASTM D648—Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
 - c. ASTM D785—Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
 - d. ASTM D790—Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- 2. American Water Works Association (AWWA)
 - a. AWWA C207—Steel Pipe Flanges for Waterworks Service – Sizes 4 through 144 inches.
- 3. International Organization for Standardization (ISO)
 - a. ISO 9000—Quality Management Systems – Fundamentals and Vocabulary.

1.04 SUBMITTALS

- A. See Section 01330, Submittals and Acceptance.
- B. Provide piping and instrumentation diagram (P&ID) drawings documentation control functionality described in this and related specifications to provide a complete and operable system.
- C. Drawing(s) showing equipment diameter, equipment length, assembly length, interface dimension for outlet and dimensions, materials of construction, and assembly weight.
- D. Included in the submittals shall be all associated hydraulic power unit and control panel, well head and 10-inch well column, borehole injection control valve, in-line check valve, and purge pump equipment catalog information, system sizing criteria, and drawings. All dimensional and operational information will be provided. All interconnecting wiring and piping information will be included and documented.
- E. Welder Certifications.
- F. Evidence of a statistical control program.
- G. Provide supporting flow distribution data where calculation methods are verified by physical flow distribution tests.

1.05 DELIVERY

- A. See Section 01650, Delivery, Storage, and Handling.

PART 2 PRODUCTS

2.01 GENERAL

- A. All system components and equipment for the Borehole injection control valve shall be furnished as a complete integrated system.
 - 1. Model: V-Smart BIC-V Borehole Injection Control Valve.
 - 2. Manufacturer: ASR Resources, LLC, 7345 S. Durango Dr., Ste B107-176, Las Vegas, NV 89113.

2.02 V-SMART BOREHOLE INJECTION CONTROL VALVE

- A. The Contractor shall provide a 6-inch, hydraulically actuated, 304 Stainless Steel, V-Smart BIC-V Borehole Injection Control Valve™ to control the injection flow rate into the well. The valve shall be sized with the appropriate number of slotted ports to provide linear throttling capacity over the entire injection flow range from 0.5 to 5 MGD. To fit into the required casing diameter, the valve outer diameter shall not exceed 9 inches.
- B. The manufacturer shall provide detailed sizing data that shows the expected valve position, pressure drops and velocities over the full range of injection flow rates at a given well head pressure, accounting for both static and dynamic water level changes.
- C. Without command input, the set point of the valve shall not be affected by changes in well head pressure, flow rates, velocities or dynamic water levels in the well. The valve shall remain locked in a set position when not being command driven to an open or closed position set point change.
- D. The valve shall be capable of local manual control and/or remote operation.

2.03 HYDRAULIC POWER UNIT AND CONTROL PANEL

- A. The V-Smart valve shall be operated by a Hydraulic Power Unit (HPU) with an electric driven, 120VAC hydraulic pump, hydraulic reservoir, adjustable pressure relief valve and pressure system components as manufactured by Continental Hydraulics.

- B. The HPU shall be provided with Allen Bradley CompactLogix PLC for digital communication of status and control.
- C. The HPU shall drive the V-Smart valve open and closed or to any set point in between full open and full closed.
- D. The HPU shall provide local and remote indication of the following: V-Smart valve full open and full closed position status, HPU pump running, V-Smart valve driving open, V-Smart valve driving closed, HOA in auto, off, or hand position.
- E. The HPU shall be furnished in a NEMA-3R stainless steel enclosure, with temperature activated fan ventilation.
- F. The enclosure shall be sized to allow access to all internal components of the HPU. The pump shall be easily removed from the enclosure for any required maintenance. The enclosure shall utilize a front mounted lockable access door.
- G. The HPU shall be furnished with internal controls, mounted on an inner door, including Hand/Off/ Auto selector switch, Pump Start and Pump Stop push buttons, and Valve Open/Valve Closed push buttons.
- H. Indication lights shall be furnished for HPU Power On, HPU Pump Running, V-Smart Valve Driving Open, V-Smart Valve Driving Closed, V-Smart Valve Position Open and V-Smart Valve Position Closed.
- I. Independently adjustable needle valves shall be furnished to provide hydraulic speed control for the valve in both the open and closed direction of travel. 3,000 psi, stainless steel, oil-filled pressure gages shall be mounted inside the inner door to show pump output pressure and output pressure on both hydraulic hoses leading to the V-Smart valve.
- J. The HPU shall include pilot operated check valves to hydraulically lock the V-Smart valve into a fixed stroke position.
- K. The HPU shall drive the V-Smart valve open and closed with a dual-coil, 3-position, 4-way, pilot operated solenoid valve with spring centered neutral position when the coils are de-energized.
- L. The HPU shall be provided with 10 gallons of food grade mineral oil shipped in a separate container for filling the reservoir at the job site.

2.04 HYDRAULIC HOSES

- A. Hydraulic hoses from the HPU to the V-Smart valve shall be provided in two continuous length sections, 20 feet and 100 feet, with locking stainless steel quick disconnect fittings at the valve, at the well head, and at the HPU hose ends, to facilitate leak-free installation or removal of the hoses.
- B. Hoses shall be Dyna Flex 711A-04 Thermoplastic Twin Line SAE 100R7 or equivalent Hydraulic Hose.
- C. Hoses must be capped and spool mounted for shipment to the jobsite.
- D. Hoses shall be rated for a maximum operating pressure of 3,000 psi, minimum burst pressure of 12,000 psi.
- E. The contractor shall secure the hoses to each section of joint pipe, using 316 SS banding or Polyethylene Strap.
 - 1. When using SS banding the contractor shall wrap the hoses with a 1/4-inch rubber pad to prevent hose damage.
- F. Hydraulic hoses shall maintain a positive slope from the V-Smart valve up to the HPU.

2.05 IN-LINE CHECK VALVE

- A. A 6-inch in-line check valve shall be installed between the V-Smart Valve and the Purge Pump as shown on the Drawings.
- B. The in-line check valve shall be Type 475, Stainless Steel Check Valve, in accordance with Section 15110, Manual, Check, and Process Valves.

2.06 WELL HEAD, WELL COLUMN AND INTERCONNECTING OR RELATED PIPING

- A. The material for the well head and well column, and related interconnecting welded pipe and fittings shall be manufactured of SCH 40 Type 304 stainless steel material and shall be in accordance with Section 15279, Stainless Steel Pipe.
- B. The material for the related interconnecting welded pipe and fittings shall be manufactured of Nitronic 50 stainless steel material.

2.07 COLUMN CENTRALIZERS

- A. The column centralizers shall be installed at maximum 8-foot intervals on the column pipe and have the following characteristics:
- B. Band and Risers
 - 1. Band: 14-Gauge, T-304 Stainless Steel.
 - 2. Width: 12 inches.
 - 3. Riser: 10-Gauge T-304 Stainless Steel.
- C. Liner
 - 1. PVC:
 - a. Dielectric Strength: 60,000 VPM.
 - b. Thickness: .090 inch +/- .010.
 - c. Hardness: 80 Durometer +/- 5.
 - 2. EPDM:
 - a. Dielectric Strength: 50,000 VPM.
 - b. Thickness: .090-inch (2.29 mm) min.
 - c. Hardness: Durometer "A" 85-90.
 - d. Water Absorption: 1% max.
 - e. Overlaps Edges.
- D. Bolts, Nuts and Washers
 - 1. Up to nominal OD of 16 inches – T-304 Stainless Steel:
 - a. 1/4-inch 20UNC x 2-inch-long bolts.
 - b. 1/4-inch hex nuts.
 - c. 1/4-inch washers SAE 2330.
 - 2. Above nominal OD of 16 inches – T-304 Stainless Steel:
 - a. 5/16-inch 18UNC x 2-inch-long bolts.
 - b. 5/16-inch hex nuts.
 - c. 5/16-inch washers SAE 2330.
- E. Runner/risers
 - 1. 2-inch-wide glass filled polymer plastic.

F. Sizes of Runner/risers available

1. Length: 11 inches (27.9 cm).
2. Effective Heights for 11-Inch Length: 1 inch, 1-1/2 inch.

G. Material Specifications

1. Rockwell Hardness (M) (ASTM D785): 101.
2. Tensile Strength (ASTM D638): 27,000 psi.
3. Flexural Strength (ASTM D790): 40,000 psi.
4. Deflection Temp. @ 264 psi (ASTM D648): 478° F (248° C).
5. Deformation Under Load @ 72° F (22° C): 3,500 lb.
6. Load (ASTM D648): 1%.

H. Welding

1. All risers are welded to the band by MIG welding. Stainless steel welds are fully passivated

I. Column centralizers shall Stainless Steel Casing Spacers as manufactured by APS, Model SSI8, or Engineer approved equal.

2.08 PURGE PUMP SYSTEM

- A. The pumping unit shall be supplied by one manufacturer and shall be complete including pump, motor, and submersible power cable and accessories. The pump shall meet all of the requirements of AWWA E-102, where not in conflict with this specification.
- B. The pump, motor, and controls shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, without cavitation, and without excessive vibration or strain. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially constructed to meet the Specifications.
- C. The pump shall be as manufactured by Peerless Pump Company or approved alternate pump, all meeting the detailed hydraulic and mechanical specifications included herein.

- D. Pump shall be designed for the conditions of service tabulated as follows. All pumps shall have a rising head capacity curve for stable pump operation from the minimum head operating point to the shut off head.

Unit designation	Value
Number:	1
Liquid:	Floridan Well Water
Design Capacity:	2,140 gpm
Design Total Head (TH):	112 feet
Minimum Pump Shut Off Head at Design Speed:	169.3 feet (minimum)
Minimum Pump Efficiency at Design Flow:	71.5%
Secondary Capacity:	2,800 gpm
Minimum TDH at Secondary Capacity:	95 feet (minimum)
Minimum pump Efficiency at Secondary Condition:	70%
Minimum Run Out Capacity:	3,450 gpm
Minimum Total Head (TH) at Run-Out Capacity:	50 feet
Minimum Bowl Efficiency at Run-Out Capacity:	52%
Maximum NPSHr (TH) at Secondary Condition:	42 feet
Maximum Operating Speed:	1,780 rpm
Non-Overload Motor to be Supplied:	100 HP (maximum)
Maximum Pump and Motor Diameter:	13.62 inches
Existing Well Casing Inside Diameter:	23.00 inches
Pump Model Used for Design (Peerless):	Vertical – 14HXB (two stages)

- E. Materials of construction shall be in conformity with nomenclature and materials as listed. No. carbon steel, leaded bronze or cast-iron parts or fasteners shall be used on the pump:

1. Impellers shall be of the closed type, machined to a smooth, hard finish and shall be dynamically balanced to ISO standards Grade G2.5 and designed, particularly for the service described herein.
2. If the impellers are trimmed to provide the characteristic performance curve for the pump as specified, this work shall be done with utmost accuracy. If the impellers are trimmed after they have been dynamically balanced, the impellers shall again be balanced prior to assembly.

3. Pump impellers shall be cast CF9M cast stainless steel. Impellers shall be locked securely to the shaft with Type 316 stainless steel tapered lock bushings or by thrust washer and key of the same material.
 4. Impeller design will allow for the future installation of wear rings during overhaul.
 5. The bowl castings shall be of cast stainless steel CF8M, be free of blow holes, sand holes, and all other faults; accurately machined and fitted to close dimensions. The bowl assembly shall be capable of working pressure equal to 150% of the pump's shut off head.
 6. Bowl assembly wear rings shall be installed in each case. Bowl wearing rings shall be of a material 50 Brinell points harder than the impellers. Bowl wear rings may be of Nitronic 50 or 60.
 7. Pump shaft shall be of Nitronic 50. Shafting shall be of sufficient diameter to transmit the pump horsepower with a liberal safety factor and rigidly support the impellers between the bowl or case bearings.
 8. The coupling connecting the motor to the pump bowl assembly shall be of sufficient size and strength to withstand maximum torque generated by the motor plus added safety factor. The coupling shall be of Nitronic 50 and keyed or spliced to the pump shaft.
 9. Bearings shall be furnished at each bowl assembly. The bearings shall be non-metallic type as manufactured by Thordon, or equal. The Manufacturer shall be responsible for providing bearings that meet the loads and all of the requirements of the service specified.
 10. A sand collar of Viton rubber or Noryl plastic shall be provided to protect the suction adapter bearings from abrasives in the liquid pumped.
 11. Intake shall be protected with a 316 stainless steel strainer to prevent ingestion of rocks.
- F. A wet wound water-filled submersible motor as manufactured by Pleuger, Hitachi, Sunstar, or Grundfos shall be furnished, designed to operate on 480-Volt, three-phase, 60 Hz electrical power supply. Motor must be of the rewindable design. The submersible motor shall be rated at the horsepower shown in the table above. The nameplate rating on the motor shall not be exceeded at any point on the pump performance curve. The motor shall have a 1.15 service factor and shall be designed to operate on a variable frequency drive power supply.
- G. All materials, design, construction and nomenclature for the motor, shall be in accordance with the NEMA standards for the class of installation and enclosure employed.
- H. The motor housing, end bell and all other parts exposed to brackish water shall be Grade CF8M stainless steel or 316L stainless steel or nickel aluminum bronze.

- I. A removable water-block lead assembly or a compression type cable shall be employed to prevent ingress of water into the motor terminals.
- J. The motor shall have a dynamically balanced rotor mounted on an amply sized 316 stainless steel shaft supported by water lubricated sleeve type carbon or Thordon bearings. Rotor bars shall be copper. Aluminum rotor bars will not be accepted. Rotor shaft extension shall be duplex stainless steel. Rotor shaft shall be supported on both ends with Thordon or carbon graphite radial bearings. The thrust bearing shall be water lubricated self-aligning and self-equalizing Kingsbury type assembly with multiple micro-finished stainless steel bearing shoes providing contact with a graphite or carbon rotating ring and shall have the capability to run in either direction without sustaining any damage.
- K. The motor shall be filled at the factory with a treated food quality glycol water internal lubricating solution for a maximum reliability and long life. The motor shall be checked at the site prior to installation to ensure the motor has not lost any of its lubricating solution.
- L. The motor shall be furnished with power and control cables sized per NEX. Cable shall be designed for submerged service and must be non-hydroscopic. Cable jacketing shall be neoprene or equal and insulation shall be Ethylene Propylene Rubber (EPR) or equal. Cables shall be rated 600 volts. Cable clamps to securely fasten the cable at intervals of not more than 10-ft shall be provided. Cable shall terminate at 480-volt terminal box at the surface. Unit shall be furnished complete with a cable splicing kit. Cable must meet NEC Standards.
- M. The motor power cable shall be factory terminated in the motor without external splice or splice kit outside the motor and shall run continuously from the motor to the 480-volt terminal box at the surface without splices. Motor cable shall be provided from the manufacturer in a minimum of 150 feet or longer as required by setting depths as shown on the project drawings.
- N. The installing Contractor shall install the wire without breaking the flat jacket, through the cable gland in the surface plate or discharge head to insure a secure seal-off to prevent water entering the interior of the jacket and wicking into the motor.
- O. Furnish all required connection in the surface plate to allow for the wire penetration and connection for instrumentation as shown on the Drawings.
- P. Wire suspension electrodes with solid-state relay for low level shut-off and alarm, to be installed under this Section, shall be as furnished.

2.09 CONTROLS & FUNCTIONAL DESCRIPTIONS

- A. The controls shall be as shown in the Drawings, as described herein, and in the Division 13, Special Construction, and Division 16, Electrical, specifications.
- B. The Borehole Injection Valve controls will communicate and annunciate with the facility PLC to allow the modes of operation described herein. The PLC will monitor, annunciate and alarm for the Borehole Injection Valve System which consists of the following inter-related equipment and instrumentation:
 - 1. Facility PLC to control, monitor and annunciate alarms and status of system.
 - 2. Recharge Pump and VFD.
 - 3. Water levels at the recharge pump wetwell and the aquifer recharge well (RW-1).
 - 4. Well head pressure as measured on the well head.
 - 5. Borehole Injection Control Valve with HPU and Control Panel.
 - 6. Purge pump manually controlled by motor control center (MCC).
- C. The system will be designed for the following modes of operation:
 - 1. Recharge Mode – Auto w/ Pump: The mode of operations is controlled by the PLC and initiated by the operations staff with the Recharge Pump VFD and V-Smart valve Control Panel set to Auto-mode. Operations staff will select the desired pump flow rate from 300 gpm to 1,400 gpm. Operators start initiation at the PLC, the V-smart valve will start in the closed position, and the pump VFD will start at a pre-set low speed to remove air entrained in the recharge force main. The system will monitor the well head pressure, and when a selected positive well head pressure is achieved, the V-Smart valve will begin to slowly open and the VFD will slowly ramp the pump to desired recharge flow rate as monitored by the recharge well flow meter.
 - 2. Recharge Mode – Auto w/ Siphon: The mode of operations is controlled by the PLC and initiated by the operations staff with the Recharge Pump VFD and V-Smart valve Control Panel set to Auto-mode. Operations staff will select the desired siphon flow rate that will be determined based on static water elevations in the recharge well compared to the recharge pump wetwell (and setup during startup phase). Operators start initiation at the PLC, the V-smart valve will start in the closed position, and the pump VFD will start at a pre-set low speed to remove air entrained in the recharge force main. The system will monitor the well head pressure, and when a selected positive well head pressure is achieved, the V-Smart valve will begin to slowly open and the VFD will slowly ramp the pump to desired recharge flow rate as monitored by the recharge well flow meter.

The pump will operate in Pump Mode for 2 to 5 minutes to confirm steady flow rate is maintained. Once achieved, the PLC will shut-down the pump, and the V-Smart valve will maintain the set flow-rate with input from the PLC including: recharge flow rate, recharge well head pressure, recharge well level, and recharge pump wet well level.

3. Recharge Mode – Hand: In this mode the recharge pump flow rate and pump speed is set manually at the VFD and the V-Smart valve is slowly opened once positive well head pressure is obtained. This mode is used for maintenance and system testing.
4. Well Backwash/Purge Mode: This mode of operation is manually controlled by the operations staff. The V-Smart valve must be in closed position prior to starting Purge Pump at MCC starter panel. The operations staff will start the pump at the MCC panel and run for desired duration and stop the pump at the MCC panel.

PART 3 EXECUTION

3.01 MANUFACTURER’S SERVICES AND CERTIFICATIONS

- A. The equipment manufacturer shall furnish the services of a qualified representative to provide installation, startup, and testing services in accordance with this Section, Section 01820, Training, and Table 11000-1, Equipment Testing and Training Requirements. Screens and airburst system shall be installed in accordance with the manufacturer’s recommendation.
- B. Factory Authorized installation supervision and start-up commissioning services shall be included in the V-Smart BIC-V valve proposal package.

END OF SECTION

SECTION 11535
SUBMERSIBLE NON-CLOG CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Work under this Section includes, but is not limited to, installing a submersible pump operating on variable frequency drive at the Recharge Pump Building wetwell as shown on the Drawings and as herein specified, and as necessary for proper and complete performance.
- B. The Contractor shall furnish all labor, new materials, equipment, and incidentals necessary for the complete installation of the submersible non-clog centrifugal pump, including but not limited to pumps, pump bases, guide rail and lifting system, and/or controls as shown on the Drawings and specified in this Section for installation procedures of all materials and equipment to provide a complete and operational submersible pump system to feed the Class V, Group 2 Recharge Well.
- C. The pumps, motors, control panels, guide rails, and access cover shall be furnished by a single supplier. The pump supplier shall be responsible for overall supply and quality of these items and shall be responsible for testing, start-up, troubleshooting, and personnel training for the submersible non-clog centrifugal pumps and lift station.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. The Contractor shall submit written certification from the pump supplier that the wet well size and layout are acceptable for the pump installation.
- B. Shop Drawings: The Contractor shall submit integrated shop drawings for the pumping system illustrating the mechanical and electrical equipment and components specified in this Section and including the following:
 - 1. Product Data: For each mechanical, structural, and electrical component include the manufacturer's descriptive literature, product specifications, published details, technical bulletins, performance, and capacity-rating curves with primary and secondary design conditions clearly noted, charts, and schedules, catalog data sheets, and other submittal materials as

required to verify that the proposed products conform to the quality and function of the specified products.

- a. Identification: Clearly indicate by an arrow on submissions covering more than one product type or style exactly which product is being submitted for approval.
 - b. Equipment Characteristics: Provide bearing ratings, complete motor data, service factors, shaft diameters, coupling type, and weights of principal parts and assembled equipment.
 - c. Manufacturer: Include the catalog name, company name, address, and telephone number for the manufacturer of each product submitted.
2. Equipment Drawings: Submit completely dimensioned plan, elevations, and cross-sections of system equipment and sub-assemblies.
3. Layout Drawings: Submit completely dimensioned drawing of pump, pump base, anchor bolt size and patterns, complete guide rails system, installation notes, recommended grout configuration of wetwell bottom, discharge elbow mounting instructions, and other pertinent setting details.
4. Product List: Provide a list of equipment and components on each drawing with each product identified by legend reference. Include product name, manufacturer, and model number.
5. Wiring Diagrams: Submit complete interconnecting wiring diagrams and schedules for electrical apparatus showing numbered wiring terminals in the pump control panel conforming to NEMA ICS-1-101. Identify field device terminals, wire number, wire sizes, control and power wire types, and interfaced elements.
6. Control Panel Drawing: Submit a dimensioned drawing of the control panel indicating the primary electrical components and panel face with control devices, lights, indicators, and other panel-face-mounted apparatus located and identified. Provide an internal face view of the equipment arrangement with equipment identified.
7. Additional Requirements: See Division 13, Special Construction, for additional submittal requirements for the control panel furnished under this Section and specified below.

- C. Pump Test Report: Submit certified copies of factory-run pump performance test curves. Factory-certified performance test curves shall indicate the following:
1. Flow in gallons per minute.
 2. Total head in feet of water.
 3. Horsepower.
 4. Pump efficiency in percent of input shaft horsepower.
 5. Pump data:
 - a. Model number.
 - b. Serial number.
 - c. Impeller diameter and type.
 - d. Impeller speed.
 6. Test condition data:
 - a. Date of test.
 - b. Mean water temperature.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Concrete Institute (ACI)
1. ACI 318/318R—Building Code Requirements for Structural Concrete.
- B. American Iron and Steel Institute (AISI)
- C. American National Standards Institute/Hydraulic Institute (ANSI/HI)
1. ANSI/HI 1.1-1.2—Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions.
 2. ANSI/HI 1.4—Rotodynamic (Centrifugal) Pumps for Manuals Describing Installation, Operation, and Maintenance.

D. American Society for Testing and Materials (ASTM)

1. ASTM A36/A36M—Standard Specification for Carbon Structural Steel.
2. ASTM A48/A48M—Standard Specification for Gray Iron Castings.
3. ASTM A105/A105M—Standard Specification for Carbon Steel Forgings for Piping Applications.
4. ASTM A123/A123M—Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM C478—Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.

E. American Society of Mechanical Engineers (ASME)

1. ASME B16.1—Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.

F. American Waterworks Association (AWWA)

1. AWWA C207—Steel Pipe Flanges for Waterworks Service, Sizes 4-Inch through 144-Inch (100 mm through 3,600 mm).

G. International Standards Organization (ISO)

1. ISO 2858—End Suction Centrifugal Pump (Rating 16-Bar) Designation, Nominal Duty Point and Dimensions.
2. ISO 5199—Technical Specifications for Centrifugal Pumps, Class II.
3. ISO 7005-2—Metallic Flanges – Part 2: Cast Iron Flanges.

H. National Electrical Manufacturer's Association (NEMA)

1. NEMA 250—Enclosures for Electric Equipment (1,000 Volts Maximum).
2. NEMA 3R—Rain-Proof and Sleet- (Ice-) Resistant-Outdoor Enclosures.
3. NEMA Design B—Electrical Induction Motors.
4. NEMA ICS-1—Industrial Control and Systems: General Requirements.

I. National Fire Protection Association (NFPA)

1. NFPA 70—National Electrical Code.

J. Underwriters Laboratory (UL)

1. UL 508—Standard for Industrial Control Equipment.

1.04 QUALITY ASSURANCE

- A. The pumps shall be shipped to the jobsite complete with the motor, local wiring, control, equipment base, and anchor bolts and other appurtenances as specified pre-installed. Control Panel and spare parts shall be shipped loose and ready for installation at the location shown on the Drawings.
- B. Modifications to the manufacturer's standard design may be required to meet these Specifications. Equipment not complying with the mechanical, electrical, and material integrity established by these Specifications shall be identified by the Contractor and submitted to the Engineer for review.

1.05 QUALIFICATIONS

- A. The manufacturer(s) of the equipment specified shall meet the following requirements:
 - 1. Shall have been in business for at least the 10 years before the Bid Date.
 - 2. Shall have a record of operating, manufacturing, and servicing the types of items specified for a minimum of 10 years before the Bid Date.
 - 3. Shall have a minimum of five installations of equipment similar to and meeting the requirements specified in this Section at municipal wastewater treatment facilities in Florida before the bid date.

1.06 SYSTEM DESCRIPTION

- A. The pump station shall have submersible centrifugal non-clog pumps as specified in this Section with controls capable of operating the pumps either individually, alternately, and/or simultaneously, depending on the load condition.
- B. The pump station shall be complete units with necessary appurtenances installed within the pump intake basin.

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

O&M manuals shall be in accordance with Section 01830, Operations and Maintenance Manuals, and shall include the following:

- A. Installation instructions.
- B. Functional description of the pumping control system for each mode of operation of equipment.
- C. Automatic and manual operation.

- D. Alarms and fail-safe features.
- E. Interlocked and/or interfaced equipment operation and control.
- F. Exploded view drawings and illustrations with descriptions for assembly and disassembly of equipment.
- G. Comprehensive parts and materials maintenance and repair list for each equipment element indicating the manufacturer and the manufacturer's identification number. Include the name, address, and telephone number of local sales and service office for major equipment items.
- H. Schedules of recommended spare parts to be stocked, including part number, inventory quantity, and ordering information.
- I. Performance rating and nameplate data for each major system component.
- J. Procedures for starting, operating, adjusting, calibrating, testing, and shutting down system equipment.
- K. Emergency operating instructions and trouble-shooting guide.
- L. Schedule of routine maintenance requirements and procedures and preventative maintenance instructions required to ensure satisfactory performance and equipment longevity.
- M. Maintenance instructions for extended out-of-service periods.
- N. Schedule of lubrication requirements, including lubricant type, service interval, and lubrication points.
- O. Field-verified power and control wiring schematics. Submit the approved schematics in each manual. After initial start-up and operation, correct these schematics to reflect any required field changes and submit the required copies for inclusion in the manuals.
- P. Four preliminary copies of the O&M manuals shall be submitted before the equipment arrives at the site. The Contractor shall not be compensated for the pumping equipment until the preliminary O&M manuals are received. Four copies of the final O&M Manuals shall incorporate the Engineer's comments and be submitted with copies of the approved shop drawings and test reports.

- Q. Installation Certificate: Submit a certificate from the manufacturer or from the manufacturer's qualified, factory-authorized representative for each pump furnished and installed and specified in this Section stating that the equipment has been installed, inspected, and adjusted as required in accordance with the manufacturer's written installation procedures and operating instructions and is ready for acceptance by the Owner.

1.08 SPECIAL CONSIDERATIONS

- A. All of the equipment, accessories, and controls specified in this Section shall be furnished by a single manufacturer and shall be standard units of proven ability as manufactured by a competent organization that is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished.

1.09 GENERAL REQUIREMENTS

- A. General: The pump manufacturer/supplier shall be responsible for furnishing the pumps, motors, and drive arrangements with all necessary items for a complete system. The pump manufacturer shall coordinate with the Contractor on the selection of the Variable Frequency Drive equipment for adjustable speed pumping units.

PART 2 PRODUCTS

Materials and equipment shall conform to the referenced publications or as specified and indicated and shall be the products of manufacturers regularly engaged in the manufacture of such products.

2.01 SUBMERSIBLE CENTRIFUGAL NON-CLOG PUMPS

- A. Major pump components shall be of grey cast iron, ASTM A48/A48M Class 35B/40B or ASTM A48/A48M Class 30, with smooth well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities. All exposed nuts or bolts shall be Type 300 series stainless steel. The discharge nozzle shall be flanged and sufficiently rigid to support the guiderail-mounted pumping unit under all operating conditions.
- B. For Enclosed Impeller: The impeller shall be an enclosed one-piece casting, ASTM A48/A48M Class 35B/40B or ASTM A48/A48M Class 30 cast iron, with not more than two non-clog passages. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity.
- C. The impeller shall be dynamically balanced and securely locked to the shaft by a key and self-locking bolt or nut.

- D. Coatings: All metal surfaces in contact with the pumped media, other than stainless steel, shall be coated in the factory with a zinc primer and polyester resin or high-solids epoxy finish.
- E. Wearing Rings: Renewable Type 316 stainless steel wearing rings shall be provided in the casing and on the impeller. The rings shall be positively locked in place.
- F. Oil Chamber Housing: The oil chamber shall contain a drain plug and a vent plug.
- G. Air-Filled Pump:
1. Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and running in an oil chamber. The lower seal unit between the pump and the oil chamber shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper seal unit between the oil chamber and the stator housing shall contain one stationary tungsten carbide ring and one positively driven rotating carbon ring. Each interface shall be held in contact by an independent spring system designed to withstand maximum suction submergence. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement.
 2. Shaft seals lacking positively driven rotating members or conventional double mechanical seals which use a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing will not be acceptable. The seals shall not rely upon the pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended periods while pumping under load.
- H. Oil-Filled Pump:
1. Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and with an oil chamber between the seals. John Crane Type 21 seals shall be used with the rotating face of the seal shall be carbon and the stationary seal faces shall be ceramic. The pump shall be equipped with 300 Series stainless-steel hardware and a 300 Series stainless-steel shaft sleeve for under the lower seal. A seal leak detection sensor shall be provided between the seals.
- I. Sealing of Mating Surfaces: All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is required. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression

in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

J. Discharge Base:

1. The manufacturer shall furnish a discharge base and discharge elbow for each pumping unit. The base shall be sufficiently rigid to firmly support the guiderails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the pump intake basin. The face of the discharge elbow inlet flange shall be perpendicular to the floor and shall make contact with the face of the pump discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ASME B16.1, Class 125.
2. The pump and motor assembly shall be automatically connected to and supported by the discharge base and guiderails so that the unit can be removed from the wet well and replaced without the need for operating personnel to enter the pump intake basin.

K. Pump Characteristics:

Unit designation	Submersible Well
Number of Units	1
Total Head at Primary Design Condition (feet)	60
Capacity at Primary Design Condition (gpm)	1,400
Minimum Efficiency at Primary Design Condition	61.5%
Total Head at Secondary Design Condition (feet)	40 (minimum)
Capacity at Secondary Design Condition (gpm)	350
Minimum Efficiency at Secondary Design Condition	39%
Shut-off Head (feet)	115 (minimum)
Rated Pump Speed (rpm)	1,780
Motor Power (hp)	50 (maximum)
Discharge Elbow Outlet Diameter (inches)	6-inch
Minimum Discharge Sphere Diameter (inches)	3
Minimum Hydrostatic Test Pressure	1.5 times shutoff head plus suction pressure

1. Pump performance shall be stable and free from cavitation and noise through the specified operating head range at minimum suction submergences.
2. Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.

L. Acceptable Pump Manufacturer/Model:

1. Grundfos Model S1.40.A50.420.4.58M.S.278.G.EX.D.6.11.
2. Flygt Model NP 3171 MT 3~ 434.
3. Engineer approved equal.

2.02 ELECTRIC MOTORS

Electric motors shall be in accordance with Division 16, Electrical, unless noted otherwise in this Section:

- A. Air-cooled: Each pump shall be driven by an air-filled, totally submersible electric motor manufactured by the pump manufacturer. Each motor shall be rated 460 volts, 60 Hz, three-phase and shall have a service factor of 1.15. The motor nameplate rating shall exceed the maximum horsepower required by the pump in the operating head of the entire pump curve. The motor shall operate over the entire range of the pump curve without overloading the motor or operating in the service factor of the motor. The stator housing shall be an air-filled, watertight casing. Motor insulation shall be moisture resistant, Class H, 180°C. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature and designed for at least 10 starts per hour.
- B. Oil-cooled: Each pump shall be driven by a dielectric oil-filled, totally submersible electric motor manufactured by the pump manufacturer. Each motor shall be rated 460 volts, 60 Hz, three-phase and shall have a service factor of 1.15. The motor nameplate rating shall exceed the maximum horsepower required by the pump in the operating head of the entire pump curve. The motor shall operate over the entire range of the pump curve without overloading the motor or operating in the service factor of the motor. The stator housing shall be an oil-filled, watertight casing. Motor insulation shall be moisture resistant, Class F, 155°C. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature and designed for at least 10 starts per hour.
- C. The motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move

axially. The bearing shall have a calculated AFBMA L₁₀ Life Rating of 40,000 hours when operating at maximum operating head.

- D. Each motor shall be capable of continuous operation in air (unsubmerged) for at least 24 hours under pump full load conditions without exceeding the temperature rise limits for the motor insulation system. Each unit shall be provided with an adequately designed cooling system, if necessary, to permit continuous operation in totally, partially, or non-submerged conditions.
- E. Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating that the cable is suitable for submerged use. Cable sizing shall conform to NEC and ICEA requirements. All cables shall be of sufficient length to terminate at the control panel or as otherwise indicated in the Drawings, with 10 feet of slack which will be coiled in the pump intake basin. Each cable shall be supported by AISI Series 300 corrosion-resistant stainless-steel Kellems or woven grips to prevent damage to the cable insulation. Mounting of cable supports in the basin shall be coordinated by the supplier to prevent damage to the cable. No splicing of cables shall be allowed.
- F. The cable entry water seal shall be water tight and include a strain relief.
- G. The motor and its integral protective controls shall be explosion proof and rated and labeled for use in a Class I, Division 1, Group D area under submerged and unsubmerged conditions.

2.03 CONTROLS

- A. The submersible pumps shall be controlled by a locally mounted variable frequency drive coordinated with the pump manufacturer to provide complete automatic operation of pumps based on the liquid level setting shown on the Drawings.
- B. Controls shall be as indicated in Division 13, Instrumentation, Division 16, Electrical, and as shown on the Contract Drawings.

2.04 FLOAT SWITCHES

- A. Float switches shall be of the suspended type with polypropylene or PVC body. Units shall have an integral electrical cable with two #19 AWG stranded

conductors. Switches shall be pilot duty, normally open or normally closed, as required for the application.

- B. Float switches shall be a direct-acting float switch which contains a mercury switch. Float switches shall be as specified below. The control panel shall have adjustable time delay switches (0 seconds to 300 seconds) so that the pump does not “chatter.” No splicing of the float switch cable shall be allowed. An extra 6 feet of looped float switch cable shall be looped and neatly tied in the basin with plastic ties.

2.05 PIPES, FITTINGS, AND VALVES

- A. Piping, fittings, and valves shall be provided where indicated on the Drawings and conform to the requirements of relevant sections.

2.06 GUIDE RAIL AND LIFTING SYSTEM

- A. Sliding Bracket: Each pumping unit shall be provided with an integral non-sparking, self-aligning guiderail sliding bracket. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The entire weight of the pump unit shall be wedged tightly against the inlet flange, making metal-to-metal contact with the pump discharge forming a seal without the use of bolts, gaskets, or o-rings. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions.
- B. Guide Rails: Each pumping unit shall be equipped with two Type 316 stainless-steel guide rails. Guide rails shall be sized by the pump manufacturer to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to the access open at the top of the pump basin. An upper guide rail bracket of AISI Type 316 stainless steel shall be provided.
- C. Lifting Chain: The pump manufacturer shall select and provide a stainless-steel lifting chain suitable for removing and installing each pump. The lifting chain shall be connected to a Type 316 stainless-steel lifting bail that is an integral part of the pump. A suitable Type 304 stainless-steel chain hook shall be provided at the top of the basin.

2.07 ACCESS HATCH COVER

- A. The pump manufacturer shall furnish new access hatch covers and all embedded items shall be shipped to the pre-cast manufacturer to be cast into the structures. All coordination shall be the Contractor’s responsibility. Access covers and accessories shall be as specified in Section 05500, Metal Fabrications, except as

otherwise specified in this Section. The cover shall be of all-aluminum construction and suitable for a live load of 300 pounds per square foot with a maximum deflection of $L/240$. The cover shall be a reinforced diamond pattern checkered plate. Structural shapes and plates shall be at least 1/4-inch thick. Each leaf shall be provided with two hinges, torsion bars, or other devices to help open an automatic hold-open arm, a retractable handle, and a padlock hasp. The frame shall be provided with strap anchors bolted or welded to the exterior and shall be provided with a lifting chain hook and a guiderail support bracket. All aluminum surfaces to be in contact with concrete or mortar shall be coated in accordance with Section 09900, Painting and Coating.

2.08 MISCELLANEOUS

- A. All metal fabrications, hangers, and hardware in the lift station shall be Type 316 stainless steel.

2.09 JOINTS AND PENETRATIONS

- A. Joints and lift station penetrations shall be as specified and detailed on the Drawings.

2.10 ANCHOR BOLTS

- A. Discharge connection anchor bolts shall be Type 316 stainless-steel epoxy anchors, not less than 3/4-inch diameter, designed for embedment in the concrete wet well floor. The anchor bolts and positioning templates shall be furnished by the pump manufacturer. All other anchor bolts shall be Type 316 stainless-steel epoxy anchors.

PART 3 EXECUTION

3.01 GENERAL

- A. Pumps, guide rails, control panel, and appurtenances shall be installed as indicated, in accordance with the Drawings and the manufacturer's instructions. The Contractor shall provide services required to install the pumps, piping, panel, and accessories and perform wiring to connect pumps, level sensors, etc., with the control panel and the control panel with power as required to place the pumping system in service in accordance with requirements of the Contract Documents, all local codes, and NFPA 70.
- B. Each discharge base shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and Hydraulic Institute Standards.

3.02 PAINTING

- A. All painting and associated work shall be performed in accordance with the paint manufacturer's recommendations for the particular application.

3.03 TESTS

Commercial testing shall be required and include the following:

- A. The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, voltage, phase, and hertz.
- B. The motor and seal housing chambers shall be hi-potted to test for moisture content and/or insulation defects.
- C. The pump shall be allowed to run dry to check for proper rotation.
- D. Discharge piping shall be attached, the pump submerged in water, and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalanced resistance exists. If so, the stator will be replaced.

3.04 FIELD REPRESENTATIVE

- A. A representative of the submersible centrifugal non-clog pump manufacturer hired by the Contractor shall inspect the pump installation and direct the startup of the station and shall instruct representatives of the Owner in startup and operation procedures. The Contractor shall procure the services of a representative of the submersible centrifugal non-clog pump manufacturer for the following:
 - 1. A minimum of 1 full day on site to inspect, adjust, and test the pump station installations and provide certification as specified.
 - 2. A minimum of 1 full day on site to place the pump station in operation to demonstrate compliance with requirements of the Contract Documents.
 - 3. A minimum of 1 full day on site to train representatives of the Owner in the operation, maintenance, and repair of the pumps, control panel, and related appurtenances.
- B. The manufacturer's services specified represent an absolute minimum acceptable level of service and are not intended to limit the responsibilities of the Contractor to comply with all requirements of the Contract Documents. The Contractor shall procure, at no additional cost to the Owner, all services required, including

additional or extended trips to the job site by the manufacturer's representative to comply with these requirements.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13300
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

1.01 DESCRIPTION

A. Scope

1. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a complete and operating instrumentation and control system.
2. The Work includes, but is not limited to, the following:
 - a. Panels and panel mounted instruments.
 - b. Field mounted instruments.
 - c. Programmable logic controllers (PLC) and software.
 - d. Uninterruptible power supply.
 - e. Network communication hardware and software required for interfacing various systems to provide one fully integrated system.

B. Coordination

1. Instrumentation and Controls:
 - a. The Work involves multiple participants who will provide related materials, equipment, or services to place the Aquifer Recharge Control and Monitoring System (ARCMS) into satisfactory operation. Programming of control logic and configuration of operator interface terminal (OIT) is part of the Work. The ARCMS supplier will provide and program the new Recharge Pump, Chemical Feed, and Recharge Well Control panels. The ARCMS supplier will program the new OIT. The Instrumentation System Supplier (ISS) will provide the instrumentation and communications interconnections between control panels.
 - b. Some panels and equipment are furnished under other sections of these Specifications. Coordinate with suppliers of these panels and equipment to provide fully functional system in accordance with the Contract Documents.
 - c. Computer system input/output list identifies inputs and outputs required and is shown on the Contract Drawings. Input/output list

is for coordinating signals between equipment provided by other suppliers and ARCMS.

- d. The supplier shall identify and document signals to be integrated into supervisory control and data acquisition (SCADA) system by the Owner at a later time. Include Work for Contractor-furnished control options not on the input/output list at no additional cost to the Owner.
- e. Coordination meetings between the Process Control Integrator, Equipment Suppliers and Manufacturers, Owner, and Engineer are required as part of this work, during which the details regarding the human machine interface (HMI) configuration and Control Loops will be coordinated and finalized.
 - (1) Pre-Development Meeting shall occur before the Contractor commences any programming or configuration efforts. Contractor questions will be addressed throughout the project via provisions allowed by Section 01310, Construction Coordination. This meeting forum encourages dialogue between involved parties to facilitate quick resolution and buy-in.
 - (2) Software Development Coordination Meeting shall occur before the Contractor commences any programming or configuration efforts. Before this meeting the Contractor (or representative third party subcontractor) shall prepare and submit the Pre-Development Application Software Design Submittal for review and comment. The Contractor shall present their proposed approach to software development, as documented in the submitted material, and be prepared to discuss options available with respect to the configuration, presentation, and control of the data graphically.
 - (3) Final Software Development Coordination meeting shall occur before deployment of the programming application modifications. Before the meeting the Contractor (or representative third party subcontractor) shall prepare and submit the Final Application Software Design Submittal. During this meeting the Contractor shall perform a live demonstration of the Control Application developed for this project. The Contractor shall use their computer hardware for the demonstration. The Owner and Engineer shall have the opportunity to operate the application to their satisfaction.

2. To centralize responsibility, materials and equipment provided under this Section shall be furnished by a single supplier.
3. With the Contractor, the supplier shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.
4. To the greatest extent possible, provide materials and equipment from a single manufacturer.
5. Supplier's Responsibilities:
 - a. Preparing all instrumentation and control equipment submittals in accordance with the Contract Documents.
 - b. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, and panels, including required interfacing with packaged control systems furnished by other equipment suppliers, and required interfacing with the Site's electrical system.
 - c. Review and coordination with manufacturers, suppliers, and other contracts of Shop Drawings and other Contractor submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.
 - d. Direct, detailed oversight of installation of instruments, panels, consoles, cabinets, wiring and other components, and related wiring and piping connections.
 - e. Calibrating, source quality control, field quality control, and start-up of the system.
 - f. Responsibility for correction period obligations for instrumentation and control system.
 - g. Training of operations and maintenance personnel in operation and maintenance (including calibration and troubleshooting) of the instrumentation and control system.

C. Related Sections

1. Section 16195, Electrical Identification.
2. Section 16482, Motor Starters.
3. Section 16775, Variable Frequency Drives.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. American Society for Quality (ASQ)
 - a. ASQ Z1.4—Sampling Procedures and Tables for Inspection by Attributes.
2. American Society for Testing and Materials (ASTM)
 - a. ASTM A269—Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - b. ASTM A312—Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - c. ASTM A403/A403M—Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
 - d. ASTM B88—Standard Specification for Seamless Copper Water Tube.
3. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE 802.1X—Local and Metropolitan Area Networks – Port-Based Network Access Control.
 - b. IEEE 802.3—Ethernet.
 - c. IEEE 8802-3—Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 3: Standard for Ethernet AMENDMENT11: Physical Layer and Management Parameters for Serial 25 Gb/s Ethernet Operation Over Single-Mode Fiber.
4. International Society of Automation (ISA)
 - a. ISA 5.1—Instrumentation Symbols and Identification.
 - b. ISA 5.4—Instrument Loop Diagrams.
 - c. ISA 20—Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
5. National Electrical Manufacturers Association (NEMA)
 - a. NEMA 250—Enclosures for Electrical Equipment (1,000 Volts Maximum).

6. National Fire Protection Association (NFPA)
 - a. NFPA 70 (NEC), Article 770, Optical Fiber Cables and Raceways.
 - b. NFPA 79, Electrical Standard for Industrial Machinery.
7. Underwriters Laboratories (UL)
 - a. UL 50—Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - b. UL 508—Industrial Control Equipment.
 - c. UL 508A—Industrial Control Panels.
 - d. UL 698A—Industrial Control Panels Relating to Hazardous (Classified) Locations.
 - e. UL 2062—Outline of Investigation for Enclosures for Use in Hazardous (Classified) Locations.

1.03 QUALITY ASSURANCE

A. Qualifications

1. Supplier:
 - a. Shall be financially sound with at least 5 years continuous experience in designing, implementing, supplying, and supporting instrumentation and control systems for municipal wastewater treatment facilities comparable to the instrumentation and control systems required for the Project, relative to hardware, software, cost, and complexity.
 - b. Shall have record of successful instrumentation and control system equipment installations. Upon the Owner's request, submit record of experience listing for each project: project name, owner name and contact information, name and contact information for the Contractor, name and contact information for engineer or architect, and approximate contract value of instrumentation and controls Work for which the supplier was responsible.
 - c. Shall have at the time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.

- d. Shall be capable of training operations and maintenance personnel in instrumentation and control applications, and in operating, programming, and maintaining the control system and equipment.
 - e. The Process Controls Integrator (PCI) shall meet the following minimum qualifications:
 - (1) A minimum of 7 years' experience with at least 5 years in water/wastewater projects.
 - (2) References for three completed projects of like size and application to the Project specified herein.
 - (3) Project bonding capacity of \$1 million.
 - (4) UL 508 certified panel shop.
 - (5) Electrical Contractors license in the Project site's state.
 - (6) On-staff licensed Professional Engineer registered in Florida.
2. Manufacturer: Manufacturers of instrumentation and control equipment furnished under this Section shall be experienced producing similar equipment and shall have the following qualifications:
- a. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
 - b. Shall have system of traceability of manufactured unit through production and testing in accordance with ASQ Z1.4.
 - c. Shall have guaranteed availability clause (99.99%, minimum for 1 year) for microprocessor-based components and appurtenances.
 - d. Shall have documented product safety policy relevant to products proposed for the Work.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Field Instruments:

- (1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
- (2) Instrument tag number in accordance with the Contract Documents.

- (3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
- (4) Description of construction features.
- (5) Performance and operation data.
- (6) Installation, mounting, and calibration details; instructions and recommendations.
- (7) Service requirements.
- (8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
- (9) Range of each device and calibration information.
- (10) Descriptions of materials of construction and listing of NEMA ratings for equipment.

b. Panels, Consoles, and Cabinets:

- (1) Layout Drawings that include:
 - (a) Front, rear, and internal panel views to scale.
 - (b) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.
 - (c) Product information on panel components.
 - (d) Nameplate location and legend including text, letter size, and colors to be used.
 - (e) Location of anchorage connections.
 - (f) Location of external wiring and piping connections.
 - (g) Mounting and installation details, coordinated with actual application.
 - (h) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.
 - (i) Calculations for heating and cooling of panels.
 - (j) Subpanel layouts and mounting details for items located inside control panels.

- (2) Product information on panel components including:
 - (a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
 - (b) Instrument tag number in accordance with the Contract Documents.
 - (c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
 - (d) Description of construction features.
 - (e) Performance and operation data.
 - (f) Installation, mounting, and calibration details; instructions and recommendations.
 - (g) Service requirements.
- (3) Wiring and piping diagrams, including the following:
 - (a) Name of each panel, console, or cabinet.
 - (b) Wire sizes and types.
 - (c) Pipe sizes and types.
 - (d) Terminal strip and terminal numbers.
 - (e) Wire color coding.
 - (f) Functional name and manufacturer's designation for components to which wiring and piping are connected.
 - (g) Lightning and surge protection grounding.
- (4) Electrical control schematics in accordance with NFPA 79. Drawings shall be in accordance with convention indicated in Annex D of NFPA 79. Typical wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.
- (5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number, and quantity for components mounted in or on the panel or enclosure.
- (6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.

- c. Field wiring and piping diagrams, include the following:
 - (1) Wire and pipe sizes and types.
 - (2) Terminal numbers at field devices and in panels.
 - (3) Fiber optic termination designations in the field and in panels.
 - (4) Color coding.
 - (5) Conduit numbers in which wiring will be located.
 - (6) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.

- d. ARCMS System:
 - (1) Submit the following general information:
 - (a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.
 - (b) Software listings for operating system, applications, and HMI.
 - (c) Software language and organization.

 - (2) Hardware:
 - (a) Layout Drawings showing front, rear, end, and plan views to scale of equipment, I/O components, power supplies, and peripheral devices.
 - (b) Equipment ventilation requirements.
 - (c) Interconnection diagrams, including termination details, cable identification list, and cable length.
 - (d) Drawings showing equipment layout.
 - (e) Installation requirements, instructions, and recommendations.

 - (3) Software:
 - (a) Licensing agreement with name of licensee, renewal requirements, release and versions, expiration dates (if any), and upcoming releases scheduled before Project completion. When upcoming releases are expected, provide

descriptions, when available, of features that differ from the proposed release.

- (b) Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging, storage, and diagnostic functions. Submit this information on electronic media.
- (c) Standard technical documentation covering all aspects of the computer system software functions and capabilities, including instruction set description and programming procedures related to monitoring, display, logging, reporting, and alarming functions.
- (d) Documentation describing memory type, size, and structure, and listing size of system memory, I/O and Data Table memory, and size of memory available for control programs.

e. System I/O Loop Wiring Diagrams:

- (1) Prepare Shop Drawings on module-by-module basis and include the following information:
 - (a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
 - (b) Wiring types, wire numbers, and color coding.
 - (c) Designation of conduits in which field I/O wiring will be installed.
 - (d) Location, functional name, tag numbers, and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
 - (e) Prepare loop wiring diagrams in accordance with ISA 5.4.

- (2) Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
 - (a) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, and motor starters. Some of this equipment may be specified in other Divisions. The Contractor is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
 - (b) Numbered terminal block and terminal identification for each wire termination.
 - (c) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
 - (d) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
 - (e) Junction and pull boxes through which wiring will be routed.
 - (f) Identification of equipment in accordance with the Contract Documents.

2. Product Data:

- a. Product data for field instruments in accordance with requirements for Shop Drawings in this Section.
- b. Product data for panels, consoles, and cabinets in accordance with requirements for Shop Drawings in this Section.
- c. Product data for field wiring and piping provided for instrumentation and control service and not included under other sections or contracts.

3. Factory Acceptance Test Procedure: Submit factory testing procedures that will be performed to fulfill requirements of the Contract Documents. Test procedure shall include the following:

- a. Visual inspection of components and assembly.
- b. Description of hardware operational testing.
- c. Description of software demonstration.
- d. Description of testing equipment to be used.
- e. Sign-off sheets to be used at time of testing.

4. HMI Display Format Examples: Examples or 'mock-ups' of proposed HMI screens, pop-ups, or other graphical interface based upon the example screens included herein. These examples may be black-and-white, hand sketched, or examples from similar facilities. However, the example screens shall explicitly illustrate the applicable portions of the Application Software Implementation Standards. Contractor to coordinate these Displays during each of the Pre-Development Meeting, Software Development Coordination Meeting, and Final Software Development Coordination Meeting as Described above.

B. Informational Submittals: Submit the following:

1. Documents to be submitted before the pre-construction conference in accordance with Section 01330, Submittals and Acceptance.
2. System Software Documentation: Submit preliminary software documentation not later than 4 weeks before scheduled start of factory testing. Software documentation shall include the following:
 - a. Complete printed copies of all programming.
 - b. Complete listing of external and internal I/O address assignments, register assignments, and preset constant values with function point descriptions. List unused/undefined I/O and data table registers available.
 - c. Copies of all proposed OIT screens.
3. Manufacturer's Instructions:
 - a. Shipping, handling, storage, installation, and start-up instructions.
4. Source Quality Control Submittals:
 - a. Factory test reports and results.
5. Special Procedure Submittals:
 - a. Submit notification to the Owner and Engineer at least 14 days before readiness to begin system checkout. Schedule system checkout on dates agreed to by the Owner and Engineer.
 - b. Submit written procedure for system checkout to the Owner 3 months before starting system checkout. Three months before starting system checkout, submit written procedure for start-up to the Owner.

6. Field Quality Control Submittals:

- a. Submit the following before commencing system checkout and start-up.
 - (1) Completed calibration sheets for each installed instrument showing five-point calibration (0, 25, 50, 75, 100% of span), signed by factory-authorized serviceman.
- b. Field calibration reports.
- c. Field testing reports.

7. Supplier's Reports:

- a. Installation inspection and check-out report.
- b. Submit a written report of results of each visit to the site by the supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within 2 days of completion of visit to the site.

8. Qualifications Statements:

- a. Supplier.
- b. Manufacturer, when required by the Owner or Contract Documents.

C. Closeout Submittals: Submit the following:

1. Operations and Maintenance Data:

- a. Submit in accordance with Section 01830, Operations and Maintenance Manuals.
- b. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.
- c. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for 1 year of operation with current price list.

2. Record Documentation:

- a. Prepare and submit record documents in accordance with Section 01785, Record Documents.

- b. Revise all system Shop Drawing submittals to reflect as-built conditions in accordance with the following.
 - (1) Two copies of each revised Shop Drawings and documentation to replace out-dated drawings and documentation contained in operations and maintenance manuals. Submit half-size black-line drawings for each drawing larger than 11 inches by 17 inches. Include specific instructions for out-dated drawing removal and replacement with record documents submittal.
 - (2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes and stored in a suitable print pocket or container inside each control panel.
 - (3) Submit CADD Drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:

1. Spare Parts and Test Equipment:

a. General:

- (1) Furnish the spare parts and test equipment as indicated below, identical to and interchangeable with similar equipment provided under this Section.
- (2) Provide source quality control for spare parts as part of factory testing before shipment of instrumentation and control equipment.
- (3) For process sensors and other analog instruments, the supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for 1 year from date of equipment installation and that the supplier understands that the Owner reserves the right to purchase none, any, or all parts quoted. Upon request, the supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of the Owner's order.

b. Furnish the following spare parts:

- (1) Five of each type of input/output relay for each quantity of forty or fraction thereof provided under the Contract.
- (2) One replacement power supply for each type and size provided under the Contract.
- (3) One-year supply of all expendable or consumable materials.
- (4) Twelve of each type and size of fuse used in instruments.

2. Software:

- a. Submit copies of programming and configuration files developed specifically for the Project in accordance with Section 01830, Operations and Maintenance Manuals.

1.05 STORAGE AND HANDLING

- A. Before packaging, each manufacturer or supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.
- B. Comply with Section 01650, Delivery, Storage, and Handling.

PART 2 PRODUCTS

2.01 SYSTEM REQUIREMENTS

A. Controls, Instruments, and Devices:

1. Arrange pump control panels to allow either manual or automatic control of equipment. When “MANUAL” operation is selected, all equipment associated with pump shall be controlled by “START/STOP” pushbuttons on the HMI. When “AUTOMATIC” operation is selected, control of equipment shall be “AUTOMATIC/START” and “AUTOMATIC/ STOP” pushbuttons, and programmable controller.

B. Power Supplies

1. Electrically powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10%, single-phase, 60 Hertz +2 Hertz, power supply. If different voltage or closer regulation is required, provide suitable regulator or transformer at no additional cost to the Owner.

2. Provide appropriate power supplies for field instruments requiring power source less than 115 volts. Power supplies shall be mounted in control panels or enclosures installed near associated instrument or in field panels.
3. Power supplies shall be capable of minimum of 130% of maximum simultaneous current draw.
4. Provide power on-off switch or air circuit breaker for each item provided under this Section that requires electric power.

C. Signal Requirements:

1. Control system shall use 4 to 20 mA DC analog signals, unless otherwise shown or indicated.
2. Provide signal converters and repeaters where required. Adequately size power supplies for signal converters and repeater loads.
3. Isolate signals from ground.
4. Signals transient DC voltage shall not exceed 300 volts over 1 millisecond, and shall not have a DC component over 300 volts.
5. Discrete signals shall use 120 VAC.

D. Surge Protection Requirements:

1. Provide surge protection to protect electronic instrumentation and control systems from surges propagating along signal and power supply cabling. Protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than instrument surge withstand level, and be maintenance-free and self-restoring.
2. Provide instruments in suitable metallic cases, properly grounded. Ground wires for surge protectors shall be connected to good earth ground and, where practical, run each ground wire individually and insulated from other wires. Mount protectors within instrument enclosure or in separate junction box compatible with the area designation coupled to the enclosure.
 - a. Analog circuits shall be protected by DEHN or Phoenix suppressors.
 - b. All instrument 120-volt power and signal circuits shall be protected by DEHN or Phoenix suppressors.

E. Miscellaneous:

1. General:

- a. Instrumentation components shall be heavy-duty types, constructed for continuous service.
 - b. System shall consist of equipment models currently in production.
 - c. Materials and equipment, including cabling and interconnections, shall be in accordance with Division 16, Electrical, and manufacturer's recommendations, unless indicated otherwise in the Contract Documents.
 - d. Materials and equipment shall, where applicable, be in accordance with UL standards and be so marked and labeled.
2. Logic and control loops shall be fail-safe. Instrumentation components shall return automatically to accurate measurement within 15 seconds upon restoration of power after power failure and when transferred to standby power supply.
3. Logic and Control Loops shall be as detailed in their respective section below. These are minimum requirements. Coordination meetings between the Process Controls Integrator, Equipment Suppliers and Manufacturers, Owner, and Engineer are required during which the details regarding the HMI configuration and Control Loops will be coordinated and finalized.
4. Provide surge protection for instruments and other control system components that could be damaged by electrical surges. Provide lightning arresters on both ends of communication lines, except for fiber optic cabling, external to buildings or structures, including leased telephone lines and similar communication lines.
5. Field-mounted instruments and system components shall be constructed for use in humid and corrosive service conditions. Field-mounted instrument enclosures, junction boxes and appurtenances shall have NEMA rating appropriate for hazardous rating requirements shown or indicated on electrical Drawings, instrument data sheets, and elsewhere in the Contract Documents.
6. Miscellaneous hardware such as fittings, fasteners, and screws, be Type 316 stainless steel or other appropriate material to prevent galvanic reactions, and shall be suitable for service intended. Piping stands shall be provided for fastening instruments as required. Provide threaded pipe stands with flange bolted to slab. Use carbon steel piping and flanges painted in accordance with Section 09900, Painting and Coating.

7. Data processing equipment and relays with interconnections to field devices shall be wired through field wiring terminal blocks in the panel. Terminals as part of relay base are unacceptable.
8. Arrange panel-mounted instruments, switches, and other devices ergonomically for functional use and ease of maintenance. Similar types of panel-mounted devices shall be by one same manufacturer and of the same model line.
9. Equipment furnished shall be of modular construction and be capable of field expansion through installation of plug-in circuit cards and additional cabinets as necessary.
10. Field- and panel-mounted instruments shall be tagged with equipment number and nomenclature indicated in the Contract Documents; if not so indicated, tag in accordance with approved Shop Drawings or as indicated by the Owner or Engineer.
11. Coordinate ranges and scales specified in the Contract Documents with manufacturer of the equipment actually furnished for operability over the intended range. Complete the coordination before submitting Shop Drawings to the Owner.
12. Treat field-mounted devices with anti-fungus spray.
13. Protect field-mounted devices from exposure to high and freezing temperatures to provide complete operability under the environmental conditions indicated in the Contract Documents.

F. Environmental Conditions:

1. Provide control system suitable for continuous operation under the following conditions:
 - a. Outdoor Instruments:
 - (1) Ambient Temperature: -15 degrees F to 120 degrees F.
 - (2) Relative Humidity: 100%, maximum.
2. Protect outdoor-mounted field instruments from direct sunlight by providing sunshade for instruments. Construct sunshade out of non-corrosive material. Sunshade shall withstand wind velocity of 140 miles per hour.

2.02 PROCESS TAPS, SENSING LINES, AND ACCESSORIES

A. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters

1. Material: Copper water tubing, ASTM B88, Type L, drawn temper or annealed.
2. Pressure Rating: Same as connecting pipe.
3. Size: 1/2-inch O.D. for water.
4. Connections: Brass compression type.
5. Shut-off Valves:
 - a. Type: Ball.
 - b. Pressure Rating: Same as connecting pipe.
 - c. Body, Ball, and Stem: Brass.
 - d. Packing: High-density Teflon.
 - e. Handle: Nylon with metal travel stops.
 - f. Support Rings: TFE coated brass.
 - g. End Connections: Removable.
6. Manifolds:
 - a. Type: Five-valve and three-valve meter manifolds.
 - b. Materials: Type 316 stainless steel body, bonnets, and stems; delrin seats; Teflon packing.
 - c. Manufacturers: Provide products of one of the following:
 - (1) Anderson-Greenwood.
 - (2) Swagelok by Crawford.
 - (3) Or equal.

B. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters

1. Material: Type 316 stainless steel tubing, ASTM A269, medium wall thickness.
2. Pressure Rating: Same as connecting pipe.

3. Size: 3/8-inch OD for air.
4. Connections: Type 316 stainless steel compression type.
5. Shut-off Valves:
 - a. Type: Ball.
 - b. Pressure Rating: Same as connecting pipe.
 - c. Body, Ball and Stem: Type 316 stainless steel.
 - d. Packing: High density Teflon.
 - e. Handle: Nylon with metal travel stops.
 - f. Support Rings: Teflon coated Type 316 stainless steel.
 - g. End Connections: Removable.
 - h. Products and Manufacturers: Provide one of the following:
 - (1) Whitey Valves.
 - (2) Anderson Greenwood.
 - (3) Or equal.
6. Manifolds:
 - a. Type: Five-valve and three-valve meter manifolds.
 - b. Materials: Type 316 stainless steel body, bonnets and stems; delrin seats; Teflon packing.
 - c. Products and Manufacturers: Provide products of one of the following:
 - (1) Anderson-Greenwood.
 - (2) Swagelok.
 - (3) Or equal.

C. Pressure Tap Sensing Lines and Accessories for Pressure Gauges and Pressure Switches

1. For Process Sensing Taps in Ductile Iron, Steel and Stainless-Steel Piping Systems:
 - a. Material and Fittings: Type 304 stainless steel pipe, ASTM A312; and threaded fittings and adapters, ASTM A403/A403M.
 - b. Sizes: 1/2-inch diameter minimum for main sensing piping and 1/4-inch diameter gauge and switch connections.
 - c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Contract Documents.
 - d. Accessories:
 - (1) For applications not requiring diaphragm seals, provide separate 1/2-inch diameter Type 316 stainless steel threaded ball valve for each gauge and switch.
 - (2) For applications requiring diaphragm seals, provide separate 1/2- inch diameter threaded Type 316 stainless steel ball valve for seal process side shutoff.
2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
 - a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. Provide PVC and CPVC piping in accordance with Division 15, Mechanical.
 - b. Sizes: 1/2-inch-diameter minimum for main process sensing piping and 1/4-inch-diameter for gauge and switch connections.
 - c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Contract Documents.
 - d. Accessories:
 - (1) For copper piping system taps with or without seals, provide separate 1/2-inch-diameter minimum threaded brass or bronze ball valve for each gauge and switch.
 - (2) For PVC and CPVC piping systems with or without diaphragm seals, provide separate 1/2-inch-diameter threaded ball valve for process sensing line shutoff.

2.03 PANELS

A. General Provisions

1. Provide electrical components and devices, support hardware, fasteners, and interconnecting wiring and piping required to provide control panels complete and operational.
2. Locate and provide hardware so that connections can be easily made and there is ample room for servicing each item.
3. Prevent movement by adequately supporting and restraining devices and components mounted on or within panel.
4. Provide panels with sub-panels for installation of all internally mounted hardware.
5. Provide numbered terminal strips for terminating field wiring and wiring from other panels, unless otherwise shown or indicated.
6. Provide copper grounding studs for hardware requiring grounding.
7. Provide the following convenience accessories inside each panel:
 - a. One 120 VAC, 20-amp duplex, grounding type receptacle.
 - b. One 120 VAC fluorescent service light fixture with 20-watt lamp and protective plastic shield or appropriate wattage incandescent bulb for panels two feet by two feet and smaller.
 - c. One 120 VAC snap switch, to turn on service light, mounted in outlet box with cover and located so that switch is easily accessible from access door.
 - d. Service light with switch and duplex receptacle shall have a dedicated circuit breaker.
8. Control of Environment (Except NEMA 7 Panels):
 - a. Provide 120 VAC thermostatically-controlled fan-driven heater units to maintain stable temperature within enclosure to protect equipment from harmful effects of condensation, corrosion, and low temperatures inside panels.
 - b. Provide automatically controlled closed-loop heat exchangers or closed-loop air-conditioners to maintain temperature inside each

- enclosure at optimum operating temperature rating of components inside the enclosure.
- c. Each heat exchanger or air conditioner shall have a dedicated, properly- sized and -rated circuit breaker.
 - d. Submit supporting calculations as part of panel Shop Drawing submittal if panel equipment to comply with specified environmental requirements is proposed to be deleted as unnecessary.
- 9. Panels shall be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.
 - 10. Panels shall be located in hazardous (classified) environments shall comply with UL 698A and UL 2062.
 - 11. Provide panels under this Section with 20% additional space requirements for future use. Install nothing in space reserved for future use.
 - 12. The Contractor is responsible for detailed layout and design of panels, in accordance with the Contract Documents. Base cutouts and design on instrument manufacturers' requirements.
 - 13. Lower 12 inches of free standing panels shall be free of devices, including panduits and terminal strips, for ease of installation and maintenance.
 - 14. For front-opening panels, install no device less than 3 feet above operating floor level, unless otherwise shown or indicated. For rear-opening panels, install no devices on the door.
 - 15. Wire bundles between subpanels and front panel-mounted devices shall be anchored and protected from damage by opening and closing of panel door.
 - 16. Do not locate front panel-mounted devices requiring manipulation by operating personnel, such as pushbuttons, hand switches, controllers, and similar devices, higher than 5.5 feet above finished floor.
 - 17. Panduits on either side of terminal strips shall have minimum clearance of 1.5 inches between the panduit and terminal strip.
 - 18. Provide a 3-inch-high channel base assembly, drilled to mate the panel to the floor pad.

19. Provide easily-accessible pocket built into panel door to enclose “as-built” panel wiring diagrams.
20. Panels shall be UL-listed.

B. Identification

1. Provide laminated plastic nameplate for identification of panels. Use self-tapping stainless steel screws for fastening nameplates to panels. When self-tapping screws may degrade panel’s NEMA rating, retain NEMA rating intact by using gaskets on each side of panel surface and use retaining plate on the panel back that is same size as nameplate. When gaskets and retaining plate are used, use full-penetration screws with nuts.
2. Panel identification nameplates shall have 1/2-inch-high engraved letters.
3. Identify front panel-mounted devices with nameplates engraved with functional description of the device. Nameplate engraving shall be in accordance with the identification provided in the Drawings.
4. Tag electric components and devices mounted within panels with high adhesive labels.
5. Identify terminal strips with nameplate engraved as “TB-XX” where “XX” is the numerical identification of terminal strip.
6. Identify terminals within each terminal strip with sequential numbers and wire numbers.
7. Internal panel wiring shall be color-coded and numerically identified with unique wire numbers affixed at each end of each wire. Color coding shall be in accordance with panel wiring color code table below:

Panel Wiring Color Code Table

Description	Color
110 VAC panel power before fuses or breakers	Black
Controlled 110 VAC power (e.g., after relay contacts, selector switch contacts, and similar equipment.)	Red
110 VAC power source from devices external to panel	Yellow
110 VAC neutral	White
24 VDC positive power from power supplies	Brown
Controlled 24 VDC power (e.g., after PLC output contacts, relay contacts, and similar)	Blue

Description	Color
24 VDC positive power from devices external to panel	Orange
24 VDC 4 to 20 mA DC signal cable	Grey with red positive, clear negative
Grounding wire	Green

C. Panel Construction Features

1. Control panels in non-environmentally controlled areas and outdoor areas shall be rated NEMA 4X and with the following features:
 - a. Panels shall be Type 316L stainless steel construction with minimum thickness of 12-gauge for all surfaces, except areas requiring reinforcing, with a smooth-brushed finish.
 - b. Stainless steel screw clamp assemblies on three sides of each door.
 - c. Rolled lip around three sides of door and along top of enclosure opening.
 - d. Hasp and staple for padlocking.
 - e. Provide clear-plastic, gasketed lockable hinged door to encompass non-NEMA 4X front-of-panel devices.
2. Wall/Stanchion-Mounted Panels:
 - a. General: Wall-mounted panels shall comply with applicable features and standards specified in this Section for the associated NEMA-rated panel.
 - b. Unless otherwise indicated or approved by the Owner, depth of wall-mounted panels shall not exceed 18 inches.
 - c. Panels may be all stainless steel, fiberglass, polycarbonate, or acrylonitrile butadiene and styrene (ABS).
 - d. Provide appropriate size and number of external mounting feet.
 - e. Drilled holes or knockouts in back of wall-mounted panels are not allowed.
 - f. Provide corrosion-resistant polyester quick release latches (for non- stainless steel panels) or stainless steel screw clamp assemblies (for stainless steel panels).

D. Programmable Logic Controller (PLC)

1. The PLC system configuration indicated is diagrammatic. The final system configuration shall utilize the System Manufacturer's standard hardware and software to meet the functional requirements of these Specifications.

2. All equipment furnished under this Contract shall be provided to meet the functional requirements of these Specifications plus a 20% growth in project requirements (e.g., additional field instrumentation and equipment, database, graphics, reports, alarms, trend functions). This equipment includes processor memory, I/O card allocations, and mass/bulk memory storage devices. All equipment shall be provided under this Contract, such that the entire 20% project growth can be implemented into the PLC system, without any additional hardware cost to the Owner.
3. The Controller Series shall be an Allen Bradley CompactLogix L30ER. No equal will be accepted.
 - a. The processor shall be programmed using ladder logic with Logix-5000.
 - b. Controller shall communicate via 10/100 Mbps Ethernet.
 - c. The process controller, in conjunction with I/O modules and Point I/O, performs all system level operations, system and data table monitoring and maintenance, alarm detection, PID control, user program executions, network request and response handling.
 - d. The controller shall be able to operate within the following environmental parameters: Processor and I/O modules shall be capable of withstanding temperatures of 32°F to 122°F at a relative humidity of 5 to 95% (non-condensing) in system manufacturer's standard enclosures.
 - e. Power Supply Module. Module shall be compatible with the Allen Bradley CompactLogix PLC and supply power to PLC modules. Power supply shall be Model 1769-PA4.
 - f. Communications Modules. Furnish the following module for Ethernet communications:
 - (1) Modbus RTU interface. Prosoft Technologies Model PLX31-EIP-MBS.
4. Input/Output Modules:
 - a. The system shall be configured to support the quantity of input/output signals required from the input/output list plus an additional 20% spare input and output signals. This includes 20% spare of each type of input and output module. For PLC system(s)

where a particular type of I/O module is not required from the input/output list, provide a minimum of one I/O module of that type in the rack. The additional 20% shall be distributed between the different I/O cards and shall be installed in the rack and wired. The additional 20% spare I/O is in addition to the spare parts to be furnished in accordance with Article 1.5 of this Section.

- b. The I/O structure shall be field expandable to the maximum spare requirements without modification to the control processor.
- c. Discrete Inputs (DI) shall be 16-point module, 120 VAC developed from dry field contacts, Allen Bradley CompactLogix Model 1769-IA16.
- d. Discrete Outputs (DO) shall be eight-point, 120 VAC/24 VDC compatible 5A relay contact modules, for dry contacts. Output contacts may be powered from the field equipment or powered from 24 VDC/120 VAC sourced from PLC control panel's power system, as required to interface with field equipment. Provide interposing relays as required to protect the relay module. Allen Bradley CompactLogix Model 1769-OW8.
- e. Analog Input (AI) circuits shall be isolated, 15-bit (minimum) resolution type. AI hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, AI modules shall be capable of receiving 4-20mA signals. Each input circuit shall have optical isolation to protect the equipment against high voltage transients. Allen Bradley CompactLogix 1769-IF4I.
- f. Analog outputs (AO) shall be coordinated with the receivers but shall generally be isolated 24 VDC, 4-20mA outputs with 16-bit resolution and powered from the PLC. Each output circuit shall have optical isolation to protect the equipment against high voltage transients. Allen Bradley CompactLogix 1769-OF4CI.

E. Operator Interface Terminal (OIT)

- a. The OIT shall be provided as specified herein and shown on the Drawings. The OIT shall include all graphics and control features for its respective PLC unless otherwise noted.
- b. The OIT display shall have a 6.5-inch flat-panel color display, minimum, with built-in port for Ethernet communications, as well as built-in USB ports and SD card. Input power for the OIT is 24 VDC with a temperature range of 0-55 degrees C.
- c. The OIT shall be provided with Factory Talk View/Studio Machine Edition software, licensed to the Owner.
- d. The OIT shall be manufacturer by Allen Bradley, Panelview Plus 7, 2711P-T7C21D8S.

F. Electrical Systems

1. Power Source and Internal Power Distribution:

- a. Provide in the panel, near where incoming power is terminated, nameplate with panel power supply source, type, voltage, and circuit number.
- b. Protect incoming 480-V, three-phase, 60 Hz power feed to power the panel by providing lightning and surge arrestors, properly connected to grounds.
- c. Provide panel with internal step down transformer with 120 VAC power distribution system with properly-sized and -rated circuit breakers to distribute power. Power not more than six devices from a single breaker. When power supplies are included in the panel, not more than two power supplies shall be powered from a single breaker. Convenience receptacles and interior panel lights shall have their own breakers. When one or more field instruments require 120 VAC power from the panel for instrument power, power not more than three instruments from a given breaker.
- d. Provide space for a minimum of two spare breakers in each panel.

2. Electrical Systems:

- a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 volts at 85 degrees C for single conductors, color-coded and labeled with wire identification.
- b. For DC signal wiring, use shielded cable with 18-gauge conductors. DC field signal wiring terminal strips shall be capable of handling wires up and including No. 12 size.
- c. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 amps, use sizes required by the NEC (NFPA 70).
- d. Inside of panels, route DC signal wiring separately from power wiring with minimum separation distance of 6 inches.
- e. Use covered panduits to route internal panel cables and wiring. Panduits in each section of panel shall be appropriately sized to accommodate the quantity of wires to be routed with a spare capacity of 40%.
- f. Install wire troughs inside panels along horizontal or vertical routes to present a neat appearance. Angled runs are unacceptable.
- g. Wiring that is routed without panduits shall be adequately supported and restrained to prevent sagging or other movement.

Use of adhesive anchors to support or restrain wiring is unacceptable.

- h. Terminate internal panel wiring using forked, insulated, crimp-on connectors; soldered connectors are unacceptable. Provide panels with 600-volt rated barrier type terminal strips mounted on Din rails. Identify terminal strips as indicated in this Section. Identification devices shall be self-stick, plastic tape strips with permanent, machine- printed numbers.
- i. Wiring in panels shall be installed such that, if wires are removed from any one device, power will not be disrupted to other devices.
- j. Provide spare terminals equal in number to 20% of terminals used for each type of wiring (e.g., DC signal and AC power).
- k. Provide ground terminals to terminate the shield wire of shielded cables. Termination of more than two shielded wires on a single ground terminal is unacceptable.
- l. Provide a single copper bus bar with 5/16-inch diameter copper grounding stud to connect the panel to external ground. Panel's internal grounds shall be terminated to the bus bar.
- m. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
- n. When DC power or low voltage AC power is required, furnish and install in the panel required power supplies and transformers.
- o. Provide complete wiring diagram of "as-built" circuitry enclosed in transparent plastic.

2.04 DATA SHEETS – PANEL INSTRUMENTS AND PRIMARY SENSORS AND FIELD INSTRUMENTS

A. General

- 1. Panel-mounted devices and instruments and primary sensors and field instruments shall be in accordance with the "data sheets" included in Part 3 of this specification.
- 2. Do not fabricate, ship, or assemble instruments and devices in panels until required Shop Drawings and other submittals required for fabrication are approved or accepted as required.

2.05 IDENTIFICATION

A. Instrument Tagging

1. Headings on the instrument index in the Contract Documents have the following meaning:
 - a. “TAG” is divided into two sections. The first seven to nine alphanumeric characters represent the Owner’s equipment number and the remaining characters comply with ISA 5.1.
 - b. “DESCRIPTION/LOCATION” is an explanation of instrument function and location.
 - c. “RANGE/SET POINT” is the limit for the specified units of the instrument and set point is the precise value within the instrument’s range.
 - d. “SPEC REF” is the paragraph reference in the Specifications where the instrument’s requirements are specified.
 - e. “DRAWING NO.” indicates the Drawing where the device is shown or indicated.
 - f. “REMARKS” contains specific notes relative to the instrument.

B. Input /Output List Identification

1. I/O point list contains information required to configure PLC I/O interface hardware, and to indicate range conversion or signal functions.
2. “POINT NUMBER” is an alphanumeric character string. For example, for the point “MP-FI-806-0123” the following apply:
 - a. The first two characters (MP) refer to the specific plant area (MP = Main Pump, for example).
 - b. The third character is the functional identifier and conforms with ISA 5.1. In the example, “F” represents flow.
 - c. The fourth (and sometimes fourth and fifth) alphabetical character (I) is the function identifier. In the example, the “I” represent indication input.
 - d. The first three-digit number (806) identifies the P&ID number.
 - e. The next four-digit number (0123) identifies the loop or field device.
 - f. Suffix, where required, is used for distinguishing between similar variables.
3. “DESCRIPTION” is an alphanumeric character string up to 40 characters in length. Points described as “SPARE” indicate pre-wired I/O.

4. “SIGNAL TYPE” is one of the following:

- a. AI indicates analog input.
- b. DI indicates discrete input.
- c. PI indicates pulse input.
- d. AO indicates analog output.
- e. DO indicates momentary, maintained or latched discrete output.

C. ISA Identification

- 1. A = Analytical.
- 2. B = Burner, Combustion.
- 3. C = Cooling (Cooling Condenser).
- 4. D = Dissolved.
- 5. E = Voltage.
- 6. F = Flow.
- 7. G = Intrusion.
- 8. H = Hand.
- 9. I = Current.
- 10. J = Power.
- 11. K = Time.
- 12. L = Level.
- 13. M = Manual.
- 14. N = UNDEFINED.
- 15. O = Overload.
- 16. P = Pressure.
- 17. Q = Communication.
- 18. R = Reverse.
- 19. S = Speed, Frequency.
- 20. T = Temperature.
- 21. U = Universal (Common).
- 22. V = Vibration.
- 23. W = Torque (Weight or Force).
- 24. X = Critical (Emergency).
- 25. Y = Event, State or Presence.
- 26. Z = Position, Dimension.

D. Function Identifier

- 1. A = Alarm.
- 2. B = UNDEFINED.
- 3. C = Control.
- 4. D = Differential.

5. E = Element.
6. F = Failure.
7. G = UNDEFINED.
8. H = High.
9. I = Indication.
10. J = UNDEFINED.
11. K = Factor.
12. L = Low.
13. M = Mode.
14. N = Normal.
15. O = Oxygen.
16. P = UNDEFINED.
17. Q = Quantity.
18. R = Rotation.
19. S = Switch.
20. T = Timer.
21. U = UNDEFINED.
22. V = Slow (output).
23. W = Slow (input).
24. X = Selector Switch (input).

2.06 PROCESS CONTROL DESCRIPTIONS

A. General

1. Program the PLC for automatic control of the Recharge Pump, Chemical Feed and Recharge Well, and interlock functions as specified.
2. System documentation including memory loading, I/O configuration and programming shall be provided per Section 01830, Operations and Maintenance Manuals.
3. Provide and install auxiliary relays and wiring for equipment and devices specified in this Section required for implementing functional requirements specified.
4. Analog inputs shall be as follows:
 - a. Scale Range and Engineering Units: Refer to the Contract Drawings. Coordinate these items during the Pre-Development Meeting as described above.
 - b. HIGH/LOW Alarm Limits: Set HIGH alarm at 100% and LOW at 1% unless noted otherwise.
 - c. Rate of change alarm limit: Set for no alarm.

- d. Totalize all flow, power, and other rate type variables.
- e. Record a historical trend of all flow rates, levels, pressures, turbidity, dissolved oxygen, borehole valve position, and other variables as indicated herein.

5. Discrete Inputs shall be as follows:

- a. Alarms: If alarm is noted, then log alarm message when input ALARM state is achieved.
- b. Status Change Logging: Deactivated for each point.
- c. Elapsed Run Time Monitoring: For all equipment units with ON/OFF status.
- d. Cycle Counters: For all pumps.

B. Control Functions

- 1. Maintain all Operator entered values (i.e. set points; process warnings, alarms, and notices).
- 2. Maintain Operator control commands (i.e. manual/automatic mode).

C. Alarm Functions

- 1. Maintain all ALARM and FAIL condition until the alarming event has cleared and the condition is manually RESET via the OIT.
- 2. Create an alarm event whenever an analog input signal exceeds the anticipated current limits. Initially create the alarm whenever the signal is less than 3.0 mA or greater than 21 mA.

D. Special Operator Interface Functions

- 1. Display Alarm and Status events received as discrete inputs.
- 2. Display and Provide operator-adjustable HIGH and LOW alarm events for all monitored parameters received as analog inputs.
- 3. Provide HAND/REMOTE indication.
- 4. Provide an operator interface for controls. Interface shall include the following:
 - a. MANUAL/AUTOMATIC operating mode selection.
 - b. Set Point Value adjustment (functional in AUTOMATIC mode, only).
 - c. Output value adjustment (functional in MANUAL mode, only).

- d. Display Set Point, Output, and Process Variable values.
 - e. Display Tuning Variables.
5. Provide numerical entry for all timers and set point values, specifically those note herein as being, “operator adjustable”, or “operator entered”.

E. Annunciation and Alarms

- 1. Provide devices in control panel conforming to requirements of Section 16470, Panelboards, for alarming of the following:
 - a. High and Low Wetwell Level.
 - b. High Turbidity Level in Recharge Pump Intake Well
 - c. Recharge Pump Not In Auto Mode and Recharge Pump/VFD Failure.
 - d. High and Low Sodium Bisulfite Levels.
 - e. High discharge pressure at Recharge Well Pump/Borehole Valve.
 - f. Air compressor (for Self-Cleaning Screen) failure.
 - g. Borehole Injection Control Valve Failure.
 - h. Other Alarms as indicated in the Control Descriptions below.
- 2. Provide at least 20% spare windows.
- 3. Wire all alarms to PLC system for relaying to remote location.

2.07 CONTROL FUNCTIONS

Below is a description of PLC functions to be used throughout the Project. Implement the control functions in the PLC, and implement the Operator Interface requirements both at the OIT and the Control System.

A. COMMON FUNCTION – START/STOP Motor Control, Non-Reversing

- 1. Operator Interface:
 - a. START/STOP Selection.
 - b. ON/OFF status indication.
 - c. HAND/REMOTE Status Indication.
 - d. FAIL alarm event.
 - e. Resettable Elapsed Run Time.
 - f. Non-Resettable Elapsed Run Time.

2. Control Functions

- a. Continuously operate the motor whenever the START/STOP selector is in the START mode. Stop motor operation whenever the START/STOP selector is in the STOP mode.
- b. In AUTO mode, START/STOP the motor in response to internal command signal. Command signal will be identified in the respective detailed loop description below.
- c. Inhibit the control and alarm functions whenever the motor starter is in HAND mode. Resume control and alarm functions whenever the motor starter returns to REMOTE mode.
- d. Monitor the Motor Elapsed Run Time. Elapsed Run Timer shall have a minimum resolution of 1/10th of an hour. Provide one operator resettable timer and one non-resettable timer. Operate the Elapsed Run Time function regardless of the HAND/REMOTE status.

3. Alarm Functions

- a. Establish a FAIL event when any of the following occur:
 - (1) The START/STOP status is not achieved with an adjustable delay after the START/STOP command is issued. The START/STOP status shall be a contact from the starter contact indicative that the contact is closed, as a minimum. Monitoring of START/STOP command is not acceptable.
 - (2) Motor winding temperature HIGH occurs.

B. COMMON FUNCTION – Variable Speed Motor Control

1. Operator Interface

- a. Motor RUN status.
- b. HAND/REMOTE Status.
- c. Motor FAIL Alarm.
- d. Drive FAIL Alarm.
- e. Network Communication FAIL alarm.

2. Control Functions:

- a. Vary the motor speed using command signal control. The process variable shall be as noted in the detailed loop specification below.

3. Alarm Function

- a. Establish a FAIL event and freeze the output variable when any of the following occur:
 - (1) Loss of the process variable signal. Loss of Signal shall be defined as the analog input signal exceeds the expected current limits (i.e., 3 mA and 21 mA).
 - (2) Error. Value exceeds a preset value a period longer than an operator adjustable value.

C. Recharge Pump Control

- 1. Overview: Provide for monitoring and control of a submersible Recharge Pump installed in the Recharge Pump Building. The Process Controls Integrator shall confirm and coordinate the provided pump controls with the selected equipment manufacturer, the Engineer, and the Owner.
 - a. Monitor the levels contained in the Recharge Pump Building (LS-02, LSL-02, LSH-02, LE-02A, LE-02B).
 - b. Monitor the turbidity contained in the Recharge Pump Building (AE-02).
 - c. Monitor the level in the Recharge Well (LE-01).
 - d. Control the Recharge Pump to maintain the flow rate per operator set point.
- 2. PLC Special Functions:
 - a. Operator Interface:
 - (1) START/STOP selection.
 - (2) ON/OFF status indication.
 - (3) HAND/REMOTE status indication.
 - (4) PUMP/SIPHON selection.
 - (5) FLOW RATE input.
 - (6) Motor speed indicator (0 to 100%).
 - (7) Borehole Injection Control Valve operation.
 - b. Control Functions:
 - (1) In PUMP mode:
 - (a) Borehole Injection Control Valve shall be in the closed position before Recharge Pump will start.

- (b) Operate the recharge pump (varying speed) to maintain the Recharge Flow set value.
 - (c) Open the Borehole Injection Control Valve to the required % Open valve to maintain the Recharge Flow set value.
- (2) In SIPHON mode:
 - (a) Operator to select the desired siphon flow rate from 350 gpm (0.5 MGD) to 700 gpm (1 MGD).
 - (b) Borehole Injection Control Valve shall be in the closed position before Recharge Pump will start.
 - (c) Operate the recharge pump at 60% speed for 5 minutes until flow-rate stabilizes.
 - (d) Pulse the Borehole Injection Control Valve to the required % Open once the pressure is within range of the injection header pressure dead-band to maintain the Recharge Flow set value.
 - (e) Gradually ramp the pump speed control down to 0% to allow system to operate on siphon.
- (3) Stop the Recharge Pump whenever either the Analog Signal driven (LE-02A, LE-02B) or Float Switch driven (LS-02, LSL-02, LSH-02) LOW LEVEL Alarm Event Occurs.
- (4) Stop the Recharge Pump whenever the operator selectable (AE-02) HIGH TURBIDITY Alarm Event Occurs.
- (5) Stop the Recharge Pump whenever an alarm signal is received from the Borehole Injection Control Valve.

c. Alarm Functions:

- (1) PUMP FAIL.
- (2) LOW WET WELL LEVEL.
- (3) HIGH TURBIDITY – RECHARGE WATER.
- (4) LOW RECHARGE HEADER PRESSURE.
- (5) HIGH RECHARGE WELL LEVEL.
- (6) BOREHOLE INJECTION CONTROL VALVE FAILURE.
- (7) PURGE INITIATED.

- d. Trending History:
 - (1) Recharge Pump Building – Intake Screen Wet Well Level.
 - (2) Recharge Pump Building – Recharge Pump Wet Well Level.
 - (3) Recharge Pump Building – Recharge Water Turbidity.
 - (4) Recharge Well Building – Recharge Well Flow.
 - (5) Recharge Well Building – Recharge Well Level.
 - (6) Recharge Well Building - Recharge Well Pressure.

D. Passive Intake Screen

- 1. Overview: Provide for monitoring and control of a passive intake screen installed in the Recharge Pump Building. The Process Controls Integrator shall confirm and coordinate the provided pump controls with the selected equipment manufacturer, the Engineer, and the Owner.
 - a. Monitor the levels contained in the Recharge Pump Building (LS-02, LSL-02, LSH-02, LE-02A, LE-02B).
 - b. Monitor the Elapsed Time and Total Flow since last Air Scour.
 - c. Control Air Scour events either manually through operator selection, or automatically through elapsed time and differential level.
- 2. PLC Special Functions
 - a. Operator Interface:
 - (1) AUTO/MANUAL selector.
 - (2) Manual Air Scour INITIATE Selector.
 - (3) Operator Entry for Start Time of Air Scour.
 - (4) Operator Entry for Duration between Air Scour events.
 - (5) Elapsed Time Since Last Air Scour.
 - (6) Total Recharge Flow since last Air Scour.
 - (7) Level Differential between WELL SCREEN LEVEL value and Recharge WELL LEVEL value.
 - b. Control Functions:
 - (1) In MANUAL mode:
 - (a) Select Hand Mode at the Control Panel for the Passive Intake Screen.

- (b) Operator pushes start button to initiate an air backwash of the passive intake screen.
 - (2) In AUTO mode:
 - (a) Operator selects the maximum duration (in days, or hours) between Air Scour INITIATE events.
 - (b) Operator selects the Level Differential between WET WELL SCREEN LEVEL value and RECHARGE PUMP WET WELL LEVEL value that will INITIATE an Air Scour event.
- c. Alarm Functions:
 - (1) AIR COMPRESSOR OR BACKWASH FAILURE.
- d. Trending History:
 - (1) Air Scour Date and Time.
 - (2) Elapsed Time between Air Scours.
 - (3) Recharge Flow Totalization between Air Scours.

E. Chemical Metering Pump Control

1. Overview: Provide for monitoring and control of a duplex chemical metering pump skid in the Chemical Feed Enclosure. The Process Controls Integrator shall confirm and coordinate the provided chemical metering pump controls with the selected equipment manufacturer, the Engineer, and the Owner.
2. Operator Interface:
 - a. Chemical Flow Rate display (gph).
 - b. Chemical Metering Pump Calibration input (gph/percent full speed).
 - c. Chemical Dose (mg/L).
 - d. Chemical Solution Strength – CONC (%).
 - e. Chemical Density – Density (lb chemical solution/gallon).
 - f. Raw Recharge Water – Enter Dissolved Oxygen Level (mg/L).
 - g. Recharge Water – Monitor Dissolved Oxygen Level (mg/L) at Recharge Well.
 - h. FAIL alarm event.
 - i. RUN Status indication.
 - j. HAND/REMOTE selection.

- k. Resettable Elapsed Run Time.
- l. Non-Resettable Elapsed Run Time.

- 3. Control Functions: Program the PLC to perform the following functions:
 - a. In AUTO mode, pass the output signal from Control Algorithm to the metering pump as percent full speed. The detailed control loop will define the Control Algorithm. Display the output signal proportional to the metering pump maximum stroke length.
 - b. In HAND mode, operate the metering pump at the calculated percent full speed to achieve the operator-entered flow rate (gph).
 - c. Provide for 'bump-less' transfer from Automatic to Manual Mode.

F. Chemical Flow Pace Control

- 1. Operator Interface:
 - a. Chemical 'dose' value (mg/L).
 - b. Chemical solution strength (CONC) value (percentage, %).
 - c. Chemical density (DENSITY) value (lb solution / gallon)
 - d. Recharge Water Dissolved Oxygen Level value (Enter value of 1 to 10 mg/L).
 - e. Rate-dependent hysteresis TRIM Value.
 - f. Resettable Elapsed Run Time.
 - g. Non-Resettable Elapsed Run Time.
- 2. Control Functions: Program the PLC to perform the following functions:
 - a. Provide the following algorithm for Chemical Flow Pace Control:

$$Q \text{ reagent} = (\text{dose} \times Q \text{ pacing} \times 8.34) \div (\text{CONC} \times \text{DENSITY})$$

Where the variables have the following units:

Q reagent	Gallons/Day
Dose	mg/L
Q pacing	Recharge Flow (Million Gallons/Day)
CONC	% active chemical/Gal
DENSITY	lb chemical solution/Gal

- b. Provide the following trim function control: Increase or decrease Q reagent (gallons/day) in response to change in difference between Recharge Water D.O. Level (Entered) and Recharge Water D.O. Level – Monitored at Recharge Well by D.O. Meter. Reduce Q

Reagent on decreasing value and Increase Q Reagent on increasing value. The selection of the rate-dependent hysteresis trim function shall be field determined during system startup.

3. Alarm Functions:

- (1) PUMP FAIL.
- (2) LOW TANK LEVEL.

4. Trending History:

- (1) Run – Metering Pump.
- (2) Q Reagent – Gals/Day (Calculated Algorithm).
- (3) Chemical Feed – Flow Rate, Measured (Gals/Hr; Gals/Day).
- (4) DO Level at Recharge Well.

G. Sodium Bisulfite Bulk Storage Tanks

1. Overview: Provide monitoring for two bulk chemical tanks installed in the Chemical Feed Enclosure. The Process Controls Integrator shall confirm and coordinate the provided chemical metering pump controls with the selected equipment manufacturer, the Engineer, and the Owner.

- a. Monitor two bulk storage tank levels (LSL-03A, LSL-03B).
- b. Monitor duplex metering pump skid.
- c. Control sodium bisulfite to injection point.
- d. Use Common Function – Metering Pump Control.

2. PLC Special Functions:

a. Operator Interface:

- (1) Provide for Operator Selection of the active bulk chemical storage tank (1/2/BOTH).

b. Control Functions:

- (1) Use the Status and Alarm events of the selected tank(s) as follows:
 - (a) STOP all metering pump operation on receipt of LOW level event for the selected bulk storage tank.

c. Alarm Functions:

- (1) LOW TANK LEVEL.

H. Recharge Water Flow Monitoring

1. Overview: Provide for monitoring of a flow monitoring in the Recharge Well Building.
2. PLC Special Functions:
 - a. Operator Interface:
 - (1) Current flow rate.
 - (2) Total daily volume.
3. Control Functions:
 - a. Provide the Recharge Flow as the process variable to other control loops described herein.
4. Alarm Functions:
 - a. None
5. Trending History
 - a. Historical flow rates
 - b. Historical total daily volumes

I. DO Monitoring

1. Overview: Provide for monitoring of a dissolved oxygen (DO) meter in the Recharge Well Building. The Process Controls Integrator shall confirm and coordinate the provided chemical metering pump controls with the selected equipment manufacturer, the Engineer, and the Owner.
2. PLC Special Functions:
 - a. Operator Interface:
 - (1) Current DO (mg/L).

3. Control Functions:
 - a. Provide the DO as the process variable to other control loops described herein.
4. Alarm Functions:
 - a. NO FLOW.
5. Trending History
 - a. Historical DO values during recharge events (mg/L).

J. Borehole Injection Control Valve

1. Overview: Provide for monitoring and control of a borehole injection control valve installed in the Recharge Well Building. The Process Controls Integrator shall confirm and coordinate the provided borehole injection control valve controls with the selected equipment manufacturer, the Engineer, and the Owner.
 - a. Monitor the pressure of the injection header (PI-01).
 - b. Monitor the level of the well (LE-01).
 - c. Control the borehole injection control valve percentage open (%) to maintain the flow rate operator set point.
2. PLC Special Functions:
 - a. Operator Interface:
 - (1) ON/OFF status indication.
 - (2) FLOW RATE input.
 - (3) Valve percent open (0 to 100%).
 - (4) Recharge header pressure.
 - (5) Level in Recharge Pump wet well.
 - (6) Level in Recharge well.
 - b. Controls:
 - (1) The borehole injection control valve shall remain closed until the well column has filled with water and the injection header pressure is within a pre-determined dead-band (as confirmed with manufacturer).

- (2) Once the PRESSURE element on the injection header is within the pressure dead-band, operate the borehole injection control valve by pulsing the valve open or closed to maintain the flow rate setpoint. Pressure on the injection header shall remain within the pressure dead-band during all operational sequences.
- (3) If the PRESSURE value begins to drop below the minimum dead-band threshold, operate the borehole injection control valve by pulsing the valve close to maintain the injection header pressure, regardless of flow rate set point.
- (4) If the WELL LEVEL element begins to rise beyond a pre-determined rate, pulse the borehole injection control valve closed until the WELL LEVEL element remains constant or begins to decrease.
- (5) If the WELL LEVEL continues to rise, close the borehole injection control valve and turn the recharge pump off once the borehole injection control valve is confirmed closed. The value of differential level, time, and pressure will be coordinated during the Software Development Coordination Meeting as described above.
- (6) Close the borehole injection control valve whenever a STOP signal is received from the recharge pump. The borehole injection control valve should always be in a confirmed closed position before stopping the recharge pump. This is necessary to prevent air entrainment.

c. Alarm Functions:

- (1) HYDRAULIC PUMP FAIL.
- (2) LOW LEVEL IN RECHARGE PUMP WET WELL.
- (3) HIGH TURBIDITY.
- (4) HIGH WELL LEVEL.
- (5) PURGE INITIATED.
- (6) LOW PRESSURE.

K. Purge Pump

1. Overview: Provide for control of a purge pump installed in the Recharge Well Building. The Process Controls Integrator shall confirm and coordinate the provided pump controls with the selected equipment manufacturer, the Engineer, and the Owner.

2. PLC Special Functions:

a. Operator Interface:

- (1) Manual Purge INITIATE Selector.
- (2) Operator Entry for Duration of Purge.
- (3) Elapsed Time Since Last Purge.
- (4) Total Flow since last Purge.
- (5) WELL LEVEL and Trending History.

b. Controls:

- (1) When the purge pump START is selected, the recharge pump shall STOP and the borehole injection control valve shall completely close before the purge pump initiates.
- (2) Purge pump can be manually started by the Operator once recharge pump is confirmed off and borehole injection valve is confirmed closed for the Operator entered duration.
- (3) Operator can manually START the Purge Pump at the pump starter panel located in the Recharge Well Building.
- (4) Maintain the Elapsed Time since last Purge event.
- (5) Maintain Flow Totalization since completion of the last Purge.
- (6) Reset both Elapsed Times and Flow Totalizer upon completion of a Purge event.

c. Alarms:

- (1) PUMP OVERLOAD.
- (2) BOREHOLE CONTROL VALVE NOT CLOSED.
- (3) RECHARGE PUMP IS NOT OFF.

2.08 SOURCE QUALITY CONTROL

A. General

1. Factory Test:

- a. Neither the Owner or Engineer will witness factory test at the testing facility during operational test of equipment. A registered Professional Engineer retained by the Contractor or supplier shall witness factory test to verify that approved test procedures are followed. When factory tests have been successfully completed,

submit to the Owner a factory test report signed and sealed by the Professional Engineer.

2. Factory test results will be acceptable when all components within tested control panel or system being tested successfully operate and meet its intended function, and are so certified by the testing entity.
3. Do not ship the equipment until obtaining the Owner's acceptance of factory test results.

B. Factory Inspection

1. Inspect each panel, console, device, and cabinet before testing and before shipping. Inspection shall include, but not be limited to the following:
 - a. Verify all "Approved as Corrected" comments on Shop Drawings were implemented.
 - b. Verify presence of and accuracy of nameplates and tags.
 - c. Verify that wire sizes and color-coding comply with the Contract Documents.
 - d. Verify presence of terminal blocks, terminal block numbers, and required quantity of spares.
 - e. Verify annunciator window engravings and quantity of spare windows comply with the Contract Documents.
 - f. Verify proper wiring practices and grounding.
 - g. Verify enclosure flatness, finish, and color.
 - h. Verify anchoring of wire bundles between subpanels and front panel-mounted devices.
 - i. Verify presence of applicable items specified in this Section.

C. Panel Operational Testing

1. Test all input/output components to verify that internal panel wiring is properly terminated at correct locations. Verify initial ranges and settings.
2. Test all system hardware and software to verify proper operation as stand-alone units. Test shall include, but not be limited to, the following:
 - a. Power distribution and breaker ratings to match approved Shop Drawings.
 - b. Power fail/restart tests.
 - c. Diagnostics checks.

- d. Demonstrate that all specified equipment functional capabilities are working properly.
3. Test components and devices requiring data transmission to verify that communication between such components is working properly. Verify communication by using the same media required for the completed system at the Site as indicated in the Contract Documents.
4. Perform integrated system test with all system equipment and simulated inputs/outputs connected to verify that equipment is performing properly as an integrated system.
5. Simulation devices shall be of suitable quality to not mask control panel defects.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify the Owner in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Environmental Requirements
 1. Do not install instruments in areas where construction may cause instrument to be damaged, without providing adequate protection for said instrument.
- B. Installation of Instrumentation
 1. Secure field-mounted instruments to stands or brackets in accordance with manufacturer's recommendations, approved or accepted (as applicable) submittals, and the Contract Documents.
 2. Locate sensors where shown on the Drawings. Confirm exact locations in the field with the Owner.
 3. Install all devices so that devices are readily accessible for service and do not cause potential hazards.

C. Services and Operator Instructions

1. Provide repairs or replacement of defective materials, equipment, or workmanship, including with respect to equipment, the services of factory-trained servicemen.
2. In addition to the calibration required for check-out, provide two additional calibrations on all instruments. The first re-calibration shall be approximately 6 months after acceptance of the system, and the second shall be approximately eleven months after acceptance. As part of each calibration, provide two copies of the calibration sheets, a detailed list of deficiencies (should any be found), and a statement that the entire system is in proper operation and condition (except for the deficiencies noted) and shall be turned over to the Owner.

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections: Field-verify calibration and performance of each instrument before start-up of the associated equipment, and document on a separate sheet for each.

1. For each calibration certification sheet, include the following information:
 - a. Project name.
 - b. Tag number and description.
 - c. Manufacturer.
 - d. Model and serial number.
 - e. Date, time, and person who performed calibration.
 - f. Calibration data to include.
 - (1) Input, output, and error at 0, 25, 75, and 100% of span for analog instruments.
 - (2) Switch setting, contact action, and deadband, if applicable, for discrete elements.
 - g. Space for comments.
 - h. Signature and date.

2. System Check-Out and Start-Up Responsibilities:

- a. The Contractor shall retain the services of the System Supplier to supervise and/or perform check-out and start-up of all system components. As part of these services, the System Supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the equipment.
- b. Check and approve the installation of all instrumentation and control system components and all cable and wiring connections between the various system components before placing the various processes and equipment into operation.
- c. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in the Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
- d. The Contractor shall provide all test equipment necessary to perform the testing during system checkout and start-up.
- e. The Contractor and System Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustments, or replacements for operation, monitoring, and control of the various processes and equipment necessary to perform the functions intended at no additional cost to the Owner. These changes or adjustments shall be documented by the Contractor and submitted to the Owner as part of the Installation Inspection Report described in Paragraph g. below.
- f. The Contractor shall furnish to the Owner certified calibration reports for field instruments and panel mounted devices specified in this Section as soon as calibration is completed.
- g. The Contractor shall furnish the Owner with an Installation Inspection Report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by

authorized representatives of the Contractor and the System Supplier.

h. Instrumentation and Control System Field Test:

- (1) Following the instrumentation and control system checkout and initial operation, the Contractor, under the supervision of the System Supplier, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended instrumentation and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by the Contractor and then retested to demonstrate proper operation.
- (2) Following demonstration of all system functions, the instrumentation and control system, including field sensors/transducers and instruments, and telemetry system shall be running and fully operational for a continuous 48-hour period.

3.04 MANUFACTURER'S SERVICES

A. General

1. The Contractor shall retain the services of the System Supplier to provide operation and maintenance training for all instrumentation and control system equipment as specified herein.
2. For equipment items not manufactured by the System Supplier, he shall provide for on-site training by an authorized representative of the equipment manufacturer as part of his services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
3. The Contractor shall be responsible for all costs associated with training and shall provide all required materials, texts and required supplies.
4. Training shall conform to the requirements of Section 11000, General Equipment Requirements.

B. On-Site Training

1. General:

- a. Provide on-site operation and maintenance training by the System Supplier and the equipment manufacturer representatives before placing the equipment in continuous operation.
- b. Training courses shall include time for students to develop and demonstrate understanding of training concepts. Testing shall include hands on training with equipment.
- c. At the conclusion of each course students shall be tested on course material. Testing shall include exercises where students must demonstrate proper response to normal operational needs, emergencies, and maintenance tasks. Every student shall be tested individually.
- d. Training shall accomplish the following:
 - (1) Provide instruction covering use and operation of the equipment to perform the intended functions.
 - (2) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.
 - (3) Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.
 - (4) Provide classes and field training as to how to change process control and alarm set points in all microprocessor based controllers and transmitters. Maintenance personnel shall be trained to enter passwords, programming or configuration data, etc.

2. Primary Sensors/Transducers and Field Instruments:

- a. The services of equipment manufacturer's representatives shall be provided for a minimum of 2 hours for each type of instrument.
- b. Training shall include:
 - (1) Basic repair and maintenance capabilities of installed equipment.

- (2) Procedures for placing the equipment in and out of operation.
- (3) Use of any special repair equipment or software packages that are used for repair or maintenance.
- (4) Procedures for testing any repair before placing equipment back in service.

3. PLC and OIT Training:

a. Training shall include:

- (1) Hardware and software configuration of PLC and OIT programs.
- (2) Perform a walk through with students identifying system components. Instructor shall test each student's knowledge of system components during walk through.
- (3) Identify key operating and alarm features of the Project-specific PLC and HMI programs.
- (4) Test students' knowledge of proper response to alarms, capabilities to replace hardware components, switch hardware and software between online and offline, add new components, know when to call for assistance, demonstrate understanding of hardware and safety requirements, understand impact of changes made to rest of the control system.
- (5) Provide instruction covering basic editing of PLC programs and OIT screens. Instruction shall include testing students programming capabilities by having students make minor changes to programs and test changes online.

END OF SECTION

DIVISION 15
MECHANICAL

SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes requirements for the following:
1. Piping materials and installation instructions common to most piping systems.
 2. Transition fittings.
 3. Dielectric fittings.
 4. Mechanical sleeve seals.
 5. Sleeves.
 6. Escutcheons.
 7. Grout.
 8. Equipment installation requirements common to equipment sections.
 9. Painting and finishing.
 10. Concrete bases.
 11. Supports and anchorages.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Welding certificates.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
1. ASTM B32—Standard Specification for Solder Metal.
 2. ASTM B813—Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
 3. ASTM B828—Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

4. ASTM C1173—Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
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 D2564—Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
8. ASTM D2657—Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
9. ASTM D2661—Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
10. ASTM D2672—Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
11. ASTM D2846/D3846M—Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
12. ASTM D2855—Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
13. ASTM D3138—Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components.
14. ASTM D3139—Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
15. ASTM D3212—Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
16. ASTM F402—Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
17. ASTM F493—Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
18. ASTM F656—Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

B. American Society of Mechanical Engineers (ASME)

1. ASME B1.20.1—Pipe Threads, General Purpose, Inch.
2. ASME B16.21—Nonmetallic Flat Gaskets for Pipe Flanges.
3. ASME B18.2.1—Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
4. ASME B31—Code for Pressure Piping.
5. ASME BPVC—Boiler and Pressure Vessel Code.

C. American Water Works Association (AWWA)

1. AWWA C110/A21.10—Standard for Ductile-Iron and Gray-Iron Fittings.
2. AWWA C219—Bolted, Sleeve-Type Couplings for Plain-End Pipe.

D. American Welding Society (AWS)

1. AWS A5.8/A5.8M—Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1/D101M—Structural Welding Code – Steel.
3. AWS D10.12—Recommended Practices and Procedures for Welding Low Carbon Steel Pipe.

1.04 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, Structural Welding Code – Steel.

B. Steel Pipe Welding: Qualify processes and operators according to ASME BPVC: Section IX, Welding and Brazing Qualifications.

1. Comply with provisions in ASME B31 Series, Code for Pressure Piping.
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing by the Engineer and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

B. Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material before, during, and after installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During the installation, piping, ductwork, and similar openings shall be capped to keep out dirt and other foreign matter.

- C. The Contractor shall store plastic pipes protected from direct sunlight and supported to prevent sagging and bending.

1.06 COORDINATION

The Contractor shall do the following:

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during construction to allow for mechanical installations.
- B. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.
- D. Provide coordination drawings at 1/4 inch = 1 foot, 0 inch scale illustrating the coordination of piping, ductwork, lighting, and structure for an interference-free installation. Provide 24-inch-x-36-inch bond paper and submit for review.

1.07 DEFINITIONS

- A. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. *Exposed, Interior Installations*: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. *Exposed, Exterior Installations*: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. *Concealed, Interior Installations*: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. *Concealed, Exterior Installations*: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 Articles where Paragraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 Piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: Refer to ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

Joining materials shall be as follows:

- A. Refer to individual Division 15 Piping Sections for special joining materials not listed below.

- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents:
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated:
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110/A21.10, rubber, flat face, 1/8-inch thick, unless otherwise indicated, and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- F. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated, and AWS A5.8/A5.8M, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D2235.
 2. CPVC Piping: ASTM F493.
 3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 4. PVC to ABS Piping Transition: ASTM D3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by the pipe manufacturer.

2.04 TRANSITION FITTINGS

Transition fittings shall be as follows:

- A. AWWA Transition Couplings: The same size as and with pressure rating at least equal to and with ends compatible with the piping to be joined.
 - 1. Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
 - 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions, one end with threaded brass insert and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions, one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Thompson Plastics, Inc.

- D. Plastic-to-Metal Transition Unions: CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Available Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C1173 with elastomeric sleeve, ends the same size as the piping to be joined, and a corrosion-resistant metal band on each end.
 - 1. Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.05 DIELECTRIC FITTINGS

Dielectric fittings shall be as follows:

- A. Description: A combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180° F.
 - 1. Available Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.

- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
1. Available Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, threaded ends, and 300-psig (2070-kPa) minimum working pressure at 225° F.
1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225°F.
1. Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.

- c. Sioux Chief Manufacturing Co., Inc.
- d. Victaulic Co. of America.

PART 3 EXECUTION

3.01 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. The Contractor shall install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. The Drawings, schematics, and diagrams indicate the general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- C. Install the piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow the application of insulation.
- K. Select system components with a pressure rating equal to or greater than the system operating pressure.
- L. Sleeves are not required for core-drilled holes.
- M. Permanent sleeves are not required for holes formed by removable PE sleeves.

- N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

3.02 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream the ends of pipes and tubes and remove burrs. Bevel the plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from the inside and outside of the pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to the tube end. Construct joints according to ASTM B828 or CDA's *Copper Tube Handbook* using lead-free solder alloy complying with ASTM B32.
- E. Brazed Joints: Construct joints according to AWS's *Brazing Handbook*, "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select the appropriate gasket material, size, type, and thickness for service application. Install the gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 5. PVC Nonpressure Piping: Join according to ASTM D2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657:
1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to the pipe manufacturer's written instructions.

3.03 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions in piping NPS 2 (DN 50) and smaller adjacent to each valve and at the final connection to each piece of equipment.
 2. Install flanges in piping NPS 2-1/2 (DN 65) and larger next to flanged valves and at final connection to each piece of equipment.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. Install equipment to allow the maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow the right of way for piping installed at the required slope.

3.05 PAINTING

- A. The painting of mechanical systems, equipment, and components is specified in Section 09900, Painting and Coating.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match the original factory finish.

3.06 CONCRETE BASES

- A. Concrete Bases: Anchor the equipment to the concrete base according to the equipment manufacturer's written instructions.
 - 1. Construct concrete bases of the dimensions indicated, but not less than 4 inches larger in both directions than the supported unit.
 - 2. Install dowel rods to connect the concrete base to the concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through the concrete base and anchor into the structural concrete floor.
 - 4. Place and secure anchorage devices. Use the supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with the items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to the supported equipment.
 - 6. Install anchor bolts according to the anchor-bolt manufacturer's written instructions.
 - 7. Use 3,000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 03300, Cast-In-Place Concrete.

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Section 05500, Metal Fabrications.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.08 GROUTING

The Contractor shall do the following:

- A. Mix and install grout for the mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for the placement of grout.
- D. Avoid air entrapment during the placement of grout.
- E. Place grout so as to completely fill the equipment bases.
- F. Place grout on the concrete bases and provide smooth bearing surface for the equipment.
- G. Place the grout around the anchors.
- H. Cure placed grout.

END OF SECTION

SECTION 15055
PIPING SYSTEMS—GENERAL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Specification describes responsibilities and requirements for Piping Systems including the following:
 - 1. Labor, materials, tools, equipment, and services to be furnished in accordance with the provisions of the Contract Documents. The materials to be used for the piping systems shown in the Drawings are listed by service in the Piping Schedule, included in the Contract Drawings.
 - 2. Coordination of work with other trades.
 - 3. Furnishing and installing all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation, although such work is not specifically indicated.
 - 4. Furnishing Record Drawings and documents for piping systems.

1.02 SUBMITTALS

The Contractor shall submit the following in accordance with Section 01330, Submittals and Acceptance:

- A. If the Contractor deviates from the piping layout as shown on the Contract Drawings, the Contractor shall submit scaled piping drawings showing locations and dimensions to and from fittings, valves, tanks, equipment, structures, and related appurtenances. Provide scaled drawings to a minimum scale of 1 inch equals 10 feet. Provide details to minimum scale of 1/8 inch equals 1 foot. Elevations shall correspond to reference vertical elevation datum shown or provided for this project.
- B. Copies of any manufacturer's written directions regarding material handling, delivery, storage, and installation.
- C. Record piping drawings shall meet the requirements of Section 01785, Record Documents. During the work, the Contractor shall maintain accurate, up-to-date Record Drawings of piping systems installed in the project, including pre-existing piping discovered, relocated, or at locations other than as originally shown on the Drawings. When the work is completed and accepted by the Owner and the Engineer, the Contractor shall submit Record Drawings in accordance with Section 01785, Record Documents. The Contractor shall identify complete

location, elevations, and description of piping systems. Piping systems and fittings are to be identified from three points on structures and/or stationary appurtenances.

- D. Submit copies of forms documenting required field pressure testing work and results.
- E. Submit welding certificate copies.
- F. Submit certified copies of mill test reports for bolts and nuts, including coatings if specified. Provide recertification by an independent domestic testing laboratory for materials originating outside of the United States.
- G. Submit manufacturer's data sheet for gaskets supplied showing dimensions and bolting recommendations.
- H. Support Systems:
 - 1. Drawings of each piping system locating each support, guide, and anchor.
 - 2. Identify support, guide, and anchor type by catalog number and shop/contract drawing detail number

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society of Mechanical Engineers (ASME)
 - 1. ASME B1.1—Unified Inch Screw Threads (UN and UNR Thread Forms).
 - 2. ASME B1.20.1—Pipe Threads, General Purpose (Inch).
 - 3. ASME B16.21—Nonmetallic Flat Gaskets for Pipe Flanges.
 - 4. ASME B18.2.1—Square, Hex, Heavy Hex, and Askew Head Bolts, and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
 - 5. ASME B18.2.2—Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
 - 6. ASME B31.1—Power Piping.
 - 7. ASME B31.1—Process Piping.
 - 8. ASME BPVC—Boiler and Pressure Vessel Code.

B. American Society for Testing and Materials (ASTM)

1. ASTM A183—Specification for Carbon Steel Track Bolts and Nuts.
2. ASTM A193/A193M—Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
3. ASTM A194/A194M—Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
4. ASTM A307—Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
5. ASTM D1330—Standard Specification for Rubber Sheet Gaskets.
6. ASTM F467—Standard Specification for Nonferrous Nuts for General Use.

C. American Water Works Association (AWWA)

1. AWWA C111/A21.11—Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C207—Steel Pipe Flanges for Waterworks Service, Sizes 4-Inch through 144 Inch. (100 mm through 3,600 mm).

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS SP-58—Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.

E. NSF International (NSF)

1. NSF 61—Drinking Water System Components – Health Effects.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.
- B. The Contractor shall protect the pipe from kinks, cuts, end damage, and other defects when transporting all piping. Binding and tie-down methods shall not damage or deflect the pipes in any way. Pipe damaged during shipment shall be rejected.
- C. Pipe shall be stored on level ground, preferably turf or sand, free of sharp objects that could damage the pipe. Stacking of any pipe shall be limited to a height that

will not cause excessive deformation of the lower layers of pipe under anticipated temperature conditions. When necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such widths to not allow deformation of the pipe at the point of contact with the sleeper or between supports. Pipe shall not be removed from storage until bedding or sub-grade work is complete and ready to receive the pipe.

- D. The joined pipe shall be handled in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Pipe or fittings shall not be dropped. Slings for handling joined pipe shall not be positioned at socket-welded joints. Sections of the pipes with cuts and gouges shall be removed and the ends of the pipe rejoined. In accordance with the pipe manufacturer's written instructions, the Contractor shall repair all pipe with damaged linings and pipe exterior coatings that have been damaged before the pipe is installed.
- E. The Contractor shall cover all pipe stored on the site with canvas or other opaque material to protect it from sunlight. Provide air circulation under the covering.
- F. The Contractor shall inspect all pipe, fittings, and other accessories upon delivery and during the work. Any defective or damaged materials found during field inspection or during tests shall be removed from the site and replaced by, and at the expense of, the Contractor.
- G. The interior of all pipe, fittings, and other accessories shall be kept free from dirt and foreign matter at all times. Fittings shall be drained and stored in a manner that will protect them from damage by freezing.
- H. Gaskets shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-delivered-to-site and first-to-be-installed rotation basis. Mechanical-joint glands, bolts, and washers shall be handled and stored in a manner that will ensure proper use with respect to types and sizes.

1.05 DEFINITIONS OF BURIED, EXPOSED, AND SUBMERGED PIPING

- A. Buried piping is piping buried in soil, beneath a structure and/or encased in concrete. Where an exterior pipe coating is specified to be factory- or field-applied, the Contractor shall provide the coating up to the penetration of a structure. Piping encased in concrete does not require an exterior coating other than what is factory furnished.

- B. Exposed piping is piping in any of the following conditions or locations:
 - 1. Above ground.
 - 2. Inside buildings, vaults, or other structures.
 - 3. In underground concrete trenches or galleries.
- C. Submerged piping is considered to be all piping within a liquid holding tank.

1.06 SYSTEM DESIGN REQUIREMENTS

- A. General
 - 1. The Specifications and Drawings are not all inclusive of explicit piping details; provide piping for intended use in compliance with laws and regulations, including ASME B31.1 Code (Power Piping).
 - 2. Pressure ratings and materials specified represent minimum acceptable standards for piping systems.
 - 3. Piping Systems: Suitable for the services specified and intended.
 - 4. Piping shall be color coded in accordance with the Florida Department of Environmental Protection (FDEP) requirements.
- B. Support Systems
 - 1. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of responsibility for sizing and providing supports for this project.
 - 2. Select and design within the specified spans and component requirements.
 - 3. Comply with requirements of MSS SP-58.
 - 4. Criteria for structural design and selection of pipe support system components:
 - a. Dead loads imposed by the weight of the pipes filled with water, within specified spans and component requirements, plus any insulation.
 - b. Safety factor: Minimum of 5.
 - 5. Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor the support, to withstand the

shear and pullout loads imposed by loading and spacing on each particular support.

- a. Piping smaller than 30 inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required and are to be provided and installed by the Contractor at no additional cost to the Owner.

C. Adapters

1. No attempt has been made to show all adapters, spool pieces, reducers, bushings, or other fittings required to accommodate the connection of pipes, fittings, and valves of various joint design and sizes throughout the project. The Contractor is completely responsible for providing, at his expense, all adapters, reducers, sleeves, spool pieces, and other fittings and appurtenances necessary for connection of pipe (for the same pipe material or a transition of pipe materials), valves, fittings, and appurtenances throughout the project, which shall be constructed of appropriate materials, coated and lined to match the materials, coatings, and linings specified for the connected components. All adapters, reducers, sleeves, spool pieces, and other fittings shall be coated and lined in accordance with the specifications for each individual pipe system.

D. Unions

1. No attempt has been made to show all unions required for the project. The Contractor shall provide unions at all connections of threaded pipe to installed equipment unless deleted by the Engineer, in writing, at certain locations. The unions shall meet or exceed the quality of materials, pressure rating, service, and painting requirements of connected piping.

PART 2 PRODUCTS

2.01 PIPING SYSTEM GENERAL REQUIREMENTS SCHEDULE

- A. Unless noted otherwise in the Drawings, piping system materials, fittings, and appurtenances are subject to requirements of the individual Specifications for the piping systems.

2.02 PIPING SCHEDULE

- A. A piping schedule (flow stream identification) listing the piping identification abbreviations, piping materials, operating pressures, field test pressures, lining systems, and color coding associated with the flow streams is provided on the

Contract Drawings. In project locations where the piping system material referenced on the piping schedule is not appropriate, the required piping material is indicated on the Contract Drawings. Materials called out in the Contract Drawings shall govern over materials stated in the piping schedule.

2.03 THREAD FORMING FOR STAINLESS STEEL BOLTS

- A. Form threads for stainless steel bolts by rolling, not by cutting or grinding.

2.04 BOLTS AND NUTS FOR FLANGES FOR DUCTILE IRON PIPE FLANGES

- A. Bolts, washers, and nuts for pipe installed indoors, outdoors above and below ground, and in vaults and structures shall be as specified in Section 15155, Ductile Iron Pipe and Fittings.
- B. Bolts, washers, and nuts for submerged Class 150 flanges shall be Type 304 stainless steel conforming to ASTM A193/A193M (Grade B8) for bolts and ASTM A194/A194M (Grade 8) for nuts. Fit shall be Class 2A conforming to ASME B1.1 when connecting to cast-iron valves having body bolt holes.

2.05 BOLTS AND NUTS FOR TYPE 304 STAINLESS STEEL PIPE FLANGES

- A. Bolts, washers, and nuts for flanges shall be Type 304 stainless steel conforming to ASTM A193/A193M, Grade B8, for bolts and ASTM A194/A194M, Grade 8, for nuts.

2.06 BOLTS AND NUTS FOR TYPE 316 STAINLESS-STEEL PIPE FLANGES

- A. Bolts, washers, and nuts for flanges shall be Type 316 stainless steel conforming to ASTM A193/A193M, Grade B8, for bolts and ASTM A194/A194M, Grade 8, for nuts.

2.07 BOLTS AND NUTS FOR PVC, CPVC, AND PVDF PIPE FLANGES

- A. Bolts for piping in sodium hypochlorite service shall be made of titanium, in accordance with ASTM F467, Grade Ti1, Ti2, or Ti7. Nuts and washers shall conform to ASTM F467 and shall be made of titanium.
- B. Bolts, washers, and nuts in chemical service other than sodium hypochlorite shall be Type 304 stainless steel conforming to ASTM A193/A193M, Grade B8, for bolts and ASTM A194/A194M, Grade 8, for nuts.
- C. Bolts, washers, and nuts for buried and submerged flanges and flanges located outdoors above ground or in vaults and structures shall be Type 304 stainless steel

conforming to ASTM A193/A193M, Grade B8, for bolts and ASTM A194/A194M, Grade 8, for nuts.

- D. The Contractor shall provide a washer under each nut and under each bolthead. Washers shall be of the same material as the nuts.

2.08 BOLTS AND NUTS FOR STEEL PIPE FLANGES

- A. Bolts, washers, and nuts for Class 150 flanges (including AWWA C207, Class D) located indoors, outdoors above ground, in vaults, and in structures shall be carbon steel, ASTM A307, Grade B. Bolts, washers, and nuts for buried service shall also be hot-dipped galvanized.
- B. Bolts, washers, and nuts for submerged Class 150 flanges shall be Type 304 stainless steel conforming to ASTM A193/A193M (Grade B8) for bolts and ASTM A194/A194M (Grade 8) for nuts. Fit shall be Class 2A in accordance with ASME B1.1 when connecting to cast-iron valves having body bolt holes.

2.09 LUBRICANT FOR STAINLESS STEEL BOLTS AND NUTS

- A. Anti-seize thread lubricant shall be applied to the thread portion of all (above grade and below grade) stainless steel bolts (stainless steel tie rods, etc.) during assembly. Anti-seize lubricant shall be chloride free and shall be nongalling NSF approved. Anti-seize thread lubricant shall be Jet-Lube “Nikal,” John Crane “Thred Gard Nickel,” Never-Seez “Pure Nickel Special,” or Permatex “Nickel Anti-Seize.”

2.10 FLANGE GASKETS FOR STEEL, DUCTILE IRON, AND STAINLESS STEEL PIPE

- A. Flange gaskets shall be in accordance with AWWA C207, except as modified in this Section. Gaskets shall be ring type. All gasket material shall be suitable for the fluid being conveyed and shall be resistant to free chlorine concentrations up to 10 mg/L. All gasket material shall be rated to the surge pressures listed in the pipe schedule. Gaskets shall be EPDM, Viton, or an approved equal.

2.11 FLANGE GASKETS FOR PVC AND CPVC PIPE

- A. Gaskets for flanged joints shall be full faced, 1/8 inch thick, having a Brinell Hardness of 50 to 70 durometer A. Gasket material shall be EPR unless noted or specified otherwise. Gasket material for sodium hypochlorite service shall be Viton ETP unless noted or specified otherwise. Gaskets shall be compatible with the fluids conveyed.

2.12 FLANGE GASKETS FOR STAINLESS-STEEL PIPE IN CHEMICAL SERVICE

- A. Gaskets shall be suitable for a maximum pressure of 300 psi and a maximum temperature of 500°F. The Contractor shall verify that the gaskets are compatible with the fluids conveyed. Gaskets for chemical service shall be one of the following materials:
 - 1. Teflon-envelope type, full face, 1/8 inch thick, with compressed nonasbestos filler. Provide free-flow design in which the Teflon is machined or milled between leaves to provide a space for the filler.
 - 2. Teflon (PTFE) with inert filler, 1/8 inch thick. Product: Garlock "Gylon 3510" shall be used for potassium hydroxide, sodium hypochlorite, and ammonium hydroxide. Garlock "Gylon 3545" shall be used for sulfuric acid, corrosion inhibitor, and hydrofluosilicic acid.

2.13 LOCATOR WIRE

- A. All 2-inch and larger buried piping shall be laid with two insulated, 12-gauge minimum AWG, THWN strand copper wires taped with adhesive-backed tape or tied to the nonmetallic pipe at 5 feet on center for location purposes.

PART 3 EXECUTION

3.01 PREPARATION

- A. Field Alignment:
 - 1. The piping shown on the Contract Drawings is generally indicative of the work, with symbols and notations provided for clarity. However, the Contract Drawings are not an exact representation of all conditions involved; therefore, install piping to suit actual field conditions and measurements as approved by the Engineer. No extra compensation will be made for work due to differences between indicated and actual dimensions.
 - 2. The Contractor shall install all adapters, fittings, flanged connections, closures, restrained joints, etc. not specified but necessary for a complete installation acceptable to the Engineer.
 - 3. The Contract Drawings do not indicate all adapters, fittings, spool pieces, bushings, unions, supports, hangers, and other items required to accommodate the installing and connecting of pipe, fittings, valves, and equipment of various joint designs and sizes. Provide such required items of appropriate designs, materials, coatings, and linings.

3.02 FIELD LAYOUT AND MODIFICATIONS

- A. Unless directed otherwise, the Contractor shall be responsible for setting construction layout stakes and/or offsets required to complete the designated work. The Contractor shall ensure that those stakes and/or offsets are protected and any re-staking required for any reason including work stoppage shall be included in the bid price and no additional compensation to the Contractor will be made.
- B. The Engineer has the right to make any modifications the Engineer deems necessary due to field conditions, conflicts with other utilities, or to protect other properties.

3.03 PIPE PRODUCTS INSPECTION

- A. The Contractor shall obtain from the pipe manufacturer a certificate of inspection to the effect that the pipe, fittings, gaskets, glands, bolts, and nuts supplied for this Contract have been inspected at the plant and that they meet the requirements of these Specifications. The Contractor shall submit these certificates to the Engineer before installing the pipe materials. The Contractor shall visually inspect all pipe and fittings at delivery and before they are lowered into the trench to be installed. Pipe or fittings that do not conform to these Specifications or have been damaged in any manner will be rejected and the Contractor must remove them immediately. The entire product of any plant may be rejected when, in the opinion of the Engineer, the methods or quality assurance and uniformity of manufacturer fail to secure acceptable and uniform pipe products or where the materials used produce inferior pipe products.

3.04 BURIED PIPING AND PIPE FITTINGS

- A. Trenching and backfilling for all pipe and fittings shall also be in accordance with Section 02305, Earthwork for Utilities.
- B. Installation:
 - 1. Inspect all piping for defects and remove all lumps or excess coatings before installation. The inside of the mechanical joint and outside of plain-end pipe shall be cleaned before joining pipe. Caution shall be taken to prevent damage to the pipe during lowering into the trench. Remove all foreign matter that has entered the pipe during storage and installation. The Contractor shall cover the pipe ends during installation to prevent debris from entering the pipe. No debris, tools, clothing, or other material shall be placed in the pipe.

2. After being placed in the trench, the pipe shall be brought to the proper line and grade by compacting the approved backfill material under it, except at the bell end. Joint deflection shall not exceed 75% of the manufacturer's limit.
3. The Contractor shall install temporary water-tight plugs on the pipe ends during the time that the pipe is in the trench but no work is in progress. If there is water in the trench upon beginning work, this plug shall remain in place until the trench has been pumped dry, unless otherwise approved by the Engineer, the Engineer's Representative, or the Owner's Representative.
4. Buried carbon steel bolts and nuts shall be coated in accordance with Section 09900, Painting and Coating, System No. 21.
5. Coat threaded portions of stainless steel bolts and nuts with lubricant before assembly.
6. Restrained plugs or caps shall be inserted into all buried dead end pipes, tees, or crosses. Provide blind flanges for all flanged exposed piping. Restrained plugs and caps installed for pressure testing shall be fully secured and blocked to withstand the test pressure.
7. Where plugging is required because of contract division or phasing for later connection, the ends of such lines shall be equipped with a suitable cast-iron or ductile-iron plug/cap or blind flange with or without a blowoff cock, as shown on the Drawings. Installation or removal of such plugging shall be considered incidental to the work and the Contractor shall not be compensated by the Owner for performing this work.

3.05 FLANGED JOINTS FOR EXPOSED PIPE AND FITTINGS

- A. When bolting flanged joints, the Contractor shall avoid restraint on the opposite end of the pipe or fitting, which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually and at a uniform rate to ensure uniform compression of the gasket, in accordance with pipe and fitting manufacturer's recommendations.
- B. Coat threaded portions of stainless steel bolts and nuts with lubricant before assembly.

3.06 PIPING CONNECTIONS TO PUMPS AND OTHER EQUIPMENT

- A. When connecting to pumps and equipment, the Contractor shall ensure that piping stresses are not transmitted to the pump and equipment. All connecting pipe shall be permanently supported and aligned so that accurate matching of bolt holes and uniform contact over the entire surface of pump flanges are obtained before any bolts are installed in the flanges or pipe is threaded into pump and equipment. In

addition, pump connection piping shall be free to move parallel to its longitudinal center line while the bolts are being tightened.

1. Pumps and equipment shall be leveled, aligned, and wedged into a position that will fit the connecting pipe, but shall not be grouted until the initial fitting and alignment of the pump and equipment may be shifted on its foundation if necessary, to properly install the connecting pipe. Each pump and piece of equipment shall, however, be grouted before final bolting of the connecting piping.
2. After final alignment and bolting, the pump and equipment connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as required and then the flanges bolted back together. The flange bolts then shall be loosened and the process repeated until no movement is observed.
3. All carbon steel bolts and nuts shall be coated with the same exterior coating applied to the piping system.

3.07 ANCHORING AND RESTRAINING

- A. Thrust blocks shall be used in new lines and shall be limited to areas in which a new fitting has been installed in an existing line and field restraining joints are not feasible as determined by the Engineer.

3.08 FLUSHING, CLEANING, TESTING AND INSPECTION OF PIPING

- A. See Section 15144, Pressure Testing of Piping, for the requirements of pipe flushing, cleaning, pressure testing, and inspection requirements.

3.09 SPECIAL REQUIREMENTS AND PIPING SPECIALTIES

- A. Welding:
 1. Use only certified welders meeting procedures and performance outlined in Section IX of the ASME BPVC and other codes and requirements in accordance with local building and utility requirements. Submit Welder's certificates to the Engineer for the project record before beginning any welding on the project. The Welder must be certified for all positions (flat, vertical, and overhead).
 2. Have all welds conform to highest industrial practice in accordance with ASME B31.1 and ASME B31.3 or other codes and requirements in accordance with local building and utility requirements.

3.10 PIPE COLOR CODING

- A. The pipe color shall be as identified on the Drawings. The Contractor shall coordinate with the Engineer and the Owner to generate a list of acceptable pipe colors for exposed piping systems. Where color-coding is achieved by painting exterior surfaces of the piping systems, painting shall be provided in accordance with Section 09900, Painting and Coating. On applicable pipes, color shall be in accordance with FDEP color-coding requirements.

END OF SECTION

SECTION 15060
PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes requirements for materials and installation of pipe hangers and supports, including accessory items such as anchor bolts and screws, pipe spiders, neoprene isolation pads, cable trays for hoses, and drip guards.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Provide line drawings of each piping system to the scale shown on the Drawings, locating each support or hanger. Identify each type of hanger or support by the manufacturer's catalog number or figure.
- B. Provide installation drawings and manufacturer's catalog information on each type of hanger and support used. Clearly indicate the actual pipe outside diameter (not just nominal pipe size) that is used for the hangers and supports.
- C. Submit layout drawings for the drip guards, showing dimensions and thicknesses. Show design of seam or joint where field connections will be made between sections and pieces of drip guards.
- D. Submit a certificate listing the type of resin to be used, describing the manufacturer's brand name or designation, composition, and characteristics.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A36/A36M—Standard Specification for Carbon Structural Steel.
 - 2. ASTM A47/A47M—Standard Specification for Ferritic Malleable Iron Castings.

3. ASTM A48/A48M—Standard Specification for Gray Iron Castings.
4. ASTM A153/A153M—Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A194/A194M—Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
6. ASTM A276/A276M—Standard Specification for Stainless Steel Bars and Shapes.
7. ASTM A307—Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
8. ASTM A575—Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
9. ASTM A576—Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
10. ASTM A635/A635M—Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
11. ASTM A1011/A1011M—Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
12. ASTM D256—Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
13. ASTM E84—Standard Test Method for Surface Burning Characteristics of Building Materials.
14. ASTM F593—Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
15. ASTM F594—Standard Specification for Stainless Steel Nuts.

B. American Society of Mechanical Engineers (ASME)

1. ASME B31.1—Power Piping.

C. Manufacturer's Standardization Society

1. MSS SP-58—Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.

1.04 QUALITY ASSURANCE

- A. All hangers, supports, and appurtenances shall conform to the latest applicable requirements of ASME B31.1, except as supplemented or modified by the requirements of this Section.

- B. All hangers, supports, and appurtenances shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for all supporting equipment, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10 feet of water-filled pipe being supported.
- C. All pipe and appurtenances connected to equipment shall be supported so as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, the Contractor shall submit certification stating that such requirements have been complied with.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.
- B. All supports and hangers shall be crated, delivered, and uncrated to protect against any damage.
- C. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.
- D. Finished iron or steel surfaces not galvanized or painted shall be properly protected to prevent rust and corrosion.

PART 2 PRODUCTS

2.01 GENERAL

- A. Not all pipe supports or hangers required are shown on the Drawings. The Contractor shall provide pipe supports for every piping system installed. Support piping by pipe support where it connects to pumps or other mechanical equipment.
- B. The Contractor shall ensure that pipe support and hanger components shall withstand the dead loads imposed by the weight of the pipes, fittings, and valves (all filled with water) plus valve actuators and any insulation and shall have a minimum safety factor of 5 based on the material's ultimate strength.

- C. All of the equipment specified in this Section is intended to support the various types of pipe and piping systems. The details shown on the Drawings are intended to indicate the generally desired methods of support under normal conditions. The Contractor shall develop final details and any details associated with special conditions not already covered to meet the system conditions specified in the respective Division 15 Pipe Sections.
- D. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, fittings, and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact.
- E. Hangers and supports shall be spaced in accordance with ASME B31.1 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified in this Section.
- F. Where flexible couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc. shall be rigidly supported.
- G. All pipe and appurtenances connected to the equipment shall be supported so as to prevent any strain from being imposed on the equipment or piping system.
- H. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for interior pipe supports shall be furnished with galvanized finish, hot-dipped, or electro-galvanized coated, except where field welding is required. Interior clamps on plastic pipe shall be plastic coated. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for exterior pipe and pipe within outdoor structures shall be of Type 316 stainless steel.
- I. Supports shall be sufficiently close together so that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.
- J. All un-insulated non-metallic piping such as PVC, CPVC, etc., shall be protected from local stress concentrations at each support point. Protection shall be provided by galvanized steel protection shields or other method as approved by the Engineer. Where pipes are bottom supported 180°, arc shields shall be furnished. Where 360° arc support is required, such as U bolts, protection shields shall be provided for the entire pipe circumference. Protection shields shall have an 18-gauge minimum thickness, not be less than 12 inches in length, and be securely fastened to pipe with stainless steel or galvanized metal straps not less than 1/2-inch wide.

- K. All insulated pipe shall be furnished with a rigid foam insulating saddle at each pipe support location as specified under respective pipe insulation. Provide galvanized protection shields as specified in Paragraph 2.01J above at each location.
- L. Pipe supports shall be provided as follows:
1. Cast-iron and ductile-iron piping shall be supported at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.
 2. Steel and stainless steel piping 2-1/2 inches or larger diameter shall be supported at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.
 3. Supports for multiple PVC plastic piping shall be continuous wherever possible. Individually supported PVC pipes shall be supported as recommended by the manufacturer except that support-spacing shall not exceed 3 feet. Multiple, suspended, horizontal plastic PVC pipe runs shall, where possible, be supported by ladder-type cable trays such as the Electray Ladder by Husky-Burndy; Cable Tray by Enduro Composite Systems; the Globetray by the Metal Products Division of United States Gypsum or equal. Ladder shall be of FRP construction. Rung spacing shall be 12 inches. Tray width shall be approximately 6 inches for single runs and 12 inches for double runs. Ladder-type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps, or fasteners similar to Globe, Model M-CAC; Husky-Burndy, Model SCR; or equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers, and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.
 4. All vertical pipes shall be supported at each floor or at intervals of not more than 12 feet by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to ensure rigid construction.
 5. Pipe supports shall not induce point loadings, but shall distribute pipe loads evenly along the pipe circumference.
 6. Supports shall be provided at changes in direction and elsewhere as shown on the Drawings or as specified in this Section. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Engineer.
 7. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split-type couplings, and sleeve-type couplings and to

minimize all pipe forces on pump housings. Pump housings shall not be used to support connecting pipes.

8. Effects of thermal expansion and contraction of the pipe shall be accounted for in the pipe support selection and installation.

- M. Any required pipe support for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes and concrete and anchor hardware similar to items previously specified in this Section and shall be subject to the approval of the Engineer.

2.02 HANGER AND SUPPORT SYSTEMS

- A. Pipe hangers and supports shall be as manufactured by Anvil, Unistrut, Cooper B-Line, Aikinstruct, Superstrut, or equal.
- B. Pipe hangers and supports shall comply with MSS SP-58 for the standard types referenced on the Drawings. The Contractor shall construct special hangers and supports if detailed in the Drawings. Type numbers for standard hangers and supports shall be in accordance with MSS SP-58 as listed below:

Type Number	Description	Manufacturer and Model (or Equal)
1	Adjustable steel clevis	Anvil Fig. 590 or 260, B-Line B3100 or B3102
3	Steel double-bolt pipe clamp	Anvil Fig. 295A or 295H, B-Line B3144 or B3144A
4	Steel pipe clamp (pipes smaller than 3 inches)	Anvil Fig. 212, B-Line B3140
4	Steel pipe clamp (pipes 3 inches and larger)	Anvil Fig. 216, B-Line 3142
5	Pipe hanger	B-Line B6690
6	Adjustable swivel pipe ring	Anvil Superstrut 714, Anvil Fig. 104
7	Adjustable steel band hanger	B-Line B3172
8	Extension pipe or riser clamp	Anvil Fig. 261, B-Line B5573
9	Adjustable band hanger	Anvil Fig. 97
10	Adjustable swivel ring band hanger	Anvil Fig. 70, B-Line B3170 NF
11	Split pipe ring with adjustable turnbuckle	Anvil Fig. 108, B-Line B3173
13	Steel turnbuckle	Anvil Fig. 230, B-Line B3202
14	Steel clevis	Anvil Fig. 299, B-Line B3201
15	Swivel turnbuckle	Anvil Fig. 114, B-Line B3224
16	Malleable iron socket	Anvil Fig. 110R, B-Line B3222
17	Steel weldless eye nut	B-Line B3200
18	Steel or malleable iron concrete insert	Anvil Fig. 281, Superstrut 452
19	Top beam C-clamp	Anvil Fig. 92, B-Line B3033
20	Side I-beam or channel clamp	Anvil Fig. 14 or 217
21	Center I-beam clamp	Anvil Figure 134
22	Welded attachment type	Anvil Fig. 66 B-Line B3083

Type Number	Description	Manufacturer and Model (or Equal)
23	C-clamp	Anvil Fig. 86, B-Line B3036L
24	U-bolt	Anvil Fig. 137, B-Line B3188
26	Clip	Anvil Fig. 262, B-Line B3180
28	Steel I-beam clamp with eye nut	Anvil Fig. 228
29	Steel wide flange	Anvil Fig. 228 clamp with eye nut
30	Malleable iron beam clamp with extension piece	Superstrut CM-754, B-Line B3054
31	Light welded steel bracket	Anvil Fig. 194, B-Line B3063
32	Medium welded steel bracket	Anvil Fig. 195, B-Line B3066
33	Heavy welded steel bracket	Anvil Fig. 199, B-Line B3067
34	Side beam bracket	Anvil Fig. 202, B-Line B3062
36	Pipe saddle support	Anvil Fig. 258, B-Line B3095
37	Pipe stanchion saddle	Anvil Fig. 259, B-Line B3090
38	Adjustable pipe saddle support	Anvil Fig. 264, B-Line B3093/B3089
39	Steel pipe covering	Anvil Fig. 160, 161, 162, 163, 164, or 165; Superstrut A 789; B-Line B3160/B3165
40	Insulation protection shield	Anvil Fig. 167, B-Line B3151
41	Single pipe roll	Anvil Fig. 171, B-Line B3114
43	Adjustable roller hanger with swivel	Anvil Fig. 181, B-Line B3110
44	Pipe roll, complete	Anvil Fig. 271, B-Line B3117SL

- C. Pipe hangers and supports shall be hot-dipped galvanized according to ASTM A153/A153M carbon steel (ASTM A36/A36M, ASTM A575, or ASTM A576). Bases, rollers, and anchors shall be steel as described above or may be cast iron (ASTM A48/A48M). Pipe clamps shall be steel as described above or may be malleable iron (ASTM A47/A47M).
- D. Offset Pipe Clamp.
- E. Anvil Figure 103, Cooper B-Line B3148, or equal. Material shall be Type 316 stainless steel unless otherwise noted.

2.03 MISCELLANEOUS PIPE SUPPORTS AND HANGERS

- A. Pipe Anchor Chair: Anvil Figure 198 or equal.
- B. One Hole Clamp: Anvil Figure 126 or equal.
- C. Roller Chair: Anvil Figure 175 or equal.

2.04 STEEL CHANNEL FRAMING SYSTEM

- A. Steel channel frames shall be 1-5/8 inches wide by 1-5/8 or 3-1/4 inches high by 12-gauge metal thickness, unless otherwise shown on the Drawings. Material shall conform to ASTM A36/A36M, ASTM A1011/A1011M (Grade 33 minimum), or ASTM A653 unless stainless steel is indicated on the Drawings.

Stainless steel shall be Type 304. One side of the channel shall have a continuous open slot with inturned clamping ridges. Maximum allowable stress under any combination of applied uniformly distributed loads and concentrated loads shall not exceed those recommended in the AISC or AISI. Deflection shall not exceed 1/240 of span. The Contractor shall use multiple back-to-back channels to achieve these criteria if single channels are not sufficient. Products: Unistrut P1000 or P5000 Series, B-Line B11 or B22 Series, or equal.

- B. Steel channels shall be hot-dipped galvanized according to ASTM A153/A153M.
- C. Nuts shall be machined and case hardened. The Contractor shall provide rectangular nuts with the ends shaped to permit a quarter turn crosswise in the framing channel. Provide two serrated grooves in the nut to engage the inturned edges of the channel.
- D. Pipe clamps (including attachment screws and nuts) shall be Unistrut P1100 or P2000 Series, B-Line B2000 Series, or equal. Material shall be Type 304 stainless steel.
- E. Hanger rods for trapezes shall be carbon steel (ASTM A36/A36M, ASTM A575, or ASTM A576) unless stainless steel is indicated on the Drawings. Stainless-steel hanger rod material shall comply with ASTM A276/A276M, Type 304.
- F. Accessory fittings and brackets shall be the same material as the channel or trapeze. Provide coating on carbon steel fittings and brackets as specified for the channels and frames.
 - 1. Flat Plate Fittings: Unistrut P1065, P1066, P1925; Superstrut AB-206, AB-207; or equal.
 - 2. Post Bases: Unistrut P2072A, Superstrut AP-232, or equal.
 - 3. 90° Brackets: Unistrut P1326, P1346; Superstrut AB-203; or equal.
 - 4. Rounded-End Flat Plate Fittings: Unistrut P2325, Superstrut X-240, or equal.
- G. Parallel pipe clamps shall be Unistrut P1563 through P1573, Superstrut AB-719, or equal. Material shall be Type 304 stainless steel.

2.05 FIBERGLASS-REINFORCED PLASTIC (FRP) CHANNEL FRAMING SYSTEM

- A. FRP pipe hangers and supports shall be Aickinstrut, Inc. or equal.

- B. Material properties shall be as follows:

Longitudinal Direction	
Ultimate Tensile (psi)	37,500 minimum
Ultimate Compressive (psi)	35,000 minimum
Ultimate Flexural (psi)	37,500 minimum
Tensile Modulus (psi) x 10**6	3.00 minimum
Flexural Modulus (psi) x 10**6	2.00 minimum
Ultimate Shear Strength (psi)	6,000 minimum
Ultimate Bearing Stress (psi)	35,000 minimum
Izod Impact (ASTM D256) ft-lb/inch notch	30 minimum
Transverse Direction	
Ultimate Tensile (psi)	10,000 minimum
Ultimate Compressive (psi)	20,000 minimum
Ultimate Flexural (psi)	14,000 minimum
Tensile Modulus (psi) x 10**6	1.0 minimum
Compressive Modulus (psi) x 10**6	1.4 minimum
Flexural Modulus (psi) x 10**6	1.0 minimum
Ultimate Shear Strength (psi)	5,500 minimum
Ultimate Bearing Stress (psi)	35,000 minimum
Izod Impact, ft-lb notch	5 minimum
Hardness	
Barcol Test	50 minimum

- C. Glass-fiber-reinforced composites and plastic products shall have a flame spread rating of 25 or less when tested in accordance with ASTM E84.
- D. Channel framing shall be 1-5/8 inches deep by 1-5/8 inches wide and shall be made using vinylester resin equal to Ashland Derakane 411, Ashland Hetron 922, or Reichhold Dion 9800. It shall have a nexus polyester surfacing veil over 100% of the surface which, along with a filler system, will protect against degradation from ultraviolet light. Channel shall be supplied with integral notches 1 inch on center. Notches shall be located on the interior flange to prevent slippage of pipe clamps and fittings after installation. In place of notched channel, unnotched channel may be used if the vertical channel sections supporting the horizontal piping are provided with stop lock hardware at each pipe clamp to prevent slippage. Channel framing shall be Aickinstrut G.R.P. Type V 2000 series or equal.
- E. Channel framing connections shall be made with vinylester glass fiber composite nuts, bolts, all threaded rods, channel fittings, bases, and hanger assemblies. Nut, bolts, and rods shall be Aickinstrut 4200 series, Strut Tech PVCG, or equal. Channel fittings shall be Aickinstrut 2800 style or equal.
- F. Load-bearing pipe clamps and nonload-bearing pipe straps shall be nonmetallic and nonconductive and shall be made by the injection-molding process using

polyurethane-base resin. Pipe clamps and straps shall be Aickinstrut 3100 series or equal.

- G. Clevis hangers shall be made with vinylester glass fiber and be Aickinstrut 1500 series or equal.
- H. Hanger rods for trapezes shall be carbon steel (ASTM A36/A36M, ASTM A575, or ASTM A576) unless stainless steel or FRP is indicated on the Drawings. Stainless steel hanger rod material shall comply with ASTM A276/A276M, Type 304. FRP hanger rod shall be by Aickinstrut, StrutTech, or equal.

2.06 PIPE SPIDERS

- A. Cooper B-Line B3281 to 3286, Superstrut S-794 or equal.

2.07 WAFFLE ISOLATION PADS

- A. Mason Type "W;" Machinery Installation Systems "Unisorb" Type S, SB, F, or FB; or equal. Provide minimum 1/4-inch thickness.

2.08 NEOPRENE ISOLATING SLEEVES FOR METAL PIPE 6 INCHES AND SMALLER

- A. Unistrut P2600, B-Line "Vibrocushion," or equal.

2.09 ANCHOR BOLTS AND SCREWS

- A. Anchor bolts and screws for attaching pipe supports and hangers to walls, floors, ceilings, and roof beams shall be Type 316 stainless steel, ASTM A276/A276M or ASTM F593. Nuts shall be Type 316 stainless steel, ASTM A194/A194M, Grade 8M, or ASTM F594, Type 316 stainless steel.

PART 3 EXECUTION

3.01 PIPE HANGER AND WALL SUPPORT SPACING

- A. The Contractor shall install pipe hangers and wall supports on horizontal and vertical runs at the spacing shown or detailed on the Drawings. Provide hanger rods (for horizontal runs) and wall supports of the sizes shown or detailed on the

Drawings. If no spacing or rod sizes are given on the Drawings or in the Specifications for a particular piping system, use the following:

1. Pipe Hanger and Wall Support Spacing for Steel and Ductile-Iron Pipe
Section 15276, Stainless Steel Pipe:

Pipe Size (inches)	Maximum Support or Hanger Spacing (feet)	Minimum Rod Size (inches)
3/8 and smaller	4	3/8
1/2 through 1	6	3/8
1-1/4 through 2	8	3/8
2-1/2 and 3	10	1/2
3-1/2 and 4	10	5/8
6	12	3/4
8	12	7/8
10 and 12	14	7/8
14 and 16	16	1
18	15	1
20 through 24	9	1
30	6	1

- B. Pipe Hanger or Wall Support Spacing for PVC Pipe (Section 15290, PVC Pipe, 3 Inches and Smaller:

Pipe Size (inches)	Maximum Support or Hanger Spacing (feet)	Minimum Rod Size (inches)
3/4	4	3/8
1	4	3/8
1-1/2	5	3/8
2	5	3/8
2-1/2	5	1/2
3	6	1/2

- C. For piping services not described, the Contractor shall provide hangers and supports according to MSS SP-58.
- D. The Contractor shall provide bracing for piping 8 inches and smaller that is installed on hangers or trapezes according to MSS SP-127, except provide lateral bracing at maximum 10-foot center-to-center spacings. Provide sway bracing for hangers for piping larger than 8 inches as detailed on the Drawings.

3.02 PIPE SUPPORT SPACING FOR SUPPORTS ON TOP OF SLABS OR GRADE

- A. The Contractor shall install pipe supports on horizontal runs at the spacing shown or detailed on the Drawings. Provide supports of the type shown or detailed on the

Drawings. If no spacings are given on the Drawings or in the Specifications for a particular piping system, use the following:

1. Pipe Support Spacing for Steel and Ductile-Iron Pipe (Sections 15155, Ductile Iron Pipe and Fittings; and 15276, Stainless Steel Pipe):

Pipe Size (inches)	Maximum Support Spacing (feet)
3/8 and smaller	4
1/2 through 1	6
1-1/4 through 2	8
2-1/2 and 3	10
3-1/2 and 4	10
6	12
8	12
10 and 12	14
14 and 16	16
18	16
20 through 24	18
30	18

- B. Pipe support spacing for other pipe materials shall be the same as described in Article 3.01, Pipe Hanger and Wall Support Spacing, in this Section.

3.03 INSTALLING PIPE HANGERS AND SUPPORTS

The Contractor shall do the following:

- A. Provide separate hangers or supports at each valve. Provide one hanger or support around each end of the valve body or on the adjacent connecting pipe within one pipe diameter of the valve end. Provide additional hangers or supports to relieve eccentric loadings imposed by offset valve actuators.
- B. Provide separate hangers or supports at each pipe elbow, tee, or fitting. Provide separate hangers or supports on both sides of each nonrigid joint or flexible pipe coupling.
- C. Adjust pipe hangers according to MSS SP-89, Paragraph 10.6.
- D. Install leveling bolts beneath support baseplates. Provide 3/4-inch-thick grout pad beneath each base.
- E. Install piping without springing, forcing, or stressing the pipe or any connecting valves, pumps, and other equipment to which the pipe is connected.

3.04 INSTALLING STEEL AND FRP CHANNEL FRAMES

- A. The Contractor shall use 1-5/8-inch-high channel frames, unless 3-1/4 inch is needed, to provide clearance from walls. Use multiple back-to-back channels if additional clearance is needed.

3.05 INSTALLING NEOPRENE ISOLATING SLEEVES

- A. The Contractor shall install a sleeve around each metal pipe 6 inches and smaller at the point of bearing or contact with the pipe hanger or support.

3.06 PAINTING AND COATING

The Contractor shall do the following regarding painting and coating:

- A. Grind the welds of fabricated steel pipe supports smooth, prepare surface by sandblasting, and apply coating system.
- B. Paint exposed metallic pipe hangers and supports to match the color of the adjacent wall using System No. 52 in accordance with Section 09900, Painting and Coating. If the adjacent wall is not painted, paint the hangers and supports to match color code of the largest pipe on the support.
- C. Coat submerged pipe hangers and supports in accordance with Section 09900, Painting and Coating, System No. 7.
- D. Coat FRP pipe hangers and supports exposed to direct sunlight with System No. 41 or 42 in accordance with Section 09900, Painting and Coating. FRP pipe hangers and supports that are hidden from direct sunlight need not be coated.

END OF SECTION

SECTION 15075
PROCESS EQUIPMENT, PIPING, AND VALVE IDENTIFICATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes requirements for materials and installation of markers, labels, and signs for pipes, tanks, and valves; for mechanical equipment; for hazardous materials warnings; and for miscellaneous plant services.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. The Contractor shall submit manufacturer's catalog data and descriptive literature describing materials, colors, letter size, and size of labels.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American National Standard Institute (ANSI)
 - 1. ANSI Z535.1—Safety Colors.
- B. American Society of Mechanical Engineers (ASME)
 - 1. ASME A13.1—Scheme for Identification of Piping Systems.

PART 2 PRODUCTS

2.01 LABELS FOR PIPING

- A. Labels for piping shall bear the full piping system name as shown in the Piping Schedule on the Drawings. The Contractor shall provide separate flow directional arrows next to each label. Color, size, and labeling shall conform to ASME A13.1 and ANSI Z535.1. Labels for piping inside buildings shall be vinyl cloth: W. H. Brady Co. B-500 vinyl cloth, Seton Name Plate Corporation Pipe Markers,

or equal. Labels for piping located outdoors shall be weather- and UV-resistant acrylic plastic and shall be W. H. Brady Co. B-946, Seton Name Plate Corporation Pipe Markers, or equal.

- B. Alternatively, the Contractor shall provide preprinted, semirigid, snap-on, color-coded pipe markers. Color, size, and labeling shall conform to ASME A13.1 and ANSI Z535.1. Label shall cover 360° (minimum). Labels shall be fabricated of weather- and UV-resistant acrylic plastic. Labels shall be Seton Nameplate Corporation SetMark pipe marks or equal.

2.02 LABELS FOR VALVES

- A. The Contractor shall provide each valve listed on the Tag Number list with an identification tag. The tag shall be 2-inch-square or circular aluminum or 1/16-inch-thick fiberglass: W. H. Brady B-60, Seton Name Plate Corp. Series SVT, or equal. Aluminum tags shall have black-filled letters. The Contractor shall provide fiberglass tags for chemical system valves. The tag shall show the valve tag number and/or name or designation as given on the Drawings.

2.03 HOSE BIBB SIGNS—UNSAFE WATER

- A. The Contractor shall provide a rigid sign labeled "DANGER--UNSAFE WATER" for each hose bibb. Size and lettering shall conform to OSHA requirements. Signs shall be Seton Nameplate Company 20-gauge baked enamel, minimum size 7 inches by 3 inches; Brady B-120 Fiber-Shield fiberglass, minimum size 7 inches by 3 inches, 1/8 inch thick; or equal.

2.04 LABELS FOR MECHANICAL EQUIPMENT

- A. The Contractor shall provide a label for each pump, compressor, tank, or other piece of mechanical equipment. The label shall show the equipment name and tag number as shown on the Tag Number list or on the Drawings. Labels shall be 1-1/2 inches (minimum) by 4 inches (minimum) brass, aluminum, or 1/8-inch-thick fiberglass tags. Provide fiberglass tags for chemical system equipment: Brady B-120 Fiber-Shield, Seton Style 2065, or equal.

2.05 LABELS FOR TANKS

- A. Signs shall be weather- and UV-resistant. Labels shall be Brady B-946, Seton Name Plate Corporation PSPL, or equal. Minimum size shall be 7 inches by 10 inches. Provide a sign on each quadrant of the tank bearing the tank tag number and the name of the liquid stored.

2.06 HAZARDOUS MATERIALS WARNING AND DANGER SIGNS

- A. The Contractor shall provide 10-inch-square hazardous materials warning diamond signs complying with NFPA 704. Wall signs shall be 1/8-inch-thick fiberglass: Brady B-120 Fiber-Shield or equal. Signs attached to tanks, cabinets, or pieces of equipment shall be self-adhesive vinyl cloth. Provide four signs for each bulk chemical storage tank, one for each quadrant of the tank. Affix a sign to the exterior side of each chemical feed room door: Brady B-946 or equal. Provide signs at the following locations:

Process	Number of Signs	Description or Tag Number	Tank, Equipment or Location	
			Location	Chemical
60	4	60-TK-1	Sodium Bisulfite Bulk Storage	Sodium Bisulfite
	4	60-TK-2	Sodium Bisulfite Bulk Storage	Sodium Bisulfite
	1	Door	Sodium Bisulfite Chemical Feed Room	Sodium Bisulfite

- B. The Contractor shall provide 10-inch-by-14-inch signs reading "DANGER" followed by the name of the chemical, gas, or hazard. Signs shall be 1/8-inch-thick fiberglass: Brady B-120 or equal. Provide one sign at each of the following locations:

Process	Description or Tag Number	Tank or Equipment	
		Location	Chemical
60	60-TK-1	Sodium Bisulfite Bulk Storage	Sodium Bisulfite
	60-TK-2	Sodium Bisulfite Bulk Storage	Sodium Bisulfite
	Door	Sodium Bisulfite Chemical Feed Room	Sodium Bisulfite

2.07 UNDERGROUND PLASTIC WARNING TAPE FOR METAL PIPE

- A. The Contractor shall provide permanent, bright-colored, continuous-printed plastic tape intended for direct burial service, not less than 6 inches wide by 3.5 mils thick. Provide tape with printing that most accurately indicates the type of service of buried pipe. Provide the following colored tape for the various piping services:

Service	Color
Cable TV	Orange
Gas	Yellow
Electric	Red
Telephone	Orange
Water	Blue
Sewer	Green
Chemical	Yellow
Raw Water	Dark Olive

2.08 UNDERGROUND DETECTABLE METALLIC PIPE WARNING TAPE

- A. The Contractor shall provide permanent, bright-colored, continuous-printed tape consisting of an aluminum or steel foil sheathed in a plastic laminate, not less than 2 inches wide by 3 mils thick. Provide tape with printing that most accurately indicates the type of buried service. Provide the following colored tape for the various piping services:

Service	Color
Cable TV	Orange
Gas	Yellow
Electric	Red
Telephone	Orange
Water	Blue
Sewer	Green
Chemical	Yellow
Raw Water	Dark Olive

PART 3 EXECUTION

3.01 INSTALLING PIPE LABELS

- A. The Contractor shall provide a label and flow arrow at each connection to pumps or other mechanical equipment, at wall boundaries, at tees and crosses, and at 20-foot centers on straight runs of piping.
- B. On piping having external diameters less than 6 inches (including insulation, if any), the Contractor shall provide full-band pipe markers, extending 360° around pipe at each location.
- C. On piping having external diameters of 6 inches and larger (including insulation, if any), provide either full-band or strip-type pipe markers but not narrower than three times letter height (and of required length), fastened by one of the following methods:
1. Laminated or bonded application of pipe marker to pipe or insulation.
 2. Strapped-to-pipe or insulation application of semirigid type with Type 304 or 305 stainless steel bands.

3.02 INSTALLING VALVE AND EQUIPMENT LABELS

- A. The Contractor shall attach labels to the valve or piece of equipment with Type 304 or 316 stainless steel chains unless otherwise noted. For sodium hypochlorite and hydrofluosilicic acid use thermoplastic chains to attach labels.

- B. The Contractor shall attach valve labels to the valve handwheels. If the valve has no handwheel, attach the label to the valve by tying the tag wire or chain around the operating shaft or nut.

3.03 INSTALLING MISCELLANEOUS SIGNS

- A. The Contractor shall attach miscellaneous signs according to the sign manufacturer's recommendations and in accordance with OSHA requirements.

3.04 INSTALLING WALL AND DOOR SIGNS

- A. Attach to walls and doors using epoxy adhesive.

3.05 INSTALLING UNDERGROUND PLASTIC WARNING TAPE FOR METAL PIPE

- A. During backfilling of each exterior underground piping system, the Contractor shall install continuous underground-type plastic line marker directly over buried line at 6 to 8 inches above the top of the pipe. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inches, install a single line marker.

END OF SECTION

SECTION 15105
WALL PIPES, SEEP RINGS, AND PENETRATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section describes requirements for materials, installation, and testing of steel, cast-iron, and ductile-iron wall pipes and sleeves (including wall collars and seepage rings) and penetrations.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit detailed drawings for fabricated steel or cast-iron wall and floor pipes and sleeves, wall flanges, seep rings, and sealing materials. Show dimensions and wall thicknesses.
- B. Show flange sizes and the appropriate ANSI or AWWA flange dimensional standard where flanged end wall pipes or penetrations are used.
- C. Show grooved-end dimensions and AWWA grooved-end dimensional standard where grooved-end wall pipes or penetrations are used.
- D. List coating systems to be applied, their manufacturer, and the dry thickness of coatings. Call out coatings where coatings are to be applied.
- E. List materials of construction with ASTM material reference and grade.
- F. Submit the manufacturer's instructions for installing rubber annular hydrostatic sealing devices:
 - 1. Submit six copies of the results of the leakage test for cast-iron sleeves having shrink-fit steel collars or collar halves bottomed in a groove and steel sleeves having welded steel collars.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of

this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Petroleum Institute (API)

1. API SPEC 5L—Specification for Line Pipe.

B. American Society for Testing Materials (ASTM)

1. ASTM A36/A36M—Standard Specification for Carbon Structural Steel.
2. ASTM A48/A48M—Standard Specification for Gray Iron Castings.
3. ASTM A53/A53M—Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. ASTM A105/A105M—Standard Specification for Carbon Steel Forgings for Piping Applications.
5. ASTM A126—Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
6. ASTM A135/A135M—Standard Specification for Electric-Resistance-Welded Steel Pipe.
7. ASTM A139/A139M—Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
8. ASTM A181/A181M—Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
9. ASTM A182/A182M—Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
10. ASTM A240/A240M—Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
11. ASTM A395/A395M—Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
12. ASTM A436—Standard Specification for Austenitic Gray Iron Castings.
13. ASTM A536—Standard Specification for Ductile Iron Castings.
14. ASTM C1107/C1107M—Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
15. ASTM D1785—Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

C. American Society of Mechanical Engineers (ASME)

1. ASME B16.1—Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
2. ASME B31.3—Process Piping.
3. ASME B36.10M—Welded and Seamless Wrought Steel Pipe.

- D. American Waterworks Association (AWWA)
 - 1. AWWA C207—Steel Pipe Flanges for Waterworks Service, Sizes 4-Inch through 144-Inch (100 mm through 3,600 mm).
- E. American Welding Society (AWS)
 - 1. AWS D1.1/D1.1M—Structural Welding Code – Steel.
- F. Plumbing and Drainage Institute (PDI)
- G. Surface Preparation Standards and Specifications (SSPC)
 - 1. SSPC SP-10/NACE No.2—Near-White Blast Cleaning.

1.04 QUALITY ASSURANCE

- A. The Contractor shall be fully responsible for the proper execution and performance of the work described in this Section. The Contractor shall be responsible for inspecting all installation conditions and bringing to the attention of the Engineer any conditions that may adversely affect the Contractor's work. Before beginning any portion of this work, the Contractor shall report any conditions unsuitable for the installation of their portion of the work to the Engineer.
- B. The location of all equipment, fixtures, and piping shall be considered as approximate only and the Engineer reserves the right to change these locations at any time before the work is installed. The positions of such equipment and piping to meet structural conditions and to provide proper headroom clearance or for other sufficient causes shall be changed without additional expense to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

- A. The Contractor shall use cast-iron, ductile-iron, or fabricated-steel wall sleeves when containing rubber annular hydrostatic sealing devices through which piping passes:
 - 1. Use only cast-iron or ductile-iron wall pipes when connecting to cast-iron and ductile-iron pipe. Use only fabricated-steel or stainless-steel wall pipes when connecting to steel or stainless steel pipe, respectively.

2. Cast-iron flanges shall conform to ASME B16.1, Class 125 or 250, to match the flange on the connecting pipe.
3. Class 150 steel flanges shall conform to AWWA C207, Class D. Class 300 steel flanges 48 inches and smaller shall conform to AWWA C207, Class F. Class 300 flanges larger than 48 inches shall conform to the dimensions of ASME B16.1 Class 250 flanges. Flanges shall be flat face. Flanges shall match the flange on the connecting pipe.
4. See Section 15055, Piping Systems—General, for flange bolts and gaskets.

2.02 CAST-IRON OR DUCTILE-IRON WALL PIPES AND SLEEVES

- A. The Contractor shall provide cast- or ductile-iron wall pipes with ends as shown in the Drawings for connecting to adjacent cast-iron and ductile-iron pipe or for containing pipes where they pass through concrete walls, ceilings, and floor slabs. Provide seepage rings on wall pipes and sleeves passing through concrete walls and slabs that are to be watertight. Locate collars so that the collar is at the center of the wall or floor slab, unless otherwise shown on the Drawings.
- B. Wall pipes and sleeves shall be of the following types:
 1. Pipe or sleeve with integrally cast seep ring.
 2. Pipe or sleeve with shrink-fit steel collar attached.
 3. Pipe or sleeve with steel collar halves bottomed in a groove provided in the pipe or sleeve.
- C. Minimum wall thickness for pipes and sleeves having integrally cast seep rings shall be as shown in the following table:

Pipe or Sleeve Size (inches)	Minimum Wall Thickness (inches)
3	0.48
4	0.52
6	0.55
8	0.60
10	0.68
12	0.75
14	0.66
16	0.70
18	0.75
20	0.80
24	0.89

1. Minimum wall thickness of pipes or sleeves having shrink-fit collars shall be special Class 52. Cut shrink-fit collars from a 1/4-inch-thick steel ring.

Attach the collar to a cast-iron or ductile-iron pipe or sleeve by heating the steel collar and allowing it to shrink over the pipe at the necessary location. Provide an epoxy bond (Keysite 740 or 742 or Scotchkote 302) between the pipe and collar. Sandblast the area of the pipe to be epoxy coated in accordance with SSPC SP-10/NACE No.2.

2. Wall pipes or sleeves having steel collar halves bottomed in a groove shall be ductile iron Special Class 54 minimum unless otherwise shown. Wall flanges shall consist of 1/4-inch-thick steel seep ring halves for pipes through 24 inches and 3/8-inch-thick halves for pipe 30 inches and larger, bottomed in a groove provided on the pipe. The pipe groove shall be machine cut to a depth of 1/16 to 5/64 inch to provide a press fit for the seep ring. Seep ring halves shall be welded together after being fit into the groove but shall not be welded to pipe. Seep rings shall be sealed completely around the pipe with silicon sealant manufactured by Dow-Corning No. 790, General Electric Silpruf, or equal.
3. The material used in cast- or ductile-iron wall flanges, wall sleeves, and wall penetrations shall conform to ASTM A395/A395M, ASTM A436, ASTM A536, ASTM A48/A48M (Class 35), or ASTM A126 (Class B).
4. Pressure test at least one of each size of cast-iron pipes or sleeves having shrink-fit steel collars or collar halves installed in a groove in the pipe at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for 4 hours and shall show zero leakage.

D. Fabricated Steel Wall Pipes and Sleeves

1. The Contractor shall provide fabricated-steel wall pipes and sleeves with ends as shown on the Drawings for connecting to adjacent steel pipes or for containing pipes where they pass through concrete walls. Provide seepage rings or wall flanges on wall pipes and sleeves passing through concrete walls and slabs that are to be watertight. Wall thickness shall be the same as the pipe wall thickness when connecting to steel pipe. Minimum wall thickness for sleeves containing pipes shall be standard weight in accordance with ASME B36.10M for sleeves 72 inches and smaller and 1/2 inch for sleeves greater than 72 inches through 96 inches.
2. Wall flanges shall be in the form of a steel wall collar welded to the steel sleeve or penetration. Cut welded wall collars from a 1/4-inch steel ring. Attach the collar to a steel wall pipe or sleeve with full-circle, 3/16-inch fillet welds. Welding procedures shall be in accordance with ASME B31.3, Chapter V.
3. Steel pipe used in fabricating wall sleeves containing pipes shall comply with ASTM 53 (Type E or S), Grade B; ASTM A135/A135M, Grade B; ASTM A139/A139M, Grade B; or API SPEC 5L. Wall pipes connecting to steel pipe shall be of the same material as the connecting pipe. Wall

collar material shall comply with ASTM A36/A36M, ASTM A105/A105M, ASTM A181/A181M, or ASTM A182/A182M.

4. Stainless steel pipe used in fabricating wall pipes shall be of the same material as the connecting pipe. Wall collar material shall comply with ASTM A240/A240M.
5. The Contractor shall pressure test at least one of each size of fabricated steel wall sleeve or penetration and collar assemblies at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for 4 hours and shall show zero leakage.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

1. PVC Pipe: ASTM D1785, Schedule 40.
2. Molded PE: Reusable PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

F. Rubber Annular Hydrostatic Sealing Devices

1. Rubber annular hydrostatic sealing devices shall be of the modular mechanical type, using interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe sleeve and the passing pipe. Assemble links to form a continuous rubber belt around the pipe, with a pressure plate under each bolthead and nut.
2. Materials of construction shall be as follows:

Compound	Material
Pressure plate	Composite glass-reinforced nylon
Bolts and nuts for links	Type 303 or 316 stainless steel
Sealing element	EPDM rubber

3. The size of the wall sleeve needed to accommodate the passing pipe shall be as recommended by the rubber annular seal manufacturer.
4. Provide centering blocks in 25% of the sealing elements on pipelines larger than 12 inches in diameter.
5. The rubber annular hydrostatic sealing devices shall be Link Seal as manufactured by Thunderline Corporation; Innerlynx as manufactured by Advance Products & Systems, Inc.; or equal.

G. Bolts, Nuts, and Gaskets for Flanged-End Wall Pipes

1. See Section 15055, Piping Systems—General.

H. Polyethylene Foam Filler for Pipe Penetrations

1. Packing foam shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam, as manufactured by Dow Chemical Company, Midland, Michigan or equal. The rod shall be 1/2 inch larger in diameter than the annular space.

I. Escutcheons: Escutcheons shall be as follows:

1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping, and an OD that completely covers opening.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Type: With set screw.
 - a. Finish: Polished chrome-plated and rough brass.
4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - a. Finish: Polished chrome-plated and rough brass.
5. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
6. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
7. One-Piece, Floor-Plate Type: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

J. Polyurethane Sealant for Pipe Penetrations

1. Sealant shall be multipart, polyurethane sealant, to cure at ambient temperature for continuous immersion in water. Install as recommended by the manufacturer. Products: SIKA Sikaflex 2C or equal.
2. Sealants at firewalls shall be a two-part foamed-silicone elastomer by Dow Corning Co., Product No. 3-6548 silicone R.T.V.; 3M brand fire barrier products caulk C.P. 25 and 3M brand putty 303; or Flame-Safe fires stop systems Fig. No. FS-500 by Thomas & Betts Corp. Sealant bead configuration, depth, and width shall be in accordance with the manufacturer's recommendations.

K. Painting and Coating

1. Line and coat sleeves and pipes (except stainless steel) with NSF 61 listed fusion-bonded epoxy. Fusion-bonded epoxy shall be 100% solids, thermosetting, fusion bonded, dry-powder epoxy resin; Scotchcoat 134 or 206N, Lilly Powder Coatings Pipeclad 1500 Red, or equal. Apply fusion-bonded epoxy in accordance with the manufacturer's instructions to a minimum thickness of 15 mils.

L. Grout: Grout shall be as follows:

1. Description: ASTM C1107/C1107M, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout:
 - a. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - b. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.
 - c. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 LOCATION OF PIPES AND SLEEVES

The Contractor shall do the following to ensure proper pipe installation:

- A. Provide a wall or floor pipe where shown on the Drawings and wherever piping passes through walls or floors of tanks or channels in which the water surface is above the pipe penetration.
- B. Provide a floor sleeve where shown on the Drawings and wherever plastic pipe, steel, or stainless steel pipe 3 inches and smaller or stainless steel or copper tubing

passes through a floor or slab. Provide a rubber annular sealing device in the annular space between the sleeve and the passing pipe or tubing.

- C. Provide wall sleeves where shown on the Drawings and wherever plastic, steel, or stainless steel pipe 3 inches and smaller or stainless steel or copper tubing passes through a wall. Provide a single rubber annular seal when the wall is 8 inches thick or less. Provide two rubber annular seals (one at each end of the sleeve) when the wall is more than 8 inches thick. Pack the annular space with polyethylene foam filler and fill the ends of the penetration with 2 inches of elastomeric sealant on both sides of the structure.
- D. Where wall sleeves are installed in which water or soil is on one or both sides of the channel or wall, provide two rubber annular seals (one at each end of the sleeve).
- E. Where pipes pass through walls or slabs and no sleeves or wall or floor pipe with seep ring is provided, pack the annular space with polyethylene foam filler and fill the ends of the penetration with 2 inches of elastomeric sealant on both sides of the structure.
- F. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with concrete floors and roof slabs. Extend sleeves installed in the floors of mechanical equipment areas or other wet areas 2 inches above the finished floor level. Extend cast-iron sleeve fittings below the floor slab as required to secure a clamping ring if a ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
 - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install a

section of cast-iron soil pipe to extend the sleeve to 2 inches above the finished floor level. For flashing:

- (1) Seal the space outside of the sleeve fittings with grout.
4. Except for underground wall penetrations, seal the annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for the size, depth, and location of joint.

3.02 INSTALLATION IN EXISTING CONCRETE WALLS AND SLABS

- A. The Contractor shall core drill holes 1 to 2 inches larger in diameter than the outside diameter of the wall flange or collar. Install wall pipe and collar assembly axially aligned with the piping to which it will be connected or which it will contain. Pack the void space between the sleeve and concrete with grout. See Section 03300, Cast-In-Place Concrete, for grouting specification.
- B. Installation in New Concrete Walls and Slabs
 1. Install wall pipes and sleeves in walls before placing concrete. Do not allow any portion of the pipe or sleeve to touch any of the reinforcing steel. Install wall pipe or sleeve and collar assembly axially aligned with the piping to which it will be attached or will contain. Provide supports to prevent the pipe or sleeve from displacing or deforming while the concrete is being poured and is curing.
- C. Installation in Dry Floors and Slabs
 1. Install pipe sleeves and spools in concrete floors and slabs that do not have water over them so that the sleeve or pipe extends from the bottom of the floor or slab to 2 inches above the floor or slab unless shown otherwise on the Drawings.
- D. Installation of Wall Pipes Having Flanged End Connections
 1. Check alignment before grouting in place or pouring concrete. Realign if the sleeve is not properly aligned.
 2. Install flanged end wall sleeves or penetrations with boltholes of the end flanges straddling the horizontal and vertical centerlines of the sleeve.

- E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for a 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals:
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select the type and number of sealing elements required for the pipe material and size. Position the pipe in the center of the sleeve. Assemble mechanical sleeve seals and install in the annular space between the pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for a 1-inch annular clear space between the pipe and sleeve for installing mechanical sleeve seals:
1. Mechanical Sleeve Seal Installation: Select the type and number of sealing elements required for the pipe material and size. Position the pipe in the center of the sleeve. Assemble mechanical sleeve seals and install in the annular space between the pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
- G. Fire-Barrier Penetrations: Maintain the indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- H. Install escutcheons for the penetrations of walls, ceilings, and floors according to the following:
1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.

- h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- I. Verify final equipment locations for roughing-in.
- J. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- K. Qualifications of Welders
 - 1. Welder qualifications shall be in accordance with AWS D1.1/D1.1M.
- L. Field Testing
 - 1. The Contractor shall check each wall penetration for leakage at the time the hydraulic structure is tested for leakage; see Section 03300, Cast-In-Place Concrete. Penetrations shall show zero leakage.

END OF SECTION

SECTION 15110
MANUAL, CHECK, AND PROCESS VALVES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required and install complete and ready for operation all valves as shown in the Drawings and as specified in this Section. All valves shall be complete with all necessary manual actuators, valve boxes, extension stems, and floor stands, which are required for proper valve operation and completion of the work.
 - 1. All valves shall be of the sizes shown in the Drawings. All equipment of the same type shall be from one manufacturer, unless authorized in writing by the Engineer.
 - 2. The valves shall include but not be limited to the following:
 - a. Air Valves.
 - b. Ball Valves.
 - c. Check Valves.
 - d. Gate Valves.
 - e. Special Types of Valves.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Product technical submittal data shall contain the following information and data:
 - 1. Acknowledgment that products submitted meet requirements of standards referenced.
 - 2. Manufacturer's installation instructions.
 - 3. Manufacturer's operation and maintenance manuals.
 - 4. Data of valves, actuators, and accessories:
 - a. Pressure and temperature rating.
 - b. Materials of construction, with ASTM reference and grade.

- c. Linings and coatings.
 - d. Dimensions and weight.
 - e. Flow coefficient.
 - f. Actuators and accessories details.
 - g. Manufacturer's product brochure, cut-sheets, and parts diagrams.
- B. Dimensions and orientation of valve actuators as installed on the valves. Show location of internal stops for gear actuators. State differential pressure and fluid velocity used to size actuators. For worm-gear actuators, state the radius of the gear sector in contact with the worm and state the handwheel diameter.
- C. The following test reports: Performance Tests; Leakage Tests; Hydrostatic Tests; and Proof-of-Design Tests as applicable or required.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Petroleum Institute (API)
 - 1. API SPEC 6D—Specification for Pipeline and Piping Valves.
 - 2. API SPEC 6FA—Specification for Fire Test for Valves.
 - 3. API STD 594—Check Valves: Flanged, Lug, Wafer, and Butt-Welding.
 - 4. API STD 607—Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats.
- B. American Society for Testing of Materials (ASTM)
 - 1. ASTM A36/A36M—Standard Specification for Carbon Structural Steel.
 - 2. ASTM A47/A47M—Standard Specification for Ferritic Malleable Iron Castings.
 - 3. ASTM A48/A48M—Standard Specification for Gray Iron Castings.
 - 4. ASTM A105/A105M—Standard Specification for Carbon Steel Forgings for Piping Applications.
 - 5. ASTM A108—Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 6. ASTM A126—Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 7. ASTM A148/A148M—Standard Specification for Steel Castings, High Strength, for Structural Purposes.

8. ASTM A181/A181M—Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
9. ASTM A182/A182M—Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
10. ASTM A193/A193M—Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
11. ASTM A194/A194M—Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
12. ASTM A216/A216M—Standard Specification for Steel Castings, Carbon, Suitable for Fusion-Welding, for High-Temperature Service.
13. ASTM A240/A240M—Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
14. ASTM A269/A269M—Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
15. ASTM A276/A276M—Standard Specification for Stainless Steel Bars and Shapes.
16. ASTM A313/A313M—Standard Specification for Stainless Steel Spring Wire.
17. ASTM A322—Standard Specification for Steel Bars, Alloy, Standard Grades.
18. ASTM A351—Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
19. ASTM A395/A395M—Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
20. ASTM A436—Standard Specification for Austenitic Gray Iron Castings.
21. ASTM A439/A439M—Standard Specification for Austenitic Ductile Iron Castings.
22. ASTM A449—Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
23. ASTM A479/A479M—Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
24. ASTM A494/A494M—Standard Specification for Castings, Nickel and Nickel Alloy.
25. ASTM A516/A516M—Standard Specification for Pressure Vessel Plates, Carbon-Steel, for Moderate- and Lower-Temperature Service.
26. ASTM A536—Standard Specification for Ductile Iron Castings.
27. ASTM A564/A564M—Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

28. ASTM A582/A582M—Standard Specification for Free-Machining Stainless Steel Bars.
29. ASTM A666—Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
30. ASTM A743/A743M—Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
31. ASTM A744/A744M—Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
32. ASTM A890/A890M—Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application.
33. ASTM B16/B16M—Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
34. ASTM B21/B21M—Standard Specification for Naval Brass Rod, Bar, and Shapes.
35. ASTM B61—Standard Specification for Steam or Valve Bronze Castings.
36. ASTM B62—Standard Specification for Composition Bronze or Ounce Metal Castings.
37. ASTM B98/B98M—Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
38. ASTM B99/B99M—Standard Specification for Copper-Silicon Alloy Wire for General Applications.
39. ASTM B127—Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
40. ASTM B148—Standard Specification for Aluminum-Bronze Sand Castings.
41. ASTM B150/B150M—Standard Specification for Aluminum Bronze Rod, Bar, and Shapes.
42. ASTM B164—Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
43. ASTM B169/B169M—Standard Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar.
44. ASTM B193—Standard Test Method for Resistivity of Electrical Conductor Materials.
45. ASTM B371/B371M—Standard Specification for Copper-Zinc-Silicon Alloy Rod.
46. ASTM B427—Standard Specification for Gear Bronze Alloy Castings.
47. ASTM B443—Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219) Plate, Sheet, and Strip.
48. ASTM B446—Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-

- Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650) Rod and Bar.
49. ASTM B462—Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
 50. ASTM B463—Standard Specification for UNS N08020 Alloy Plate, Sheet, and Strip.
 51. ASTM B472—Standard Specification for Nickel Alloy Billets and Bars for Reforging.
 52. ASTM B584—Standard Specification for Copper Alloy Sand Castings for General Applications.
 53. ASTM B763/B763M—Standard Specification for Copper Alloy Sand Castings for Valve Applications.
 54. ASTM D1248—Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
 55. ASTM D1784—Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 56. ASTM D1785—Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 57. ASTM D2000—Standard Classification System for Rubber Products in Automotive Applications.
 58. ASTM D3222—Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
 59. ASTM D4101—Standard Specification for Polypropylene Injection and Extrusion Materials.
 60. ASTM F441/F441M—Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
 61. ASTM F467—Standard Specification for Non-Ferrous Nuts for General Use.
 62. ASTM F468—Standard Specification for Non-Ferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use.

C. American Society of Mechanical Engineers (ASME)

1. ASME B1.20.1—Pipe Threads, General Purpose (Inch).
2. ASME B1.20.7—Hose Coupling Screw Threads (Inch).
3. ASME B16.1—Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
4. ASME B16.5—Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.

5. ASME B16.10—Face-to-Face and End-to-End Dimensions of Valves.
6. ASME B16.11—Forged Fittings, Socket-Welding and Threaded.
7. ASME B16.18—Cast Copper Alloy Solder Joint Pressure Fittings.
8. ASME B16.24—Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valve Classes 150, 300, 600, 900, 1500, and 2500.
9. ASME B16.34—Valves – Flanged, Threaded, and Welding End.
10. ASME B16.42—Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
11. ASME B16.47—Large Diameter Steel Flanges NPS 26 through NPS 60 Metric/Inch Standard.
12. ASME B36.10M—Welded and Seamless Wrought Steel Pipe.

D. American Society of Safety Engineers (ASSE)

1. ASSE 1011—Performance Requirements for Hose Connection Vacuum Breakers.

E. American Water Works Association (AWWA)

1. AWWA C110/A21.10—Ductile-Iron and Gray-Iron Fittings.
2. AWWA C111/A21.11—Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C115/A21.15—Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
4. AWWA C207—Steel Pipe Flanges for Waterworks Service, Sizes 4-Inch through 144-Inch (100 mm through 3,600 mm).
5. AWWA C500—Metal-Seated Gate Valves for Water Supply Service.
6. AWWA C504—Rubber-Sealed Butterfly Valves.
7. AWWA C507—Ball Valves 6-Inch through 60-Inch (150 mm through 1,500 mm).
8. AWWA C508—Swing-Check Valves for Waterworks Service, 2-Inch through 48-Inch (50 mm through 1,200 mm) NPS.
9. AWWA C509—Resilient-Seated Gate Valves for Water-Supply Service.
10. AWWA C512—Air Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service.
11. AWWA C515—Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
12. AWWA C550—Protective Interior Coatings for Valves and Hydrants.
13. AWWA C606—Grooved and Shouldered Joints.
14. AWWA C800—Underground Service Line Valves and Fittings.

F. Fluid Controls Institute (FCI)

1. FCI 70-2—Control Valve Seat Leakage.

G. Manufacturers Standardization Society (MSS)

1. MSS SP-61—Pressure Testing of Valves.
2. MSS SP-67—Butterfly Valves.
3. MSS SP-68—High Pressure Butterfly Valves with Offset Design.
4. MSS SP-81—Stainless-Steel or Stainless-Steel-Lined Bonnetless, Knife Gate Valves with Flanged Ends.
5. MSS SP-83—Class 3000 Steel Pipe Unions Socket Welding and Threaded.
6. MSS SP-108—Resilient-Seated Cast Iron Eccentric Plug Valves.

H. National Association of Corrosion Engineers International (NACE)

1. NACE MR-0103/ISO 17945—Petroleum, Petrochemical, and Natural Gas Industries – Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments.
2. NACE MR-0175/ISO 15156—Petroleum, Petrochemical, and Natural Gas Industries – Materials for Use in H₂S-Containing Environments in Oil and Gas Production.

I. National Fluid Power Association (NFPA)

1. NFPA T3.6.7—Fluid Power Systems and Products – Square Head Industrial Cylinders – Mounting Dimensions.
2. NFPA T3.6.68—Fluid Power – Square Head Cylinders – Determination of the Static Failure Pressure Rating of Pressure-Containing Components.

J. NSF International (NSF)

1. NSF 61—Drinking Water System Components – Health Effects.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.
- B. All valves, unless otherwise directed, shall be loaded and unloaded by lifting, and under no circumstances shall valves be dropped, skidded, or rolled. Valves shall not be stacked or placed under pipe, fittings, or other valves in such a manner that damage could result.

- C. Slings, hooks, or tongs used for lifting shall be padded in such a manner as to prevent damage to exterior surface or interior linings and valve components. If any part of the coating, lining, or components is damaged, the repairs or replacement shall be made by the Contractor at his expense and in a manner satisfactory to the Engineer before attempting to install such valves.
- D. Only new valves will be allowed for installation and shall be stored in a manner to prevent damage and be kept free of dirt, mud, or other debris.

1.05 QUALIFICATIONS

- A. All of the valves shall be products of well-established firms which are fully experienced, reputable, have been selling this product for a minimum of 10 years, and are qualified in the manufacture of the particular product furnished. The valves shall be designed, constructed, and installed in accordance with the requirements and procedures of applicable AWWA standards and shall comply with these Specifications as applicable.

1.06 VALVE TYPE CLASSIFICATIONS

- A. Air Valves (Type 100 series):
 - 1. Type 100: Air Release Valves for Water Services, Compound Lever.
 - 2. Type 125: Combination Air Valves for Water Services, Single Body.
 - 3. Type 140: Air Valves for Sewage Services, Air Release.
- B. Ball Valves (Type 200 series):
 - 1. Type 210: Double-Union PVC Ball Valves, 3 Inches and Smaller, for Water and Light Chemical Service.
 - 2. Type 212: Double-Union PVC Ball Valves, 3 Inches and Smaller, with Vented Ball for Chemical Service.
 - 3. Type 215: Double-Union CPVC Ball Valves, 3 Inches and Smaller, for Water and Chemical Service.
 - 4. Type 221: Full-Port Threaded Stainless-Steel Ball Valves, 2 Inches and Smaller, for Water Service.
- C. Check Valves (Type 400 series):
 - 1. Type 475: Stainless Steel Check Valve
 - 2. Type 476: Ductile-Iron Ball Check Valves with Fluoroplastic Lining, 3/4 Inch through 6 Inches, Class 150.

D. Gate Valves (Type 600 series):

1. Type 630: Cast-Iron Gate Valves, 4 Inches through 48 Inches.
2. Type 685: Ductile-Iron Resilient Wedge Gate Valves, 24 Inches through 36 Inches, for Exposed and Buried Service (AWWA C515).

E. Other Special Types of Valves (Type 1100 series):

1. Type 1195: Borehole Injection Control Valve.

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves are identified in the Drawings by size and type number. For example, a callout of 36V300 refers to a 36-inch-diameter Type 300 valve. A Type 300 valve is a flanged, rubber-seated butterfly valve that is 4 inches through 72 inches for exposed service.
- B. All valves shall be complete with all necessary geared actuators, chainwheels and chains, handwheels, levers, valve bonnets, valve boxes, extension stems, operating nuts, and T-handle wrenches, which are required for proper valve operating and completing of the work included under this Section. Renewable parts including discs, packing, and seats shall be of types specified in this Section and acceptable by valve manufacturer for the intended service. All units shall have the name of the manufacturer and the size of the valve cast on the body or bonnet or shown on a permanently attached stainless-steel plate in raised embossed letters. All isolation valves shall be suitable for the intended service with bubble-tight shutoff to flow in either direction.
- C. Bronze or brass components in contact with water shall comply with the following requirements:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

- D. Valves and valve operators shall be factory prepared and primed and field finish coated in accordance with Section 09900, Painting and Coating.

2.02 VALVE ACTUATORS

- A. The valve actuator shall be an integral part of a valve. The valve actuator shall be provided, installed, and adjusted by the valve manufacturer. Actuator mounting arrangements shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the Drawings.
- B. All valves shall open counter clockwise as viewed from the top. Unless otherwise required by the Owner, the direction of rotation of the wheel or wrench nut to open each valve shall be to the left (counterclockwise). Each valve body or actuator shall have the word "Open" cast on it and an arrow indicating the direction to open.
- C. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. All exposed nuts, bolts, and washers shall be AISI Type 304 stainless steel. Unless noted otherwise, valves shall be equipped with the following manual actuators:
 - 1. Exposed Valves 6 Inches and Smaller: Removable lever or handwheel actuators.
 - 2. Exposed Valves 8 Inches and Larger: Geared actuators with handwheels.
 - 3. Buried or Submerged Valves 6 Inches and Smaller: 2-inch-square operating nuts (with valve bonnets, valve boxes, and extension stems as required) and T-handle wrench.
 - 4. Buried or Submerged Valves 8 Inches and Larger: Geared actuators with 2-inch-square operating nuts (with valve bonnets, valve boxes, and extension stems as required) and wrench.
- D. Levers or handwheels shall be provided to actuate the valves where the valves are within 6 feet and 7 inches from finished grade or the operating floor. Handwheels shall be constructed of ductile-iron. Levers and handwheels shall be coated in accordance with Section 09900, Painting and Coating. Handwheel diameters for traveling nut actuators shall not exceed 8 inches for valves 12 inches and smaller and shall not exceed 12 inches for valves 20 inches and smaller.
- E. Chainwheel and guide actuators shall be provided for all exposed valves installed with their centerlines more than 6 feet and 9 inches above finished grade. Chainwheels shall be cast-iron with stainless-steel stem, clip, and pins. The actuating chain shall be AISI Type 304 stainless steel. Stainless-steel chain baskets shall also be provided with these units. Chainwheels shall be coated in accordance with Section 09900, Painting and Coating.
 - 1. Chainwheels and guides shall be Clow Figure F-5680, DeZurik Series W or LWG, Stockham, or equal.

- F. Gear actuators for valves 8 inches through 20 inches shall be of the worm-and-gear or of the traveling-nut type. Gear actuators for valves 24 inches and larger shall be of the worm-and-gear type. Gear actuators for motorized valves shall be of the worm-and-gear type, regardless of size.
1. Gear actuators should be designed assuming that the differential pressure across the valves is equal to the test pressure of the connecting piping and assuming a line fluid temperature range of 33°F to 125°F, unless otherwise required in the detailed valve specifications.
 2. Gear actuators shall be enclosed and oil lubricated with seals provided on shafts to prevent entry of dirt and water into the actuator. Gear actuators for valves aboveground or in vaults and structures shall have handwheels. The actuators for valves in exposed service shall contain a dial indicating the position of the valve disc or plug.
 3. Traveling nut and worm-and-gear actuators shall be of the totally enclosed design and proportioned to permit operation of the valve under full differential pressure rating of the valve with a maximum pull of 80 pounds on the handwheel or crank. Stop-limiting devices shall be provided in the actuators in the open and closed positions. Actuators shall be of the self-locking type to prevent the disc or plug from creeping. Design actuator components between the input and the stop-limiting devices to withstand without damage a pull of 200 pounds for handwheel or chainwheel actuators and an input torque of 300 foot-pounds for operating nuts when operating against the stops.
 4. The self-locking worm gear shall be a one-piece design of gear bronze material (ASTM B427; or ASTM B584, Alloy C86200) that is accurately machine cut. Actuators for eccentric and lubricated plug valves may use ductile-iron gears provided the gearing is totally enclosed with spring-loaded rubber lip seals on the shafts. The worm shall be hardened alloy steel (ASTM A322, Grade G41500 or G41400; or ASTM A148/A148M, Grade 105-85) with thread ground and polished. Support worm-gear shafts at each end by ball or tapered roller bearings. The reduction gearing shall run in a proper lubricant. The handwheel diameter shall be no more than twice the radius of the gear sector in contact with the worm. Worm-gear actuators shall be Limitorque Model HBC, EIM Series W, or equal.
- G. For buried or submerged service, provide watertight shaft seals and watertight valve and actuator cover gaskets. Provide totally enclosed actuators designed for buried or submerged service.
- H. All buried valves shall have non-rising stems. All buried valves 3 feet below grade or deeper as measured at the valve centerline shall be furnished with an

operator stem extension to extend the operating nut within 6 inches from the top of the valve box cover.

2.03 VALVE END CONNECTIONS

- A. Provide valve end connections conforming to connected piping and as shown in the Drawings. Generally, all buried valves shall be mechanical joint type end connectors. Exposed valves shall be screwed-end, socket-weld end, or flanged to conform to adjacent exposed connected piping system.
- B. Comply with the following standards:
 - 1. Threaded: ASME B1.20.1.
 - 2. Flanged: ASME B16.1 Class 125 unless other noted or AWWA C207.
 - 3. Mechanical (gland) Type: AWWA C111/A21.11.
 - 4. Soldered: ASME B16.18.
- C. Nuts, Bolts, and Washers: Wetted or internal to be bronze or stainless-steel. Exposed to be zinc or cadmium-plated.
- D. Epoxy Interior Coating: Provide epoxy coating for all interiors of ferrous valve body surfaces in accordance with AWWA C550. Coatings shall be NSF-approved for valves in all potable water piping services. Coatings shall not be required for stainless-steel valve interiors.

2.04 VALVE BOXES

- A. All buried valves 2-inch size and larger shall be equipped with a standard cast-iron roadway valve box. Valve boxes shall be of the slip or sliding type with a round lid marked "Water" for potable water valves or "Sewer" for wastewater and a square lid marked "Reclaimed Water" for reclaimed water valves. The box shall be designed to prevent transfer of the surface loads directly to the valve or piping. Valve boxes must have a minimum adjustable range of 12 inches and a minimum inner diameter of 6 inches. All valve boxes and lids shall be produced from grey cast-iron conforming to the latest revision of specification for grey iron castings, ASTM A48/A48M, Class 20A-25A. All castings shall be true and free of holes and shall be cleaned according to good foundry practice, chipped and ground as needed to remove fins and rough places on castings. Valve boxes have to be rated to sustain FDOT H-20 loadings and have a minimum depth of 8 inches. The valve box lid shall fit flush in the top of the box without forcing and shall not rock, tip, or rattle.
- B. Provide debris cap as required in the Drawings.

- C. Coat buried cast-iron pieces as specified in Section 09900, Painting and Coating, System No. 21 or with fusion-bonded epoxy.
- D. Valve boxes shall be as manufactured by Tyler Pipe, Geneco, Star Pipe Products, or equal.

2.05 EXTENSION STEMS

- A. Where the depth of the valve is such that its centerline is more than 4 feet below grade, provide operating extension stems to bring the operating nut to a point 6 inches below the surface of the ground and/or box cover. Where the valve is submerged, provide operating extension stems to bring the operating nut to 6 inches above the water surface. Extension stems shall be Type 316 stainless steel, solid core, and shall be complete with 2-inch-square operating nut. The connections of the extension stems to the operating nuts and to the valves shall withstand without damage a pull of 300 foot-pounds.
- B. Extension stem diameters shall be as tabulated below:

Valve Size (inches)	Minimum Extension Stem Diameter (inches)
2	3/4
6	1
10, 12	1-1/4
20, 24, 30, 36	1-3/4

- C. Provide buried valves or valves located inside manholes or vaults with valve boxes cast in the manhole or vault roof with a valve position indicator designed to fit standard 5-1/4-inch valve boxes. The indicators shall show valve position and the direction and number of turns required to fully open (or close). All internal gearing shall be sealed. Ship each unit ready for field installation complete with valve box cast-iron adapter, capscrews, guide bushing, position indicator, flexible washer, centering plate, and 2-inch AWWA nut. Valve box and indicator shall be provided by the valve manufacturer. Indicators shall be Westran Position Indicator, Pratt Diviner, or equal.

2.06 FLOOR STANDS

- A. When required by the installations, provide floor stands for the operation of valves. Floor stands shall be of the nonrising stem, indicating type, complete with steel extension stems, couplings, handwheels, stem guide brackets, and special yoke attachments as required by the valves and recommended and supplied by the stand manufacturer. Floor stands shall be cast-iron base type: Clow,

Figure F-5515; Bingham and Taylor; Stockham; or equal. Handwheels shall turn counterclockwise to open the valves.

- B. Provide Type 316 stainless-steel anchor bolts.
- C. Provide Type 316 stainless-steel extension stems for valves in exposed service. Provide Type 316 stainless-steel stems for valves in submerged service.
- D. Provide adjustable stem guide brackets for extension stems. The bracket shall allow valve stems to be set over a range of 2 to 36 inches from walls. Provide bushings drilled to accept up to 2-inch-diameter stems. Base, arm, and clamp shall be Type 316 stainless-steel. Bushing shall be bronze (ASTM B584, Alloy C86400 or C83600). Bolts, nuts, screws, and washers (including wall anchor bolts) shall be Type 316 stainless steel. Provide slots in the bracket to accept 3/4-inch bolts for mounting the bracket to the wall. Products: Trumbull Industries, Inc., Adjustable Stem Guide or equal.

2.07 BOLTS, NUTS, AND GASKETS FOR FLANGED VALVES

- A. Bolts, nuts, and gaskets for flanged valves shall be as described in Section 15055, Piping Systems—General.

2.08 PAINTING AND COATING

- A. Coat metal valves located aboveground or in vaults and structures the same as the adjacent piping. If the adjacent piping is not coated, coat valves as specified in Section 09900, Painting and Coating, System No. 7 or System No. 10. Apply the specified prime and finish coat at the place of manufacture. The finish coat shall match the color of the adjacent piping. Coat handwheels the same as the valves.
- B. Coat buried metal valves at the place of manufacture as specified in Section 09900, Painting and Coating, System No. 21.
- C. Coat submerged metal valves, stem guides, extension stems, and bonnets at the place of manufacture as specified in Section 09900, Painting and Coating, System No. 7.
- D. Line the interior metal parts of metal valves 4 inches and larger, excluding seating areas and bronze and stainless-steel pieces, as specified in Section 09900, Painting and Coating, System No. 7. Apply lining at the place of manufacture.
- E. Coat floor stands as specified in Section 09900, Painting and Coating, System No. 10.

- F. Test the valve interior linings and exterior coatings at the factory with a low-voltage (22.5 to 80 volts, with approximately 80,000-ohm resistance) holiday detector, using a sponge saturated with a 0.5% sodium chloride solution. The lining shall be holiday free.
- G. Measure the thickness of the valve interior linings as specified in Section 09900, Painting and Coating. Repair areas having insufficient film thickness as specified in Section 09900, Painting and Coating.

2.09 AIR VALVES (TYPE 100 SERIES)

A. General Description

- 1. All valves shall meet or exceed all applicable provisions of the latest revision of AWWA C512. All valves for drinking water services shall comply with NSF 61. Design pressure is 150 psig. Valves shall be operable for water temperatures of above freezing to 125°F.
- 2. All valves shall consist of a float or a float assembly. Valves shall be identified properly in plates attached permanently on the valve body. The body and cover shall be cast-iron ASTM A126, Class B, or ASTM A48/A48M, Class 35. Valves 3 inches and smaller shall have threaded ends. Valves 4 inches and larger shall have flanged ends. Threaded ends shall comply with ASME B1.20.1. Flanges shall comply with ASME B16.1, Class 125. All flanges shall be flat faced.
- 3. The float shall be Type 304 or 316 Stainless-Steel. For valves with inlet sizes less than 4 inches, the float shall be able to withstand a collapse pressure of 1,000 psig. For inlet sizes 4 inches and larger, the float shall be capable of withstanding collapse pressures of 750 psig. Trim shall be Type 304 or 316 Stainless-Steel. The valve seat shall be of EPDM or other rubber materials applicable to wastewater and sludge. The valve seat shall be easily removed and replaced in the field.
- 4. Drain/test ports on all valves with inlet size 1 inch or larger shall have two 1/2-inch NPT minimum plugged ports, one near the bottom of the valve body and the other near the top of the valve. The plug shall be of bronze, ASTM B584, Alloy C83600.

B. Type 100—Air-Release Valves for Water Services, Compound Lever:

- 1. Type 100 air-release valves for water services shall be inlet size 2 inches, of a compound lever with linkage mechanism to release air, Class 300. Orifice size shall be 1/8 or 3/32 inch. Valves shall be APCO 200A, Val-Matic Model 38, or equal.

C. Type 125—Combination Air Valves for Water Services, Single Body:

1. Type 125 combination air valve for water service shall be 2-inch inlet size. It shall consist of an air and vacuum valve with an air-release valve in a single-body double-orifice arrangement. The valve body and cover shall be constructed of ASTM A126 Class B cast-iron. The body inlet shall be baffled with a Buna-N float cushion. The floats shall be 300 series stainless-steel. The seats shall be Buna-N and provide drop tight shut-off. Valves shall be APCO 140C Series, Val-Matic Model 201C – 204C, or equal.

D. Type 140—Air Valves for Sewage Services, Air Release:

1. Type 140 air valves for sewage service shall have elongated cylindrical chambers. All valves shall provide the following: 1/2-inch clearance around the float in the chamber; minimum size 1/2-inch isolation valve and quick-disconnect couplings at the valve venting for back-flushing; blowoff port and valve at the bottom of the chamber; and inlet valve at the valve inlet. A back-flushing assembly shall be provided for all valves. The back-flushing assembly shall consist of an inlet shutoff valve, a flush valve, a clear water inlet valve, rubber supply hose, and quick-disconnect couplings. Type 140 valves shall be air-release valves. Valves shall be APCO 450 Series, Val-Matic Model 49ABW, or equal.

2.10 BALL VALVES (TYPE 200 SERIES)

A. Type 210—Double-Union PVC Ball Valves, 3 Inches and Smaller, for Water and Light Chemical Service:

1. Unless noted otherwise, ball valves installed in PVC piping systems 3 inches and smaller shall be constructed from polyvinyl chloride (PVC) ASTM D1784, rated to 150 psi minimum from 30° to 120°F, double-union design with two-way blocking capability, socket end connection except where threaded or flanged-end valves are specifically shown in the Drawings, double EPDM O-ring seals and EPDM backing cushions, PTFE seals, ABS handle, NSF 61 certified. Valves shall be as manufactured by Asahi/America Inc., Quarter-Bloc Ball Valve Series, or approved equal.

B. Type 212—Double-Union PVC Ball Valves, 3 Inches and Smaller, with Vented Ball for Chemical Service:

1. Vented PVC ball valves 3 inches and smaller for chemical service shall be rated at a pressure of 230 psi at a temperature of 70°F and 150 psi at a temperature of 105°F. Provide a machined vent hole, deburred, in the ball

to allow gases to vent. Body, ball, and stem shall be PVC conforming to ASTM D1784, Cell Classification 12454-A. Stems shall have double O-rings and be of blowout-proof design. Seats shall be PTFE and shall have an elastomeric backing cushion of the same material as the valve seals. O-ring seals shall be FKM. Valve ends shall be of the double-union design. Ends shall be socket-welded except where threaded or flanged-end valves are specifically shown in the Drawings. Valves shall have handles for manual operation. Valves shall be Asahi/America Type 21 or approved equal.

C. Type 215—Double-Union CPVC Ball Valves, 3 Inches and Smaller, for Water and Chemical Service:

1. CPVC ball valves, 3 inches and smaller, for water and chemical service shall be rated at a pressure of 150 psi at a temperature of 105°F and rated at a pressure of 100 psi at a temperature of 150°F. Body, ball, and stem shall be CPVC conforming to ASTM D1784, Type 4, Grade 1. Seats shall be PTFE. O-ring seals shall be EPDM. Valve ends shall be of the double-union design. Ends shall be socket-welded except where threaded or flanged-end valves are specifically shown in the Drawings. Valves shall have handles for manual operation. Valves shall be Nibco Chemtrol Tru-Bloc Series, Hayward TB Series, Spears Manufacturing Company True Union Ball Valves, Plast-O-Matic MBV Series, or approved equal.

D. Type 221—Full-Port Threaded Stainless-Steel Ball Valves, 2 Inches and Smaller, for Water Service:

1. Stainless-steel ball valves 2 inches and smaller for water service shall be rated at a minimum pressure of 1,000 psi WOG at a temperature of 100°F. Provide full-port ball and body design. Valve body, ball, and stem shall be Type 316 stainless-steel, ASTM A276/A276M or A351. Seat and seals shall be reinforced PTFE. Valves shall have lever actuators, plastic coated. Valves shall have screwed ends (ASME B1.20.1) and non-blowout stems. Valves shall be Worchester Series 59, Apollo 86A-100 Series, or approved equal.

2.11 CHECK VALVES (TYPE 400 SERIES)

A. Type 475—Stainless-Steel Check Valves:

1. Stainless-steel check valves 1/4 inch through 2 inches shall be constructed of Type 304 stainless-steel body. The body and spring shall be constructed of stainless-steel. Valves shall have a pressure rating of 400 psi WOG at a

temperature of 180°F. Valves shall be FLOMATIC Model 100SS-VFD for sizes 1/4 inch through 2 inch, FLOMATIC Model 80S6 for sizes greater than 2 inch up to 10 inch, or engineer approved equal.

B. Type 476—Ductile-Iron Ball Check Valves with Fluoroplastic Lining, 3/4 Inch through 6 Inches, Class 150:

1. Valves shall consist of a two-part flanged body with a sinking-type solid PTFE ball. The design shall be such that the fluid flow forces the ball into a receiving cavity in the valve. When the fluid flow stops, the ball shall fall out of the cavity into a fluoroplastic seat in the body to shut off flow. Valve shall be suitable for vertical upward or horizontal flow conditions. Pressure rating shall be 40 psi at a temperature of 175°F. Body material shall be ductile-iron (ASTM A395/A395M or A536) with 15-mil fusion-bonded epoxy coating in accordance with AWWA C550. Provide minimum 1/8-inch-thick lining in the valve body. Provide Type 316 stainless-steel fasteners. Flanges shall be Class 150 in accordance with ASME B16.42. Products: ITT/Richter Series BC or equal.

2.12 GATE VALVES (TYPE 600 SERIES)

A. Type 630—Cast-Iron Gate Valves, 4 Inches through 48 Inches:

1. Valves shall conform to AWWA C500 and the following. Valves shall be cast-iron or ductile-iron bodied, bolted bonnet, nonrising stem, solid bronze internal working parts, parallel faced, bottom wedging double-discs, and O-ring seals. Discs for valves 12 inches and smaller shall be solid bronze; discs for valves larger than 12 inches shall either be solid bronze or shall be cast-iron or ductile-iron with bronze facings. Bronze for internal working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 (85-5-5-5) or ASTM B584 (Alloy C83600), except that stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10% elongation in 2 inches (ASTM B584, Alloy C87600). Body bolts shall be Type 316 stainless-steel, ASTM A276/A276M. End connections for exposed valves shall be flanged. End connections for buried valves shall be mechanical joint type to match the connecting pipe material. Valves shall be Clow AWWA gate valves, Mueller, or approved equal.

- B. Type 685—Ductile-Iron Resilient Wedge Gate Valves, 24 Inches through 36 Inches, for Exposed and Buried Service (AWWA C515):
1. Valves shall be cast-iron or ductile-iron body valves and comply with AWWA C515 and the following. Valves shall be of the bolted-bonnet type with nonrising stems. The valve gate shall be of ductile-iron with a resilient wedge. Valve stems shall be Type 304 or 316 stainless-steel or cast, forged, or rolled bronze. Stem nuts shall be made of solid bronze. Bronze shall conform to ASTM B62 or ASTM B584. Body bolts shall be Type 316 stainless-steel. End connections for exposed valves shall be flanged. End connections for buried valves shall be mechanical joint type. Provide reduction-thrust bearings above the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in the stem above the thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets. Valves shall be lined and coated at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Minimum epoxy thickness shall be 8 mils.
 2. Manufacturers: Clow, AVK, American Flow Control, Kennedy, or approved equal.

2.13 OTHER SPECIAL TYPES OF VALVES (TYPE 1100 SERIES):

- A. Type 1195—Borehole Injection Control Valve
1. The Borehole Injection Control Valve shall be in accordance with Section 11450, Borehole Injection Control Valve System. Valve shall be manufactured by ASR Resources, V-Smart Model, or approved equal.

PART 3 EXECUTION

3.01 JOINTS

- A. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseal or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.
- B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

- C. Install lug-type valves with separate hex head machine bolts at each bolt hole and each flange (two bolts per valve bolt hole).
- D. Install grooved-end couplings for valves in accordance with Section 15055, Piping Systems—General.

3.02 INSTALLING EXPOSED VALVES

- A. Unless otherwise indicated in the Drawings, install valves in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the floor with their operating stems vertical. Install valves in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the floor with their operating stems horizontal.
- B. Install valves on vertical runs of pipe that are next to walls with their stems horizontal, away from the wall. Valves on vertical runs of pipe that are not located next to walls shall be installed with their stems horizontal, oriented to facilitate valve operation.

3.03 INSTALLING BURIED VALVES

- A. Connect the valve, coat the flanges, apply tape wrapping or polyethylene encasement as required on the Drawings, and place and compact the backfill to the height of the valve stem.
- B. Place block pads under the extension pipe to maintain the valve box vertical during backfilling and repaving and to prevent the extension pipe from contacting the valve bonnet.
- C. Mount the upper slip pipe of the extension in midposition and secure with backfill around the extension pipe. Pour the concrete ring allowing a depression so the valve box cap will be flush with the pavement surface.
- D. In streets without concrete curbs and in open areas, install the valve box as for a paved area with concrete curb but include a marker post. Cut the marker post from 4-inch-by-4-inch dense structural grade Douglas fir No. 2 or Southern pine No. 2 surfaced on four sides to a length of 5 feet. Chamfer the top. Set the post in concrete, 2 feet into the ground, away from traffic, and to the side of the pipeline. Coat with a seal and finish coat of white alkyd exterior paint. On the side facing the valve, letter in black the word “VALVE” and the distance in feet from the marker post to the valve box cap.

- E. Install debris cap as close as possible under the cast-iron cover without interfering with the cover operation. Trim flexible skirt to provide a smooth contact with the interior or the extension pipe.

3.04 INSTALLING EXTENSION STEM GUIDE BRACKETS

- A. Install extension stem guide brackets at 6- to 8-foot centers. Provide at least two support brackets for stems longer than 10 feet, with one support near the bottom of the stem and one near the top.

3.05 FIELD COATING BURIED VALVES

- A. Coat flanges of buried valves and the flanges of the adjacent piping and the bolts and nuts of flanges and mechanical joints, as specified in Section 09900, Painting and Coating, System No. 24.
- B. Wrap buried metal valves 6 inches and larger with polyethylene sheet as specified in Section 15155, Ductile Iron Pipe and Fittings.

3.06 VALVE LEAKAGE AND FIELD TESTING

- A. Test valves for leakage at the same time that the connecting pipelines are tested. See Section 15144, Pressure Testing of Piping, for pressure testing requirements. Protect or isolate any parts of valves, actuators, or control and instrumentation systems whose pressure rating is less than the pressure test. Valves shall show zero leakage. Repair or replace any leaking valves and retest.
- B. Operate manual valves through three full cycles of opening and closing. Valves shall operate from full open to full close without sticking or binding. Do not backfill buried valves until after verifying that valves operate from full open to full closed. If valves stick or bind or do not operate from full open to full closed, repair or replace the valve and repeat the tests.
- C. Test gear actuators through three full cycles from full-open to full-close without binding or sticking. The pull required to operate handwheel- or chainwheel-operated valves shall not exceed 80 pounds. The torque required to operate valves having 2-inch AWWA nuts shall not exceed 150 foot-pounds. If actuators stick or bind or if pulling forces and torques exceed the values stated previously, repair or replace the actuators and repeat the tests. Operators shall be lubricated in accordance with the manufacturer's recommendations before operating.

WATER SERVICE CARD

Date of Installation _____

Contract Drawing Number _____

Service Line Size (inches) _____

Length of Water Service Line (feet) _____

Meter Size (inches) _____

Name _____

House/Business Address or Location:

Phone # _____

GPS coordinate @ main _____

GPS coordinate @ meter _____

Confirm Photos are attached _____

Installation Foreman _____

Service Layout

Provide a brief sketch of the installed configuration. Indicate lengths, depths of the water service, and show three ties to meter box and to corporation stop:

Depth @ Main (feet) _____

Depth @ stub out (feet) _____

Contractor Signature

Resident Observer Signature

(Rev 2 – 15 Oct 2006)

ISOLATION VALVE CARD

Date of Installation _____

Contract Drawing Number _____

Closest Street Address to Valve or Location of Valve

Size of Valve (inches) _____

Circle Type of Valve: Gate Butterfly

GPS Coordinate @ Valve _____

Installation Foreman _____

Confirm Photos are attached _____

Isolation Valve Layout

Provide a brief sketch of the installed configuration. Show depths of the water line and show three ties to the isolation valve:

Depth @ Main (feet) _____

Contractor Signature

Resident Observer Signature

(Rev 2 – 15 Oct 2006)

FIRE HYDRANT CARD

Date of Installation _____

Contract Drawing Number _____

Closest Street Address to Fire Hydrant or Location of Fire Hydrant

Length of Hydrant Line (feet) _____

List any offset fittings required. _____

List Utilities requiring offset fittings _____

GPS coordinate @ main _____

GPS coordinate @ Hydrant _____

Installation Foreman _____

Confirm Photos are attached _____

Fire Hydrant Layout

Provide a brief sketch of the installed configuration. Indicate lengths, depths of the water line and hydrant, offset fittings, and show three ties to the fire hydrant isolation valve:

Depth @ Main (feet) _____

Depth @ hydrant (feet) _____

Contractor Signature

Resident Observer Signature

(Rev 2 – 15 Oct 2006)

END OF SECTION

SECTION 15125
PIPING APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required and install complete and ready for operation all piping appurtenances as shown on the Drawings and as specified in this Section.
- B. All piping appurtenances shall be of the size shown on the Drawings. All equipment of the same type shall be from one manufacturer, unless authorized in writing by the Engineer.
- C. All piping appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon the body.
- D. The piping appurtenances shall include, but not be limited to, the following:
 - 1. Tapping Saddles.
 - 2. Pressure Gauge Assembly.
 - 3. Annular Diaphragm Seal and Pressure Gauge Assembly.
 - 4. Water Meter.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Product technical submittal data shall contain the following information and data:
 - 1. Acknowledgment that products submitted meet requirements of standards referenced.
 - 2. Manufacturer's installation instructions.
 - 3. Expansion joints, flexible joints, couplings, adaptors, tapping sleeves, and other appurtenances:
 - a. Pressure and temperature rating.
 - b. Materials of construction.
 - c. Linings.

- d. Dimensions and weight.
- e. Accessories.
- f. Manufacturer's product brochures, cut-sheets, and parts diagrams.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Iron and Steel Institute (AISI)
 - 1. AISI Type 304L—Stainless Steel.
 - 2. AISI Type 316—Stainless Steel, Annealed Sheet.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A536—Standard Specification for Ductile Iron Castings.
 - 2. ASTM C285—Standard Test Methods for Sieve Analysis of Wet-Milled and Dry-Milled Porcelain Enamel.
- C. American Society of Mechanical Engineers (ASME)
 - 1. ASME B16.5—Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standards.
- D. American Water Works Association (AWWA)
 - 1. AWWA C105/A21.5—Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 2. AWWA C153/A21.53—Ductile-Iron Compact Fittings.
 - 3. AWWA C207—Steel Pipe Flanges for Waterworks Service, Sizes 4-Inch through 144-Inch (100 mm through 3,600 mm).
 - 4. AWWA C210—Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
 - 5. AWWA C213—Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
 - 6. AWWA C500—Metal-Seated Gate Valves for Water Supply Service.
 - 7. AWWA C502—Dry-Barrel Fire Hydrants.
 - 8. AWWA C700—Standard for Cold-Water Meters—Displacement Type, Metal Alloy Main Case.
 - 9. AWWA C800—Underground Service Line Valves and Fittings.

E. National Sanitation Foundation (NSF)

1. NSF 61—Drinking Water System Components – Health Effects.

1.04 DELIVERY, HANDLING, AND STORAGE

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.
- B. All piping appurtenances, unless otherwise directed, shall be loaded and unloaded by lifting, and under no circumstances shall any piping appurtenances be dropped, skidded, or rolled.
- C. Slings, hooks, or tongs used for lifting shall be padded to prevent damage to exterior surface or interior linings of piping appurtenances. If any part of the coating, lining, or components is damaged, the Contractor shall make repairs or replacement at his expense and in a manner satisfactory to the Engineer before attempting to install such piping appurtenances.
- D. Only new piping appurtenances will be allowed for installation and shall be stored to prevent damage and be kept free of dirt, mud, or other debris.

1.05 QUALIFICATIONS

- A. All of the piping appurtenances shall be products of well-established firms that are fully experienced, reputable, have been selling this product for a minimum of 10 years, and qualified in the manufacture of the particular product furnished. The piping appurtenances shall be designed, constructed, and installed in accordance with the requirements and procedures of applicable AWWA standards and shall comply with these Specifications as applicable.

PART 2 PRODUCTS

2.01 TAPPING SADDLE

- A. Saddle body shall be made of stainless steel. Saddles shall be of the multiple strap design. The straps shall be made from Type 304 stainless steel. The straps shall have a nominal width of 2 inches. Strap studs shall be made from AISI Type 304L stainless steel.
- B. Nuts and washers shall be made from Type 304 stainless steel and shall be treated to prevent galling. The straps shall have a curvature accurately formed to meet the diameter of the pipe on which the service saddle is to be installed. A Neoprene

gasket shall be securely glued to or embedded in the body of the clamp to ensure positive sealing against the pipe. Outlet sizes of 2 inches shall be female I.P. thread.

2.02 PRESSURE-GAUGE ASSEMBLY

- A. Pressure-gauge assemblies shall be provided at locations listed below or as shown on the Drawings. All pressure-gauge assemblies shall include a pressure gauge, AISI Type 316 stainless steel, NPT threaded ball valves for isolation and venting, and sensor piping. Sensor piping tubing and fittings shall be Type 316 stainless steel. The pressure gauge shall be constructed of Type 316 stainless-steel wetted parts and Type 304 stainless-steel case and bayonet ring, adjustable pointer, laminated safety-glass window, glycerin liquid-filled case, 1.5% span accuracy, and shall have a 2.5-inch-diameter dial size, minimum. The pressure gauge shall be as manufactured by WIKA Instrument Corporation, Type LM 233.54, or approved equal.
- B. The Contractor shall furnish and install pressure-gauge assemblies with pressure-gauge ranges as follows and/or shown on the Drawings.

2.03 ANNULAR DIAPHRAGM SEAL AND PRESSURE GAUGE ASSEMBLY

- A. Annular diaphragm seal and pressure gauge assemblies shall be provided at locations listed in this Section or as shown on the Drawings. All annular diaphragm-seal pressure gauge assemblies shall include an ethylene-glycol factory liquid-filled pressure-gauge and an annular seal assembly factory calibrated and ready for field installation. The annular seal assembly shall consist of a Buna-N diaphragm annual seal sleeve, carbon steel body, and ASME B16.5 Class 150 full-faced flanges (through bolted configuration). Pressure gauges shall be constructed with a stainless steel case with pressure ranges listed below. Annular diaphragm seal and pressure-gauge assemblies shall be as manufactured by the Red Valve Company, Incorporated, Series 48, or approved equal.
- B. The Contractor shall furnish and install annular seal and pressure-gauge assemblies with pressure gauge ranges as follows and/or shown on the Drawings:

<u>Location</u>	<u>Number of Assemblies</u>	<u>Pressure Gauge Range (psi)</u>
Recharge Pump Buidling	1	-30 to 60

2.04 WATER METER

- A. Water meters through 2-inch diameter shall comply with AWWA C700 and NSF 61 standards. The meter housing, bottom plates, and trim shall be bronze.

The measuring chamber, disc, strainer, generator housing, register lid, and shroud shall be thermoplastic. The magnet shall be ceramic. The disc and magnet spindles shall be stainless steel. External bolts shall be non-corrosive metal.

- B. Water meters shall be rated for continuous operation and have a maximum operating pressure of 150 psi. The measuring element shall be a positive displacement rotating disc. An oscillating piston-type meter is not acceptable. The sealed register shall consist of a straight reading, odometer-type totalizing display with a 10,000,000-gallon capacity (minimum) for meters smaller than the 1.5-inch unit and a 100,000,000-gallon capacity (minimum) for the 1.5-inch meter and larger, 360° test circle with center sweep hand, and flow finder to detect leaks. All meters shall have rigid, non-ferrous strainers that are easily removable and have an effective straining area of double that of the main-case inlet.
- C. The meters shall have the following minimum characteristics:

Meter Size	Minimum Test Flow	Normal Test Flow Limits	Pressure Loss @ AWWA Max. Cap.	Laying Length
1 1/2"	1 1/4 gpm	2 1/2 - 100 gpm	7.5 psi	12 5/8" or 13"
2"	1 1/2 gpm	2 1/2 - 160 gpm	9.0 psi	15 1/4" or 17"

- D. Water meters shall be Badger Recordall Model, Neptune, or approved equal. Headloss through the meter shall not exceed the published headloss through the named meters at any point on the headloss curve.
- E. Water meters larger than 1 inch shall have flanges for inlet and outlet connections; other water meters shall have threaded male inlet and outlet. All meters shall be easily removed from the installed piping.

2.05 TOOLS

- A. If required for normal operation and maintenance, special tools shall be supplied with the equipment. Two T-handle wrenches to operate standard 2-inch nuts on buried valves and buried valve actuators shall be provided as part of the work.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The Contractor shall install all piping appurtenances as shown on the Drawings.

- B. All piping appurtenances shall be installed in the location shown, unless approved otherwise, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Owner and the Engineer.
- C. Install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and shall be responsible for the proper location of these piping appurtenances during the construction of the structures.

3.02 SHOP PAINTING

- A. Exterior surfaces of ferrous valves and piping appurtenances shall be painted in accordance with Section 09900, Painting and Coating, unless noted or specified otherwise.

3.03 INSPECTION AND TESTING

- A. Completed valves and piping appurtenances shall be subjected to hydrostatic pressure test as described in Section 15055, Piping Systems—General, and the detail pipe sections of these Specifications. All leaks in valves and piping appurtenances shall be repaired and lines retested as approved by the Engineer. Before testing, the valves and pipelines shall be supported and thrust restrained for forces in excess of the test pressure to prevent movement during tests.

END OF SECTION

SECTION 15144
PRESSURE TESTING OF PIPING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies the hydrostatic, pneumatic, and leakage testing of pressure piping for pumping stations, wastewater treatment plants, water treatment plants, and other facilities; water distribution and transmission mains; and raw sewage force mains and lift stations.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Test bulkhead locations and design calculations, pipe attachment details, and methods to prevent excessive pipe wall stresses.
- B. Six copies of the test records to the Engineer upon completion of the testing.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Water Works Association (AWWA)
 - 1. AWWA C600—Installation of Ductile Iron Mains and Their Appurtenances.
 - 2. AWWA C605—Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

1.04 TEST PRESSURES

- A. Test pressures for the various services and types of piping are shown in the Piping Schedule in the Drawings. At a minimum the Contractor shall perform pressure and leakage test at 1.5 times the maximum system pressure or 100 psi, whichever

is greater (based on the elevation or the lowest point of the section under test and corrected for gage location).

1.05 TESTING RECORDS

- A. The Contractor shall provide records of each piping installation during the testing. These records shall include the following information:
 - 1. Date and times of test.
 - 2. Identification of process, pipeline, or pipeline section tested or retested.
 - 3. Identification of pipeline material.
 - 4. Identification of pipe specification.
 - 5. Test fluid.
 - 6. Test duration.
- B. Test pressure at low point in process, pipeline, or pipeline section.
- C. Remarks: Leaks identified (type and location), types of repairs, or corrections made.
- D. Certification by Contractor that the leakage rate measured conformed to the Specifications.

PART 2 PRODUCTS

2.01 VENTS AND DRAINS FOR ABOVEGROUND PIPING

- A. The Contractor shall install vents on the high points of aboveground piping, whether shown in the Drawings or not. Install drains on low points of aboveground piping, whether shown in the Drawings or not. Provide a valve at each vent or drain point. Valves shall be 3/4 inch for piping 3 inches and larger and 1/2 inch for piping smaller than 3 inches. Valves shall be ball or gate valves unless otherwise shown on the Drawings. Valves shall be rated for the pressure of the adjacent piping and shall be suitable for use with the adjacent pipe material.

2.02 MANUAL AIR-RELEASE VALVES FOR BURIED PIPING

- A. The Contractor shall provide temporary manual air-release valves at test bulkheads for pipeline test. Construct the pipe outlet in the same manner as for a permanent air valve and, after use, seal with a blind flange, pipe cap, or plug and coat the same as the adjacent pipe.

2.03 TEST BULKHEADS

- A. The Contractor shall design and fabricate test bulkheads in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. Materials shall comply with Part UCS of the code. Design pressure shall be at least 2.0 times the specified test pressure for the section of pipe containing the bulkhead. Limit stresses to 70% of yield strength of the bulkhead material at the bulkhead design pressure. Include air-release and water drainage connections.

2.04 TESTING EQUIPMENT

- A. The Contractor shall provide calibrated pressure gauges, pipes, bulkheads, pumps, compressors, chart recorder, and meters to perform the hydrostatic testing. The Contractor shall provide any necessary assistance required for testing.

PART 3 EXECUTION

3.01 TESTING PREPARATION

- A. Pipes shall be in place, backfilled, and anchored before beginning pressure testing.
- B. The Contractor shall conduct pressure tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.
- C. For buried piping, the pipe may be partially backfilled and the joints left exposed for inspection during an initial leakage test. However, perform the final pressure test after completely backfilling and compacting the trench.
- D. Provide any temporary piping needed to carry the test fluid to the piping that is to be tested. After the test has been completed and demonstrated to comply with the Specifications, disconnect and remove temporary piping. Do not remove exposed vent and drain valves at the high and low points in the tested piping; remove any temporary buried valves and cap the associated outlets. Plug taps or connections to the existing piping from which the test fluid was obtained.
- E. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing.
- F. Before starting the test, the Contractor shall notify the Engineer and the Owner's Representative.

3.02 CLEANING

- A. Before conducting hydrostatic tests, the Contractor shall flush pipes with water to remove dirt and debris. For pneumatic tests, blow air through the pipes. Maintain a flushing velocity of at least 3 fps for water testing and at least 2,000 fpm for pneumatic testing. Flush pipes for the period given by the formula:

$$T = \frac{2L}{3}$$

in which:

T = flushing time (seconds)

L = pipe length (feet).

- B. For pipelines 24 inches or larger in diameter, acceptable alternatives to flushing are use of high-pressure water jet, sweeping, or scrubbing. Water, sediment, dirt, and foreign material accumulated during this cleaning operation shall be discharged, vacuumed, or otherwise removed from the pipe.

3.03 TESTING AND DISINFECTION SEQUENCE FOR POTABLE WATER PIPING

- A. Perform required disinfection after hydrostatic testing, unless otherwise indicated.

3.04 LENGTH OF TEST SECTION FOR BURIED PIPING

- A. The maximum length of test section for buried pipe of 12 inches or smaller in diameter is 3,500 feet; for buried pipe larger than 12 inches, 1 mile. Provide intermediate test bulkheads where the pipeline length exceeds these limits.

3.05 INITIAL PIPELINE FILLING FOR HYDROSTATIC TESTING

- A. The maximum rate of filling shall not cause the water velocity in the pipeline to exceed 1 fps. Filling may be facilitated by removing automatic air valves and releasing air manually.

3.06 TESTING NEW PIPE WHICH CONNECTS TO EXISTING PIPE

- A. Before testing new pipelines that are to be connected to existing pipelines, the Contractor shall isolate the new line from the existing line by test bulkheads, spectacle flanges, or blind flanges. After the new line has been successfully tested, remove test bulkheads or flanges and connect to the existing piping.

3.07 HYDROSTATIC TESTING OF ABOVEGROUND OR EXPOSED PIPING

- A. Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.
- B. Subject the piping system to the test pressure indicated on the Piping Schedule in the Drawings or as stated in the Contract Specifications, whichever is more conservative. Maintain the test pressure for a minimum of 2 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.08 HYDROSTATIC TESTING OF BURIED PIPING

- A. Where any section of the piping contains concrete thrust blocks or encasement, the Contractor shall not make the pressure test until at least 10 days after the concrete has been placed. When testing mortar-lined or PVC piping, fill the pipe to be tested with water and allow it to soak for at least 24 hours to absorb water before conducting the pressure test.
- B. Apply and maintain the test pressure by a positive displacement hydraulic force pump.
- C. Maintain the test pressure for the 2 hours by restoring the pressure whenever it falls 5 psi.
- D. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage volume is defined by the formulas:

PVC Pipe:

$$L = \frac{ND(P)^{1/2}}{C}$$

in which:

- L = allowable leakage (gallons)
- N = number of rubber-gasketed joints in the pipe tested
- D = diameter of the pipe (inches)
- P = specified test pressure (psig)
- C = 7,400

Ductile Iron Pipe:

$$L = \frac{SD(P)^{1/2}}{C}$$

in which:

- L = allowable leakage (gallons)
- S = length of pipe tested (feet)
- D = diameter of the pipe (inches)
- P = specified test pressure (psig)
- C = 133,200

FPVC Pipe: As specified in Section 15148, Fusible Polyvinyl Chloride Pipe and Appurtenances.

- E. The leakage test shall be a separate test following the pressure test and shall not be less than 2 hours long. All leaks evident at the surface shall be repaired and leakage eliminated regardless of the total leakage as shown by test. Lines that fail to meet tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves, and accessories shall be removed and replaced.
- F. The allowable leakage for buried piping having threaded, brazed, or welded (including solvent welded) joints shall be zero.
- G. Submit plan for testing to the Engineer for review at least 10 days before starting the test.
- H. Peening shall not be used to repair pinhole leaks in welded pipes. Any leakage in welded pipes shall be repaired by appropriate welding techniques.
- I. Repair and retest any pipes showing leakage rates greater than that allowed in the criteria above.

3.09 REPETITION OF TEST

- A. If the actual leakage exceeds the allowable leakage, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair. Eliminate visible leakage.

3.10 BULKHEAD AND TEST FACILITY REMOVAL

- A. After a satisfactory test, the Contractor shall remove the testing fluid, remove test bulkheads and other test facilities, and restore the pipe coatings/linings.

END OF SECTION

SECTION 15148
FUSIBLE POLYVINYLCHLORIDE PIPE
AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Work included in this Section consists of furnishing all labor, equipment, tools, appliances, and materials and performing all operations necessary to construct and install fusible polyvinyl chloride (FPVC) mains, including all piping, casing, and appurtenances, complete and ready for operation as indicated on the Drawings and described in this Section.
- B. The Work shall include but not be limited to FPVC, fittings, and butt-fusion techniques; testing of pipe and all other work necessary to complete the installation.
- C. The Contractor shall furnish to the Owner with a 2-year warranty on the design, materials, fabrication, and workmanship of all FPVC pipe and fittings furnished. The warranty period shall begin upon Substantial Completion of the Project.

1.02 RELATED WORK

- A. Section 01330, Submittals and Acceptance
- B. Section 02305, Earthwork for Utilities.
- C. Section 15055, Piping Systems—General.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. In general, shop drawings and related manufacturer's product certification shall be made for approval before the manufacturer constructs or fabricates the material. The following items, which require shop drawings, are brought to the Contractor's attention. The list may not include all items for which shop drawings must be submitted to meet the requirements of the project.
 - 1. Catalog/manufacturer data sheets of all classes of pipe, joints, and fittings.
 - 2. Detail drawings of restrained and flexible joints, including test reports to confirm thrust restraint capacities and restraining mechanism application.

3. Pipeline laying schedule tabulated and referenced to construction line and grade controls shown on plans, with station, offset, and elevations. References shall be provided for pipe fittings, valves, service connections, and other important features of the pipeline.
 4. All appurtenant items.
- B. The pipe manufacturer shall perform and furnish certification and test reports for the materials, manufacturing, and testing of the types of pipe supplied.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Specification Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM D1784—Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated PVC (CPVC) Compounds.
2. ASTM D1785—Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
3. ASTM D2152—Standard Specification for Test Method for Degree of Fusion of Extruded PVC Pipe and Molded Fittings by Acetone Immersion.
4. ASTM D2241—Standard Specification for PVC Plastic Pipe (SDR-PR).
5. ASTM D2837—Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
6. ASTM F477—Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
7. ASTM F1057—Standard Specification for Standard Practice for Estimating the Quality of Extruded PVC Pipe by the Heat Reversion Technique.

B. American Water Works Association (AWWA)

1. ANSI/AWWA C110/A21.10—Standard for American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and other Liquids.
2. ANSI/AWWA C111/A21.11—Standard for American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

3. AWWA C605—Standard for Underground Installation of PVC Pressure Pipe and Fittings for Water.
4. AWWA C651—Standard for Disinfecting Water Mains.
5. AWWA C900—Standard for PVC Pressure Pipe and Fabricated Fittings, 4 in. through 12 in., for Water Distribution.
6. AWWA C905—Standard for PVC Pressure Pipe and Fabricated Fittings, 14 in. through 48 in., for Water Distribution and Transmission.
7. AWWA M23—AWWA Manual of Supply Practices PVC Pipe-Design and Installation Second Edition.

C. Other Standards

1. UNI-PUB-08—Tapping Guide for PVC Pressure Pipe.
2. NSF-14—Plastics Piping System Components and Related Materials.
3. NSF-61—Drinking Water System Components-Health Effects.
4. PPI TR-2—PVC Range Composition Listing of Qualified Ingredients.

1.06 QUALITY ASSURANCE

A. Technical Guidance

1. Plastic Pipe Institute (PPI) Manual TR-4: Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds.
2. Plastic Pipe Institute Manual TR-3: Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
3. Plastic Pipe Institute Manual TR-3.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

B. Inspection Upon Delivery

1. All pipe fittings and appurtenances shall be subject to visual inspection by a representative of the Owner at the point of delivery and again just before being lowered into the trench. All materials found to be defective due to manufacture or damaged in transit shall be rejected and shall be immediately removed from the job site.
2. The Owner may perform or cause to be performed all tests as specified in the applicable standards to ensure conformance with the standard. If the

pipe or appurtenances fail to comply with such standards, the responsibility for replacing the defective materials shall be that of the manufacturer or the Contractor.

3. The entire product of any manufacturer may be rejected when, in the opinion of the Owner, the methods of manufacture fail to secure uniform results or where the materials are such as to produce pipe and/or fittings of inferior quality.

1.08 QUALIFICATIONS

A. Manufacturer Requirements:

1. All piping shall be made from PVC compound conforming to cell classification 12454 per ASTM D1784. The material shall have a minimum hydrostatic design basis of 4,000 psi at 73°F in accordance with ASTM D2837.

B. Fusion Technician Requirements:

1. The Fusion Technician shall be fully qualified by the pipe supplier to install FPVC pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.

C. Specified Pipe Suppliers:

1. FPVC pipe shall be used as manufactured under the trade names Fusible C-900® and FPVC®, for Underground Solutions, Inc., Poway, CA, (858) 679-9551. Fusion process shall be as patented by Underground Solutions, Inc., Poway, CA, Patent No. 6,982,051.

1.09 TESTING REQUIREMENTS (NOT USED)

1.10 MAINTENANCE (NOT USED)

1.11 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- A. O&M Manuals shall be in accordance with Section 01830, Operations and Maintenance Manuals.

1.12 RECORD DRAWINGS

- A. The Contractor shall provide Record Drawings redlines indicating exact locations of all pipe and fittings. The Contractor shall provide a minimum of two ties for

each fitting, valve, or appurtenance and its elevation. The Contractor shall provide record information for all existing buried utilities encountered.

1.13 SYSTEM IDENTIFICATION

A. The following features shall be included in the design of the facilities:

1. All transmission and distribution piping shall be color-coded in accordance with the Table in the Contract Drawings. For FPVC mains, the color shall be an integral part of the pipe material.
2. All aboveground valves, meters, and other devices and appurtenances shall be painted in accordance with the Contract Drawings and Section 09900, Painting and Coating.
3. Tracer wire and non-magnetic marking tape shall be installed for all FPVC mains.
4. Covers for all valve boxes and other belowground devices on the system shall be painted in accordance with Section 09900, Painting and Coating. Valve boxes shall be square, U.S. Foundry or approved equal.

1.14 DEFINITIONS (NOT USED)

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 PIPE AND FITTINGS – FPVC

A. FPVC Pressure Pipe

1. FPVC pipe shall conform to AWWA C900, ASTM D1785, or ASTM D2241 for standard dimensionality, as applicable. Testing shall be in accordance with the referenced AWWA standards.
2. FPVC pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. No bell or gasket of any kind shall be incorporated into the pipe.
3. FPVC pipe shall be manufactured in a standard 45-foot nominal length or custom lengths as specified.
4. Dimension ratios for FPVC pipe shall be minimum DR 18 for pressure applications and DR 25 for gravity applications.

5. Pipe generally shall be marked to include as a minimum:
 - a. Nominal pipe size.
 - b. PVC.
 - c. Dimension Ratio, Standard Dimension Ratio, or Schedule.
 - d. Pressure class or standard pressure rating.
 - e. Standard designation number or pipe type.
 - f. Extrusion production-record code.
 - g. Trademark or trade name.
6. Cell Classification 12454 and/or PVC Material Code 1120 may also be included.
7. Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

B. Fusion Joints

1. Unless otherwise specified, FPVC pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier's written guidelines for this procedure. All fusion joints shall be completed as described in this specification.

C. Connections and Fittings for Pressure Applications

1. Connections shall be defined in conjunction with the coupling of project piping, as well as the tie-ins to other piping systems.

D. Ductile Iron Mechanical and Flanged Fittings

1. Acceptable fittings for use with FPVC pipe shall include standard ductile as specified in Section 15155, Ductile Iron Pipe and Fittings.
 - a. Connections to FPVC pipe may be made using a restrained or non-restrained retainer gland product for PVC pipe, as well as for MJ or flanged fittings.
 - b. Connections to fittings and valves shall be restrained.
2. Ductile iron fittings and glands must be installed according to the manufacturer's guidelines.

E. Restrained Joints

1. The following pipe joints and fittings restraint methods can be used to prevent pipe joints and fittings from separating under pressure. No additional financial compensation will be provided to the Contractor for providing the following methods of restraint:
 - a. Mechanical joint fittings used with PVC/FPVC pipe (3-inch-through 36-inch-diameter DR 18 pipe) shall be restrained with the EBAA Iron MEGALUG® Series 2000 PV Restrainer or an equal approved by the Engineer. The Series 2000 PV restrainers shall provide a minimum of 165-psi restraint with a 2 to 1 safety factor. The restraining device and Tee head bolts shall be manufactured of high-strength ductile iron meeting ASTM A536, Grade 65-42-10. Clamping bolts and nuts shall be manufactured of corrosion-resistant, high-strength, low-alloy CORTEN steel meeting the requirements of ASTM A242.
 - b. All parts of the joint restraint systems shall be coated with coal tar epoxy as in Section 09900, Painting and Coating, Mega-Bond coating system by EBAA Iron, Inc. or Engineer-approved equal.

F. PVC Gasketed, Push-On Fittings

1. Acceptable fittings for use with FPVC pipe shall include standard PVC pressure fittings conforming to AWWA C900.
 - a. Acceptable fittings for use joining FPVC pipe other sections of FPVC pipe or other sections of PVC pipe shall include gasketed PVC, push-on type couplings and fittings, including bends, tees, and couplings as shown on the Drawings.
 - b. Bends, tees, and other PVC fittings shall be restrained with the use of thrust blocking or other restraint products as indicated on the Drawings.
 - c. PVC gasketed, push-on fittings and mechanical restraints, if used, must be installed according to the manufacturer's guidelines.

G. Sleeve-Type Couplings

1. Sleeve-type mechanical couplings shall be manufactured for use with PVC pressure pipe and may be restrained or unrestrained as indicated on the Drawings.
2. Sleeve-type couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.

H. Connection Hardware

1. Bolts and nuts for buried service shall be made of non-corrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21.11, regardless of any other protective coating.

2.03 FUSION PROCESS

A. General

1. FPVC pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.
2. FPVC pipe will be fused by qualified fusion technicians, as documented by the pipe supplier.
3. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.
4. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:

B. Heat Plate—Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; the cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, according to the pipe supplier's guidelines.

C. Carriage—Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.

D. General Machine—Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.

E. Data Logging Device—An approved data-logging device with the current version of the pipe supplier's recommended and compatible software shall be used. Data-logging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods, an independent 110V power source shall be available to extend battery life.

- F. Other equipment specifically required for the fusion process shall include the following:
1. Pipe rollers shall be used for support of pipe to either side of the machine.
 2. A weather-protection canopy that allows full machine motion of the heat plate, fusion assembly, and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, in accordance with the pipe supplier's recommendations.
 3. An infrared (IR) pyrometer shall be used to check pipe and heat plate temperatures.
 4. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
 5. Facing blades specifically designed for cutting FPVC pipe shall be used.
- G. Joint Recording—Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of FPVC pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

2.04 BORING EQUIPMENT (NOT USED)

PART 3 EXECUTION

3.01 DIRECTIONAL DRILLING (NOT USED)

3.02 DRILLING FLUIDS AND THEIR DISPOSAL (NOT USED)

3.03 CHECKING AND CLEANING

- A. The pipe shall be checked for any flaws in manufacturing before and after installation.
- B. The installed and successfully checked pipeline shall be cleaned with stiff brushes followed by a swabbing mandrel sufficient to remove all debris including soils.

3.04 HYDROSTATIC TESTING AND LEAKAGE TESTING FOR PRESSURE PIPING

- A. Hydrostatic and leakage testing for piping systems that contain mechanical jointing as well as fused PVC jointing shall comply with AWWA C605.

B. To prepare for pressure testing, the following parameters must be followed:

1. All air must be vented from the pipeline before pressurization. This may be accomplished using air-relief valves or corporation stop valves, vent piping in the testing hardware or end caps, or any other method that adequately allows air to escape the pipeline at all high points. Venting may also be accomplished by ‘flushing’ the pipeline in accordance with the parameters and procedures as described in AWWA C605.
2. The pipeline must be fully restrained before pressurization. This includes complete installation of all mechanical restraints in accordance with the restraint manufacturer’s guidelines, whether permanent or temporary to the final installation. This also includes installing and curing all required thrust blocking. All appurtenances included in the pressure test, including valves, blow-offs, and air-relief valves, shall be checked for proper installation and restraint before the test begins.
3. Temporary pipeline alignments that are being tested, such as those that are partially installed in their permanent location, shall be configured to minimize the amount of potentially trapped air in the pipeline.

END OF SECTION

SECTION 15155
DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall provide all materials and incidentals, including piping, fittings, flanged joints, mechanical joints, retainer glands, polyethylene bagging for buried ductile iron piping, fittings, valves, and appurtenances for the ductile iron piping systems required for the work shown on the Drawings, in the Drawing—Piping Schedule, and described in Section 15060, Pipe Hangers and Supports.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. All ductile iron pipe and fittings to be installed under this Contract shall be inspected and tested at the foundry where the material for this project is manufactured. The Contractor shall submit sworn certificates of such tests and their results.
- B. Shop Drawings, including layout drawings, shall be submitted as specified in Section 15055, Piping Systems—General.
- C. The Contractor shall submit the pipe manufacturer's certification of compliance with the applicable sections of the Specifications.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A193/A193M—Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

2. ASTM A194/A194M—Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. ASTM A307—Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
4. ASTM A536—Standard Specification for Ductile Iron Castings.
5. ASTM A563—Standard Specification for Carbon and Alloy Steel Nuts.
6. ASTM B117—Standard Practice for Operating Salt Spray (Fog) Apparatus.
7. ASTM C150/C150M—Standard Specification for Portland Cement.
8. ASTM C283—Standard Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
9. ASTM D714—Standard Test Method for Evaluating Degree of Blistering of Paints.
10. ASTM D792—Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
11. ASTM D1238—Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
12. ASTM E96—Standard Test Methods for Water Vapor Transmission of Materials.
13. ASTM G95—Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).

B. American Society of Mechanical Engineers (ASME)

1. ASME B1.1—Unified Inch Screw Threads (UN and UNR Thread Form).
2. ASME B16.1—Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
3. ASME B16.21—Nonmetallic Flat Gaskets for Pipe Flanges.

C. American Water Works Association (AWWA)

1. AWWA C104/A21.4—Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C110/A21.10—Ductile-Iron and Gray-Iron Fittings.
3. AWWA C111/A21.11—Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C115/A21.15—Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
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 C207—Steel Pipe Flanges for Waterworks Service, Sizes 4-Inch through 144-Inch (100 mm through 3,600 mm).

9. AWWA C600—Installation of Ductile-Iron Mains and their Appurtenances.
 10. AWWA C651—Disinfecting Water Mains.
- D. International Organization for Standardization (ISO)
1. ISO-9001—Quality Management Systems – Requirements.
- E. NSF International (NSF)
1. NSF 61—Drinking Water System Components – Health Effects.

1.04 QUALITY ASSURANCE

- A. Source Quality Control:
1. The ductile iron pipe manufacturer shall submit certification that the pipe and fitting products meet all tests required by AWWA C151/A21.51.
 2. All materials shall be new and have a manufacturer's certificate verifying compliance to all tests and inspections as required in this Section. The weight, class, and casting period shall be shown on each piece of pipe. The manufacturer's "mark," the year produced, and the word "Ductile" or the letters "DI" shall be cast or stamped on all pipe.

1.05 TESTING REQUIREMENTS

- A. See Section 15144, Pressure Testing of Piping, for testing requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. All ductile iron piping shall be designed and manufactured in accordance with AWWA C150/A21.50 and AWWA C151/A21.51 for the following minimum operating conditions:
1. The minimum internal design pressure shall be 150 psi with a 100-psi surge allowance, with a safety factor of 2, for a total internal design pressure of 500 psi.
 2. The external loads design criteria shall be for the minimum cover indicated on the Drawings at 120 lb per cubic feet soil weight and live load based on one AASHTO H-20 truck load. The thickness design of ductile iron pipe shall be in accordance with AWWA C150/A21.50.

3. The horizontal deflection of cement-mortar-lined ductile iron pipe resulting from external load conditions shall not exceed 3% of the pipe diameter based on the trench design shown on the Drawings.
4. Pressure Class: All ductile iron piping shall meet the following minimum working pressure classes:
 - a. 4 inches through 12 inches: 350 psi.
 - b. Pipe greater than 12 inches: 250 psi.

2.02 JOINTS

- A. Ductile iron fittings shall be furnished with mechanical joints and flanged joint ends as shown on the Drawings and specified in this Section:
 1. Mechanical Joints: All buried ductile iron fittings shall be furnished with mechanical joint ends unless noted otherwise. Mechanical joints shall conform to AWWA C111/A21.11. Glands shall be constructed of ductile iron.
 2. Flanged Joints: Pipe for threaded flange fabrication shall be Special Thickness Class 53 in accordance with AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C115/A21.15. Bolt circle and bolt holes shall match those of ASME B16.1 Class 125 flanges. The flanges shall be rated for a maximum working pressure of 250 psi. Threaded flanges shall be individually fitted and machine tightened on the pipe ends. Flange facing shall be smooth or with shallow serrations in accordance with AWWA C115/A21.15.

2.03 FITTINGS

- A. General: Ductile iron pipe fittings shall be the compact type meeting the requirements of AWWA C110/A21.10 and AWWA C153/A21.53 where applicable. Ductile iron fittings shall be cement lined and seal coated, glass lined, or epoxy lined. Lining of fitting shall conform to lining specified for piping and service as specified on the Drawing—Flow Stream Identification. Fittings shall be manufactured in accordance with AWWA C110/A21.10. Where taps are shown on fittings, tapping bosses shall be provided. At a minimum, fittings shall have the same pressure rating as the connecting pipe.
 1. Flanged Joint: AWWA C110/21.10 and ASME B16.1, faced and drilled 125-pound ANSI standard.

2. Mechanical Joint: AWWA C110/A21.10

- a. Provide mechanical joint fittings for all buried fittings as shown in the Drawings, unless noted otherwise.
- b. Provide specified gaskets.

2.04 LINING AND COATING

- A. The Contractor shall provide lined ductile iron piping and fittings in accordance with the Drawing—Flow Stream Identification. The Contractor shall perform all field measurements confirming the accuracy of the piping sizes and lengths shown on the Drawings. The Contractor shall notify the Engineer immediately before deviating from or altering the lining of ductile iron piping shown on the approved layout schedule.
- B. Ceramic Epoxy Lined Pipe and Fittings: The Contractor shall notify the Engineer immediately before cutting epoxy-lined ductile iron pipe in the field. The Contractor shall repair the cut end in accordance with the pipe manufacturer's written procedures.
 1. General: The lining shall be an amine-cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. The lining material shall be Protecto 401 Ceramic Epoxy as manufactured by Induron Protective Coatings, Inc. The lining shall be applied by a competent pipe lining specialty firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.
 2. Lining Materials: Lining material shall meet the following requirements and properties:
 - a. A permeability rating of 0.00 when tested according to Method A of ASTM E96, Procedure A with a test duration of 30 days.

- b. The following test shall be run on coupons from lined ductile pipe:

Test Parameter	ASTM Test Method	Typical Value
Salt Spray	B117	0.0 undercutting after 2 years
Cathodic disbondment 1.5 volts @ 77° F	G95	No more than 0.5 mm undercutting after 30 days
Immersion	D714	No effect after 2 years for 20% sulfuric acid, 140°F 25% sodium hydroxide, 160°F distilled water
Immersion	D714	0.0 undercutting after 2 years for 120°F tap water

3. Application: The lining applicator shall apply lining according to the requirements of the Protecto 401 Specification and application methods and procedures.

C. Cement-Lined Ductile Iron Pipe and Fittings: Interior surfaces of all cement-lined ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with a standard thickness cement-mortar lining applied in conformity with AWWA C104/A21.4, Portland cement mortar. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the Contractor shall repair or replace damaged or unsatisfactory portions with lining conforming to these Specifications at no additional cost to the Owner.

1. All ductile iron pipe and fittings cement-mortar linings shall be surface sealed with an asphaltic seal coating, 1 mil, in accordance with AWWA C104/A21.4.

D. Glass Lined Pipes and Fittings:

1. General: The lining shall be applied by a competent pipe lining specialty firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

2. Lining Materials: The lining material shall be vitreous and inorganic and the lined pipe and fittings shall meet the following requirements and properties:

Test Parameter	Test Method	Typical Value
Minimum density	ASTM D792	2.5 to 3.0 grams per cubic centimeter
Thermal shock of 350°F		Without crazing, blistering, or spalling
Immersion in 8% sulfuric acid at 125°F for 15 minutes	ASTM C283	A weight loss of no more than 3 milligrams per square inch

The glass-lined pipe and fittings shall be resistant to corrosion in a pH range of 3 to 10 at 125°F. It shall have a hardness of 5 to 6 on the Mohs scale.

3. Application: The lining shall be applied by an ISO 9001 certified firm with a successful history of applying glass linings to the interior of ductile iron pipe and fittings.

2.05 MANUFACTURERS

- A. Acceptable ductile iron pipe manufacturers include US Pipe, American Ductile Pipe, Griffin Pipe, or approved equal.

2.06 BOLTS

- A. General: The Contractor shall provide carbon steel, ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts. Threads shall be as specified in ASME B1.1 coarse thread series, Class 2A external and Class 2B internal. Nuts, bolts, and gaskets for flanged fittings and blind flanges shall be designed to withstand the design and test pressure ratings for the pipe.

2.07 GASKETS

- A. Gaskets for mechanical joints shall be compatible with raw water pipe service. See Section 15055, Piping Systems—General, for gasket requirements.
- B. Gaskets for flanged joints shall be 1/8-inch-thick, cloth-inserted rubber conforming to applicable parts of ASME B16.21 and AWWA C207. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in raw water lines. Gaskets shall be full-face type for 125-pound flanges.

2.08 RETAINER GLANDS

- A. Retainer glands shall be provided for all buried ductile-iron mechanical joints, fitting, and ductile-iron pipe connections to buried valves. Retainer glands shall be designed for joint retaining through the use of a follower gland and set screw-anchoring devices that impart multiple wedging action against the pipe. The mechanical joint-restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.
1. Gland: Manufactured of ductile iron conforming to ASTM A536. Gland dimensions shall match AWWA C111/A21.11 and AWWA C153/A21.53.
 2. Restraining Devices: Manufactured of ductile iron heat treated to a minimum hardness of 370 BHN. Restraining devices shall incorporate a set screw/twist-off nut bolt to ensure the proper actuating of the restraining device. The twist-off nut shall be designed to come off at the torque limit desired to anchor the restraining device in place on the pipe.
 3. Joint Deflection: Retainer gland joint deflection shall be limited to manufacturer's recommended maximum deflection angle. Joint deflection shall be applied before the set screws are torqued.
 4. Acceptable Manufacturers:
 - a. EBAA Iron, Inc. – Megalug 1100 Series.
 - b. Or approved equal.

2.09 EXTERNAL PIPE RESTRAINTS

- A. Ductile iron pipe push-on (bell and spigot) joint restraint shall be provided by a restraining harness consisting of a restraint ring, connecting tie-rods, and split-ring assembly installed at all push-on joints. The restraint ring shall consist of wedging components made from 60-42-12 ductile iron conforming to ASTM A536 and wedges heat treated to minimum 370 BHN. Torque limiting twist-off nuts shall be provided on each wedge to ensure proper applied installation torque. The split ring shall be made from 60-42-12 ductile iron conforming to ASTM A536. The connecting rods shall be made of steel conforming to AWWA C111/A12.11. Sizes 4- to 16-inch-diameter restraining harnesses shall have 350-psi maximum working pressure rating and 18- to 36-inch-diameter restraining harnesses shall have 250-psi maximum working pressure rating. All harnesses shall be designed with a 2-to-1 safety factor applied to the maximum working pressure rating.

B. Acceptable Manufacturers:

1. EBAA Iron, Inc. – Series 1700.
2. Or approved equal.

2.10 INTERNAL PIPE RESTRAINT

A. Acceptable Manufacturers:

1. American Ductile Iron Pipe:
 - a. Fast Grip ® Gasket.
 - b. Flex Ring ® Joint.
2. US Pipe:
 - a. Field Lok ® Gasket.
 - b. TR Flex Restrained Joint Pipe and Fittings.
3. Or Engineer-approved equal.

2.11 POLYETHYLENE BAGGING

- A. Polyethylene bagging for buried ductile iron pipe, fittings, and valves shall be 8 mils thickness minimum polyethylene, manufactured in accordance with ASTM D1238, Type I, Class C, Grade E1.

2.12 COLOR CODING OR MARKING

- A. All pipe, including fittings, shall be color coded in accordance with the table in the Contract Drawings. Underground plastic pipe shall be solid-wall colored pipe, shall have a co-extruded colored external skin, or shall be white or black pipe with colored stripes incorporated into or applied to the pipe wall in accordance with the table in the Contract Drawings; and underground metal or concrete pipe shall have stripes applied to the pipe wall. Pipe striped during manufacturing of the pipe shall have continuous stripes that run parallel to the axis of the pipe, that are located at no greater than 90° intervals around the pipe, and that will remain intact during and after installation of the pipe. If tape or paint is used to stripe pipe during installation of the pipe, the tape or paint shall be applied in a continuous line that runs parallel to the axis of the pipe and that is located along the top of the pipe; for pipes with an internal diameter of 24 inches or greater, tape or paint shall be applied in continuous lines along each side of the pipe as well as along the top of the pipe. Marking tape shall be 3 inches wide with adhesive backing. Paint stripe shall be 3 inches wide. Aboveground pipe at

drinking water treatment plants shall be color coded and labeled in accordance with subsection 62-555-320(10), FAC, and all other aboveground pipe shall be painted in accordance with the table in the Contract Drawings or shall be color coded or marked like underground pipe.

PART 3 EXECUTION

3.01 HANDLING PIPE AND FITTINGS

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe, fitting, lining, and coating. Pipe and fittings shall not be dropped. All pipe and fittings shall be examined before installation, and no piece that the Engineer finds defective shall be installed. The Contractor shall repair any damage to the pipe and fittings coating and/or lining found to be defective. If the Engineer determines that the coating and/or lining cannot be repaired, the Contractor shall replace the damaged pipe and fittings at no additional compensation.
- B. All pipe and fittings shall be subjected to a careful inspection immediately before installation.
- C. If any defective pipe is discovered after it has been installed, the Contractor shall remove and replace it with a pipe in satisfactory condition at no additional expense to the Owner.
- D. Ceramic epoxy and glass-lined pipe and fittings shall be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.

3.02 PIPE INSTALLATION

- A. The Contractor shall provide and use proper implements, tools, and facilities for the safe and convenient performance of the work. All pipe, fittings, valves, and appurtenances shall be lowered carefully into the trench and at above-grade locations to prevent damage to the pipe, protective coating, lining, and polyethylene bagging. Under no circumstances shall pipeline materials be dropped off or dumped. A trench shall be dewatered before the pipe is installed.
- B. The Contractor shall carefully examine all pipe fittings, valves, and other appurtenances for damage and other defects immediately before installation and before bagging buried ductile-iron pipe. The Contractor shall mark and hold defective materials for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.

- C. The Contractor shall remove all lumps, blisters, and excess coating from the socket and plain ends of push-on joint pipe for buried service. The outside of the plain end and the inside of the bell shall be wiped clean and dry and be free from dirt, sand, grit, or any foreign material before the pipe is laid in trench.
- D. The Contractor shall prevent foreign material from entering the pipe while the pipe is being placed in the trench. During installation, no debris, tools, clothing, or other materials shall be placed in the pipe.
- E. As each length of buried pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.
- F. When pipe is not being laid, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. When practical, the plug shall remain in place until the trench is pumped completely dry. Care shall be taken to prevent pipe flotation should the trench fill with water.
- G. Trench width at the top of pipe, bedding conditions, and backfill placement and compaction shall be such that design loadings on the pipe will not be exceeded.
- H. Joint Assembly: Pipe joints shall be assembled in accordance with the manufacturer's instructions and the requirements of AWWA C600.
 - 1. Flanged Joint: Before connecting flanged pipe, the Contractor shall thoroughly clean all faces of the flanges of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to ensure proper sealing of the flange gasket. Bolts shall be tightened so that the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.
 - 2. Push-On, Restrained Joint, or Mechanical Joint: The Contractor shall joint piping in accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes will be permitted under any circumstance.
- I. Pipe Deflection: When it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane or where long radius curves are permitted, the amount of deflection shall not exceed that shown in AWWA C600 and that recommended by the retainer gland manufacturer for mechanical joint pipe and fittings.

- J. Pipe Cutting: For inserting valves, fittings, or closure pieces pipe shall be cut in a neat, workmanlike manner without damaging the pipe or lining. Ductile cast iron may be cut using an abrasive pipe saw, rotary wheel cutter, guillotine pipe saw, milling wheel saw, or oxyacetylene torch. Cut ends and rough edges shall be ground smooth, and for push-on joint connections the cut end shall be beveled.

3.03 ABOVE-GROUND PIPE INSTALLATION

- A. The Contractor shall install pipe in horizontal or vertical planes, parallel or perpendicular to building surfaces unless otherwise shown. Support pipe and fittings to prevent strain on joints, valves, and equipment. Install flanged joints so that contact faces bear uniformly on the gasket. Tighten bolts in accordance with the pipe manufacturer's recommendations.

3.04 SURFACE PREPARATION AND PAINTING

- A. All exposed pipe and fittings shall be painted as specified in Section 09900, Painting and Coating.
- B. All buried steel bolts, nuts, washers, rods, harnesses, clamps, sleeves, and appurtenances shall be painted with System No. 21 as specified in Section 09900, Painting and Coating.

3.05 INSPECTION, TESTING, AND DISINFECTION

- A. See Section 15055, Piping Systems—General; Section 15141, Disinfection of Piping and Water Storage Facilities; and Section 15144, Pressure Testing of Piping.

END OF SECTION

SECTION 15250 SMALL-DIAMETER PIPING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall provide small-diameter pipe and fittings (nominal diameters less than 4 inches unless noted otherwise on the Drawings) as shown on the Contract Drawings and described in Section 15055, Piping Systems—General.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance, and Section 15055, Piping Systems—General.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A53/A53M—Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A90/A90M—Standard Test Method for Weight/Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - 3. ASTM A105/A105M—Standard Specification for Carbon Steel Forgings for Piping Applications.
 - 4. ASTM A182/A182M—Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - 5. ASTM A193/A193M—Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and other Special Purpose Applications.
 - 6. ASTM A194/A194M—Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 7. ASTM A312/A312M—Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - 8. ASTM A320/A320M—Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.

9. ASTM D1784—Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
10. ASTM D1785—Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
11. ASTM D2464—Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
12. ASTM D2466—Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
13. ASTM D2467—Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
14. ASTM D2564—Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
15. ASTM F439—Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM F441/F441M—Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
17. ASTM F493—Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
18. ASTM F656—Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

B. American Society of Mechanical Engineers (ASME)

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 Standards.
3. ASME B16.11—Forge Fittings, Socket-Welding and Threaded.
4. ASME B18.2.1—Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
5. ASME B36.10M—Welded and Seamless Wrought Steel Pipe.
6. ASME B36.19M—Stainless Steel Pipe.

C. Plastic Pipe Institute (PPI)

1. PPI TR-31—Underground Installation of Polyolefin Piping.

D. National Sanitation Foundation (NSF)

1.04 QUALITY ASSURANCE

- A. Piping materials and manufacturing shall adhere to the standards referenced in Section 15055, Piping Systems—General.

- B. The Contractor shall strictly adhere to the manufacturer's written storage, handling, installation, and joining.

PART 2 PRODUCTS

2.01 GENERAL

- A. All pipe joints and fittings shall have the same schedule, pressure ratings, thermal resistance, chemical resistance, and other pertinent properties as the pipe being joined or connected. Plastic fittings shall be manufactured of the same resin as used in the manufacture of the pipe being joined.
- B. Each pipe length shall be clearly marked with the manufacturer's name or trademark, applicable ASTM standards, size, pressure rating, and/or schedule.
- C. Provide line size reducing tees for connecting lateral or instrumentation to pipe systems. Seal threaded fittings with Teflon™ tape or Teflon™ paste. Engage threaded fittings in accordance with ASTM A53/A53M.
- D. All flange bolts, nuts, and washers shall be AISI Type 304 stainless steel, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex head nuts unless noted otherwise. Bolts shall be fabricated in accordance with ASME B18.2.1 and shall be provided with washers. Treat all bolts with anti-galling compound before assembly.

2.02 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. Pipe: ASTM D1785, manufactured from Class 12454-B rigid PVC compounds with a hydrostatic design stress of 13.8 MPa (2,000 psi) designated as PVC 1120. Provide Schedule 40 PVC piping and socket welded fittings and Schedule 80 PVC threaded fittings, unless noted otherwise on the Drawings or in the Specifications.
- B. Joints: Solvent-welded unless flanged or threaded joints are indicated on the Drawings or required for connection to equipment. Solvent cement shall be as specified in ASTM D2564 for PVC pipe and ASTM F493 for CPVC pipe.
- C. Fittings:
 - 1. Solvent-welded: ASTM D2466 or D2467, manufactured from Class 12454-B rigid PVC compound; solvent cement conforming to ASTM D2564. Solvent cement shall be as specified in ASTM D2564 for PVC pipe and ASTM F493 for CPVC pipe.

2. Threaded: ASTM D2464 manufactured from Class 12454-B rigid PVC compound; thread tape of Teflon. Only Schedule 80 PVC threaded pipe fittings shall be used.
- D. Flanges: PVC Schedule 80 ANSI Class 150 flanges manufactured from rigid PVC compounds conforming to ASTM D1784.
1. Gaskets: Flat-face elastomer as specified and compatible for pipe system service.
 2. Bolts: AISI Type 304 stainless steel conforming to ASTM A320/A320M, Grade B.
- E. Unions: ASTM D2467 manufactured from Class 12454-B rigid PVC compound with elastomer o-rings as specified and compatible for service. Schedule 40 or 80 to match adjacent piping.

2.03 CHLORINATED POLYVINYL CHLORIDE PIPE (CPVC) AND FITTINGS:

- A. Pipe: ASTM F441/F441M Schedule 80 manufactured from Class 23447-B Rigid CPVC Compounds with a hydrostatic design stress of 13.8 MPA (2,000 psi) designated as CPVC 1120.
- B. Joints: All CPVC piping joints shall be Socket-Type unless otherwise indicated on the Drawings. Piping shall be solvent welded, threaded, or flanged only.
- C. Socket Type Fittings: ASTM F439 manufactured from Class 23447-B Rigid CPVC Compound.

2.04 GALVANIZED STEEL PIPE

- A. Pipe: Steel piping shall conform to the requirements of ASTM A53/A53M, Type S, Grade B, and ASME B36.10M, Schedule 40 as indicated on the Contract Drawings.
- B. Fittings: Forged steel conforming to ASTM A105/A105M and ASME B16.11, Class 2000.
- C. Joints: Threaded conforming to ASME B1.20.1.
- D. Galvanizing: Conform to ASTM A90/A90M.

2.05 STAINLESS STEEL PIPE

- A. Stainless Steel Pipe—Threaded Joints: Conforming to ASTM A312/A312M, Grade TP 304 and 316, and ASME B36.19M, Schedule 40S.
 - 1. Fittings: Conforming to ASTM A182/A182M, Grade F 304 and 316, and ASME B16.11 Class 2000, or Class 3000 where indicated on the Drawings or in the Specifications.
 - 2. Threaded Joints: Conforming to ASME B1.20.1.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. The Contractor shall lay and maintain all pipes straight and true to line in conformance with the lines, grades, and elevations indicated on the Drawings. Line and grade tolerances, where applicable, shall be in accordance with limits given for specific material.
- B. Trenching, bedding, and backfill shall be in accordance with Section 02305, Earthwork for Utilities, and shall be installed in accordance with Section 15055, Piping Systems—General.
- C. During laying operations, the Contractor shall not permit debris, tools, clothing, or similar items to be placed inside pipes. Pipe interior shall be free of mud and kept clean at all times. The Contractor shall secure the open ends of all piping at the end of construction each work day or any portion of a work day to prevent the intrusion of debris, precipitation, or soil from erosion. The proposed method of securing pipe open ends shall be approved by the Engineer. If the Contractor fails to secure piping or if the secured end is dislodged, the Engineer shall require the Contractor to flush all affected piping to remove accumulated debris and verify that the piping is free of debris using a method acceptable to the Engineer, at no additional cost to the Owner.
- D. Pipe ends shall be kept clear and clean and the Contractor shall ensure that inside surfaces are maintained smooth and free from any projections that may interfere with joint assembly or flow through the completed line.
- E. The Contractor shall be careful when lowering pipe into trenches or on subgrade to prevent damage or twisting of the pipe. After laying and before completing backfill or cover operations, pipe shall be protected from any vehicular traffic.
- F. Existing piping flanged joints that are disassembled by the Contractor shall be fitted with new gaskets, as specified, upon reassembly.

3.02 PRESSURE AND LEAKAGE TESTS

A. Pressure Testing

1. The Contractor shall pressure test and leak test all new PVC, stainless steel, CPVC, and galvanized steel piping shown on the Drawings, the Flow Stream Identification Drawing, and Section 15055, Piping Systems—General, and Section 15144, Pressure Testing of Piping.

END OF SECTION

SECTION 15276 STAINLESS STEEL PIPE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes materials and installation of stainless steel pipe and fittings 30 inches in diameter and smaller conforming to ASTM A312/A312M and having a maximum design pressure of 200 psi.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Submit materials list showing material of pipe and fittings with ASTM reference and grade. Submit manufacturer's certification of compliance with referenced standards, e.g., ASTM A53/A53M, A135/A135M, A587, AWWA C200. Show piping service (fuel oil, gasoline, water, air, etc.).
- B. For piping 6 inches and larger, submit piping layout drawings showing locations and dimensions of pipe and fittings. Include laying lengths of valves, meters, in-line pumps, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe and provide the following information for each item:
 - 1. Material of construction, with ASTM or API reference and grade.
 - 2. Wall thickness of steel cylinder.
 - 3. Manufacturer's certificates of compliance with referenced pipe standards, e.g., ASTM A53/A53M, ASTM A135/A135M, API SPEC 5L, AWWA C200.
 - 4. Show weld sizes and dimensions of grooved-end collars, flanges, reinforcing collars, wrapper plates, and crotch plates.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of

this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM A53/A53M—Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A105/A105M—Standard Specification for Carbon Steel Forgings for Piping Applications.
3. ASTM A125—Standard Specification for Steel Springs, Helical, Heat-Treated.
4. ASTM A135/A135M—Standard Specification for Electric-Resistance-Welded Steel Pipe.
5. ASTM A181/A181M—Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
6. ASTM A182/A182M—Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
7. ASTM A193/A193M—Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
8. ASTM A312/A312M—Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
9. ASTM A351—Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
10. ASTM A380/A380M—Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
11. ASTM A403/A403M—Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
12. ASTM A530/A530M—Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
13. ASTM A587—Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
14. ASTM A743/A743M—Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
15. ASTM A774/A774M—Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
16. ASTM D2000—Standard Classification System for Rubber Products in Automotive Applications.
17. ASTM F2015—Standard Specification for Lap Joint Flange Pipe End Applications.

B. American Petroleum Institute (API)

1. API SPEC 5L—Specification for Line Pipe.

C. American Society of Mechanical Engineers (ASME)

1. ASME B1.20.1—Pipe Threads, General Purpose (Inch).
2. ASME B16.1—Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
3. ASME B16.5—Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
4. ASME B16.9—Factory-Made Wrought Buttwelding Fittings.
5. ASME B16.11—Forged Fittings, Socket-Welding and Threaded.
6. ASME B16.25—Buttwelding Ends.
7. ASME B31.3—Process Piping.
8. ASME B36.19M—Stainless Steel Pipe.
9. ASME BPVC—ASME Boiler and Pressure Vessel Code.

D. American Welding Society (AWS)

1. AWS A5.4/A5.4M—Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding.
2. AWS A5.9/A5.9M—Welding Consumables – Wire Electrodes, Strip Electrodes, Wire, and Rods for Arc Welding of Stainless and Heat Resisting Steels – Classification.

E. American Water Works Association (AWWA)

1. AWWA C200—Steel Water Pipe – 6-Inch (150 mm) and Larger.
2. AWWA C220—Stainless Steel Pipe 1/2 Inch (13 mm) and Larger.
3. AWWA C606—Grooved and Shouldered Joints.
4. AWWA M11—Steel Pipe: A Guide for Design and Installation.

F. Manufacturers Standard Society (MSS)

1. MSS SP-83—Class 3000 and 6000 Pipe Unions, Socket Welding and Threaded (Carbon Steel, Alloy Steel, Stainless Steels, and Nickel Alloys).
2. MSS SP-97—Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends.

PART 2 PRODUCTS

2.01 PIPE

- A. Pipe smaller than 3 inches shall conform to ASTM A312/A312M, Grade TP 304L. Pipe 3 inches and larger shall conform to ASTM A312/A312M, Grade TP 304L.
- B. Pipe sizes and wall thicknesses shall conform to ASME B36.19 as follows:

Pipe Size	Wall Thickness
1 inch and smaller	Schedule 80S
1-1/4 inches through 3 inches	Schedule 80S
3-1/2 inches through 8 inches	Schedule 40S

2.02 FITTINGS

- A. Fittings 3 inches and smaller shall be socket welded, conforming to ASME B16.11, 3,000-pound CWP. Material for socket-welded fittings shall conform to ASTM A403/A403M, Class WP 304L or ASTM A182/A182M, Grade F304L.
- B. Fittings for buried or submerged pipe larger than 3 inches through 24 inches shall be butt-welded, conforming to ASTM A403/A403M, Class WP or ASTM A774/A774M, the same material and wall thickness as the pipe, conforming to ASME B16.9. Elbows shall be long radius.
- C. Fittings for aboveground or exposed pipe larger than 3 inches through 24 inches shall be butt-welded or flanged, conforming to ASTM A403/A403M, Class WP or ASTM A774/A774M, the same material and wall thickness as the pipe, conforming to ASME B16.9. Elbows shall be long radius.

2.03 PREPARATION AND FINAL CLEANING

- A. Pipe and fittings shall be final cleaned, pickled, and passivated in accordance with ASTM A380/A380M. Passivation shall be the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of the stainless steel by a chemical dissolution, a treatment with an acid solution that will completely remove the surface contamination but will not significantly affect the stainless steel itself. After final cleaning, wet surfaces with water and inspect for rust spots after 24 hours. Reclean if there is any evidence of rusting.

2.04 QUALITY CONTROL

- A. Include the "Hydrostatic Test" and "Flattening Test" requirements described in ASTM A530/A530M.

2.05 PROTECTIVE END CAPS

- A. The Contractor shall provide protective end caps on each piece of pipe or fabricated section, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting or ship and store fittings in sealed boxes or containers.

2.06 UNIONS

- A. Unions shall be 3,000-pound WOG-forged stainless steel, with dimensions conforming to MSS SP-83. Ends shall be socket-welded type. Material shall conform to ASTM A182/A182M, Grade F304L for socket-welded type.

2.07 JOINTS

- A. Joints for pipes 3 inches and smaller shall be socket welded, the same material as specified for fittings, 3,000-pound WOG, conforming to ASME B16.11.
- B. Joints for buried or submerged pipe larger than 3 inches shall be butt-welded.
- C. Joints for aboveground or exposed pipe larger than 3 inches shall be grooved end or flanged or butt-welded. Grooved-end joints for piping 24 inches and smaller shall be of the roll-grooved type.
- D. Provide plain-end pipe where flexible pipe couplings are to be provided. Provide lugs for thrust harnesses where shown in the Drawings, as specified in Section 15125, Piping Appurtenances.
- E. Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

2.08 OUTLETS AND NOZZLES

- A. Outlets of 3 inches and smaller in piping 4 inches and larger shall be of the Thredolet type, in accordance with MSS SP-97 and AWWA M11. Outlets shall be 3,000-pound WOG stainless steel in accordance with ASTM A182/A182M, Grade F304L F316L or ASTM A403/A403M, Grade WP304L WP316L. Threads shall comply with ASME B1.20.1. Outlets shall be Bonney Forge Co. "Thredolet," Allied Piping Products Co. "Branchlet," or equal.

- B. Alternatively, threaded openings not less than 2 inches or more than 3 inches in nominal size shall be a flat-bottom half-coupling conforming to ASME B16.11, Class 3000. Where the mounting surface is curved to a diameter of 36 inches or less, the mounting diameter shall be the same as that of the surface upon which it is to be mounted. Forge the threaded outlet and its plug from steel conforming to ASTM A105/A105M or ASTM A181/A181M, Class 70.
- C. For outlets 3 inches and smaller in piping smaller than 4 inches, use a tee with a threaded outlet.
- D. For outlets larger than 3 inches, use a tee with a flanged outlet.

2.09 GROOVED-END COUPLINGS

- A. Grooved-end couplings for piping 24 inches and smaller shall be Type 316 stainless steel. Couplings shall be flexible type, square-cut grooved, per AWWA C606. Couplings shall be Victaulic Style 77-S, Gustin-Bacon Figure 100, or equal.
- B. Gaskets shall be CPDM and shall conform to ASTM D2000.
- C. Bolts in exposed service shall conform to ASTM A193/A193M, Grade B8M, Class 2. Bolts in buried or submerged service shall be ASTM A193/A193M, Grade B8M, Class 2.
- D. Couplings for connecting to grooved-end valves shall be Victaulic Style 75 to match the valve ends.
- E. Grooved-end adapter flanges for pipe 18 inches and smaller having a maximum test pressure of 200 psi shall comply with ASME B16.1, Class 125 dimensions. Flanges shall be Victaulic Style 741 or 742, Gustin-Bacon Figure 154, or equal.

2.10 THREAD LUBRICANT

- A. Use Teflon thread lubricating compound or Teflon tape.

2.11 FLANGES

- A. The Contractor shall provide weld-neck flanges (conforming to ASME B16.5) for piping 3 inches and smaller to connect to flanged valves, fittings, or equipment. Provide weld-neck or Van Stone flanges (in accordance with ASTM F2015) for piping larger than 3 inches. Flanges shall be Class 150 in accordance with

ASME B16.5. Flanges shall match the connecting flanges on the adjacent fitting, valve, or piece of equipment. Flanges shall be flat face.

- B. Material for weld-neck flanges shall conform to ASTM A182/A182M, Grade F304L.
- C. Material for Van Stone flanges shall be stainless steel conforming to ASTM A351, Grade CF8M.

2.12 BOLTS AND NUTS FOR FLANGES

- A. See Section 15055, Piping Systems—General.

2.13 LUBRICANT FOR STAINLESS STEEL BOLTS AND NUTS

- A. See Section 15055, Piping Systems—General.

2.14 GASKETS FOR FLANGES

- A. See Section 15055, Piping Systems—General.

2.15 WYE STRAINERS

- A. Strainers 2 inches and smaller shall be stainless steel, wye pattern, with minimum pressure rating of 300-psi WOG. Material shall conform to ASTM A351 or A743/A743M, Grade CF8M. Screen shall be 20 mesh and the same material as the strainer. Provide pet cock of the same material as the strainer body in the blowoff connection. Ends shall be threaded conforming to ASME B1.20.1. Provide one spare screen for each strainer. Strainers shall be Sarco Type 316, Muessco No. 861, or equal.

PART 3 EXECUTION

3.01 FABRICATION, ASSEMBLY, AND ERECTION

- A. Beveled ends for butt-welding shall conform to ASME B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding. When welding the reverse side, chip out slag before welding.
- B. Fabrication shall comply with ASME B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of the ASME BPVC.

- C. The minimum number of passes for welded joints shall be as follows:

Steel Cylinder Thickness (inch)	Minimum Number of Passes for Welds
Less than 0.1875	1
0.1875 through 0.25	2
Greater than 0.25	3

Welds shall be full penetration.

- D. Use the shielded metal arc welding (SMAW) submerged arc welding (SAW), flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process for shop welding. Use the SMAW process for field welding.
- E. Welding preparation shall comply with ASME B31.3, Paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ASME B31.3, Table 341.3.2, and Paragraph 341.4 for visual examination.
- F. Identify welds in accordance with ASME B31.3, Paragraph 328.5.
- G. Clean each layer of deposited weld metal before depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.
- H. Use an inert or shielding gas welding method. Do not use oxygen fuel welding. The interior of the pipe shall be purged with inert gas before the root pass.
- I. Welded butt joints (both longitudinal and circumferential) shall comply with AWWA C220, Section 4. Do not use backing rings. Provide full penetration and smooth internal diameters for the root bead of welds. Grind the inside weld of socket welds flush with the pipe internal diameter. Welds shall be of smooth finish. Use anti-spatter compounds specifically formulated or designed for use with stainless steel. Do not allow heat tint to form in the heat-affected zone or remove heat tint completely from the heat-affected zone of the finished weld. The maximum depth of grinding or abrasive blasting to remove defects shall not exceed 10% of the wall thickness. Do not perform abrasive blasting with steel shot, grit, or sand.
- J. No iron or steel surfaces shall come into contact with the stainless steel. This includes placing the stainless steel on steel tables, racks, pipe supports, etc. Do not use carbon steel wire brushes or grinders.

- K. Welding electrodes shall comply with AWS A5.4/A5.4M. Bare wire shall comply with AWS A5.9/A5.9M. Use electrodes as follows:

Pipe Material	Welding Electrode Material
Type 304	E 308
Type 304L	E 347
Type 316	E 316
Type 316L	E 318

3.02 SHOP TESTING OF FABRICATED OR WELDED COMPONENTS

- A. After completion of fabrication and welding in the shop and before the application of any lining or coating, test each component according to the referenced standards. Test fabricated fittings as specified in AWWA C200. Test the seams in fittings which have not been previously shop hydrostatically tested by the dye penetrant method as described in ASME BPVC Section VIII, Appendix B. In lieu of the dye penetrant method of testing, completed fittings may be hydrostatically tested. Use the field hydrostatic test pressure or 125% of the design pressure, whichever is higher.

3.03 INSTALLING THREADED PIPING

- A. Ream, clean, and remove burrs from threaded piping before making up joints. Apply thread lubricant to threaded ends before installing fittings, couplings, unions, or joints.

3.04 INSTALLING FLANGED PIPING

- A. See Section 15055, Piping Systems—General.

3.05 INSTALLATION OF STAINLESS STEEL BOLTS AND NUTS

- A. See Section 15055, Piping Systems—General.

3.06 INSTALLING GROOVED-END PIPING

- A. See Section 15055, Piping Systems—General.

3.07 INSTALLING UNIONS

- A. Provide unions on exposed piping 3 inches and smaller as follows:
1. At every change in direction (horizontal and vertical).
 2. Six to 12 inches downstream of valves.

3. Every 40 feet in straight piping runs.
4. Where shown in the Drawings.

3.08 INSTALLING ABOVEGROUND OR EXPOSED PIPING

- A. See Sections 15055, Piping Systems—General.

3.09 INSTALLING BURIED PIPING

- A. Install in accordance with Sections 02305, Earthwork for Utilities, and as follows.
- B. When installing pipe in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.

3.10 INSTALLING SUBMERGED PIPING

- A. Install pipe on the alignment shown in the Drawings.
- B. Do not add water into the basins while the pipe is empty.

3.11 FIELD HYDROSTATIC TESTING

- A. The Contractor shall hydrostatically test pipe and fittings in the field in accordance with Section 15144, Pressure Testing of Piping. See Piping Schedule for test pressures.
- B. Do not allow test water to remain in the pipe for more than 5 days. Drain and dry the piping after completing the testing.

3.12 PAINTING AND COATING

- A. Coat exposed carbon steel grooved-end couplings and Van Stone flanges in accordance with Section 09900, Painting and Coating, System No. 7.
- B. Coat submerged carbon steel grooved-end couplings and Van Stone flanges with System No. 7 as specified in Section 09900, Painting and Coating.
- C. Coat buried carbon steel grooved-end couplings and Van Stone flanges with System No. 24 in accordance with Section 09900, Painting and Coating.
- D. Do not coat stainless steel grooved-end couplings and Van Stone flanges.
- E. Do not coat buried stainless steel piping.

3.13 COATING BURIED AND SUBMERGED BOLTS, NUTS, AND TIE RODS

- A. See Section 15055, Piping Systems—General.

END OF SECTION

SECTION 15285
VYLON PVC DRAINAGE PIPING AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, equipment, and materials required to supply, install, and test (PVC) drainage piping and fittings, including accessories, as shown on the Drawings and/or specified in this Section. The PVC drainage pipe shall be closed-profile pipe manufactured by Lamson Vylon Pipe, or engineer-approved equal.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance, and Section 15055, Piping Systems—General:

- A. In general, shop drawings and related manufacturer's product certification shall be made in accordance with the General and Special Conditions of the Contract for approval before the manufacturer constructs or fabricates the material.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM D1734—Standard Practice for Making Cementitious Panels for Testing Coatings.
 - 2. ASTM D1784—Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - 3. ASTM D2321—Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 4. ASTM D3034—Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fitting.
 - 5. ASTM D3212—Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

6. ASTM F477—Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
7. ASTM F679—Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
8. ASTM F1417—Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air.
9. ASTM F1803—Standard Specification for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.

1.04 QUALITY ASSURANCE

- A. The Contractor shall submit to the Engineer written evidence that the pipe furnished under this Specification is in conformance with the material and mechanical requirements specified in this Section. Certified copies of independent laboratory test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM testing standards by experienced, competent personnel.
- B. Each PVC closed profile wall pipe length and fitting shall be clearly marked with the following:
 1. Manufacturer's Name.
 2. Nominal Pipe Size.
 3. Cell Classification.
 4. ASTM F1803 Designation.
 5. Pipe Stiffness – 46 PSI.
- C. All pipes shall be factory air tested with gasket in place and marked accordingly.

1.05 DELIVERY, HANDLING, AND STORAGE

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.
- B. The Contractor shall handle and store pipe in accordance with the manufacturer's written instructions.

PART 2 PRODUCTS

2.01 GENERAL

- A. Apart from structural voids and hollows associated with profile wall designs, the pipe and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions, and other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties.
- B. Pipe cover shall be as shown on the Drawings. Unless otherwise shown on the Drawings, the maximum depth of cover, measured from the pipe crown to the ground surface, permitted for all 21-inch to 54-inch sizes of Vylon® Pipe PS-46 will be 50 feet with standard bedding.
- C. All pipe, joints, fittings, and adapters shall be designed to withstand the forces imposed on the pipe by the soil cover and an AASHTO H-20 load.

2.02 PIPE

- A. PVC profile wall pipe and fittings shall be manufactured in accordance with the requirements of ASTM F1803, latest edition.
- B. PVC profile wall pipe shall be made from a compound meeting the requirements of cell classification 12364A as defined by ASTM D1784.

2.03 JOINTS

- A. PVC profile wall pipe joints shall be the bell-and-spigot type with elastomeric seals and conform to the requirements of ASTM D3212.
- B. Gaskets shall meet the requirements of ASTM F477 and be molded into a circular form or extruded to the proper section, and then spliced into circular form. Gaskets shall be made of a properly cured high-grade elastomeric compound.
- C. Gaskets shall be factory installed and chemically bonded to the bell end of the pipe. Field-installed gaskets and field-cut beveled lengths of pipe shall be done in accordance with the manufacturer's instructions and recommended equipment and materials.
- D. The Contractor shall thoroughly clean and lubricate all pipe gaskets and spigots before assembly.

2.04 FITTINGS

- A. All fittings shall be fabricated from pipe meeting the requirements of the standards above. Fabricated miter joints shall be reinforced by fusion heat welding.

2.05 D.I./PVC MECHANICAL JOINT ADAPTORS

- A. The manufacturer of the PVC profile wall pipe shall supply all D.I./PVC mechanical joint adaptors and accessories required to perform the work as shown on the Drawings.
- B. Joint restraints shall be provided to keep the connecting pieces from pulling apart.

2.06 LOCATOR WIRE

- A. All PVC profile wall piping shall be installed with two insulated 12-gauge minimum AWG solid strand copper wires for location purposes as specified in Section 15055, Piping Systems—General.

PART 3 EXECUTION

3.01 GENERAL

- A. Installation shall be in accordance with the recommendations contained in this Section and in the pipe manufacturer's installation guide. All applicable safety regulations shall be followed.

3.02 INSTALLATION REQUIREMENTS

- A. All pipes shall be laid and maintained straight and true to line in conformance with the lines, grades, and elevations indicated on the Drawings. Line and grade tolerances, where applicable, shall be in accordance with limits given for specific material.
- B. Trenching, bedding, and backfill shall be in accordance with Section 02305, Earthwork for Utilities, and shall be installed in accordance with Section 15055, Piping Systems—General.
- C. During laying operations, the Contractor shall not permit debris, tools, clothing, or similar items to be placed in pipes. Pipe interior shall be free of mud and kept clean at all times. The Contractor shall secure the open ends of all piping at the end of construction each work day or any portion of a work day to prevent the intrusion of debris, precipitation, or soil from erosion.

- D. Pipe ends shall be kept clear and clean and the Contractor shall ensure that inside surfaces are maintained smooth and free from any projections that may interfere with joint assembly or flow through the completed line.

3.03 INSPECTION AND TESTING

- A. After any section of pipe is completed, the grades, joints, and alignment shall be true to line and grade. There shall be no visual leakage and the sewer shall be completely free from any cracks and from protruding joint materials, and deposits of sand, mortar, or other materials on the inside to the satisfaction of the Engineer.
- B. The Contractor shall conduct air tests for leakage as determined by the Engineer. Testing shall be conducted in accordance with all applicable safety standards.
- C. Air Test: Each section of sewer between two or more manholes shall be tested in accordance with ASTM F1417.

If any test fails to meet the established requirements, the Contractor shall determine the cause and correct if necessary.

- D. At the Engineer's request the Contractor shall perform a deflection test. The deflection can be measured mechanically by a mandrel or manually using an extension ruler. The final deflection test shall not be made on a section of sewer until all the backfill on that section has been in place for 30 days.

The minimum acceptable diameter shall be as follows:

Pipe Size (in)	Minimum Acceptable Diameter (in.)	
	5% Test	7 ½% Test
21	19.11	18.61
24	21.65	21.08
27	24.41	23.77
30	27.18	26.46
36	32.71	31.85
42	38.23	37.22
48	43.61	42.47
54	48.98	47.69

All excess deflections shall be corrected. The Contractor shall correct the deficiency and retest the pipe.

3.04 CLEANUP

- A. After completing each section of the sewer line, the Contractor shall remove all debris, construction materials, and equipment from the site of the work; grade and smooth over the surface on both sides of the line; and leave the entire right of way in a clean, neat, and serviceable condition.

END OF SECTION

SECTION 15290
PVC PIPE, 3 INCHES AND SMALLER

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes materials, installation, and testing of PVC pipe and fittings of size 3 inches and smaller for use in process piping having a maximum design pressure of 150 psi and having a maximum design temperature of 105°F.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. The Contractor shall do the following:
 - 1. Submit materials list showing materials of pipe and fittings with ASTM reference and grade. Submit manufacturer's certification of compliance with referenced standards, e.g., ASTM D1784, D1785, and D2467. Show wall thickness of pipe and fittings. Show fitting dimensions.
 - 2. Submit data sheets for solvent cement and demonstrating compliance with ASTM D2564 and F656.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM D1784—Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 2. ASTM D1785—Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - 3. ASTM D2464—Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - 4. ASTM D2467—Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

5. ASTM D2564—Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 6. ASTM D2774—Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
 7. ASTM D2855—Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
 8. ASTM F656—Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- B. American Society of Mechanical Engineers (ASME)
1. ASME B1.20.01—Pipe Threads, General Purpose (Inch).
 2. ASME B16.5—Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
- C. NSF International (NSF)
1. NSF 61—Drinking Water System Components – Health Effects.

PART 2 PRODUCTS

2.01 PIPE

- A. Pipe shall be Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D1784 and D1785.

2.02 FITTINGS

- A. Fittings shall be Schedule 80 and shall conform to ASTM D2464 for threaded fittings and ASTM D2467 for socket-type fittings.

2.03 FLANGES

- A. PVC flanges shall be of the one-piece solid socket design and shall be made of the same material as the pipe. Pressure rating shall be at least 150 psi at a temperature of 73°F. Minimum burst pressure shall be 500 psi. Flanges shall match the dimensions of ASME B16.5, Class 150, steel flanges for outside diameter, bolt circle, and bolt holes. Do not use Van Stone flanges.

2.04 UNIONS

- A. Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, per ASTM D1784.

2.05 JOINTS

- A. Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to valves and equipment.

2.06 SOLVENT CEMENT IN OTHER THAN CHEMICAL AND CHEMICAL CARRIER WATER SERVICE

- A. Solvent cement for socket joints shall comply with ASTM D2564 and ASTM F656.

2.07 SOLVENT CEMENT IN CHEMICAL AND CHEMICAL CARRIER WATER SERVICE

- A. Solvent cement shall be free of silica. Products: IPS “Weld-On 724” or Oatey “Lo V.O.C. PVC Heavy Duty Gray.”

2.08 GASKETS FOR FLANGES

- A. See Section 15055, Piping Systems—General.

2.09 BOLTS AND NUTS FOR FLANGES

- A. See Section 15055, Piping Systems—General.

2.10 LUBRICANT FOR STAINLESS STEEL BOLTS AND NUTS

- A. See Section 15055, Piping Systems—General.

2.11 WYE STRAINERS

- A. PVC wye strainers shall be manufactured of the same material as the pipe, with 30-mesh screens and Viton seals. Connecting ends shall be the socket type, solvent welded. Provide one spare screen for each strainer.

PART 3 EXECUTION

3.01 GENERAL

The Contractor shall adhere to the following:

- A. Do not install PVC pipe when the temperature is below 40°F or above 90°F. Store loose pipes on racks with a maximum support spacing of 3 feet. Provide shade for pipe stored outdoors or installed outdoors until the pipe is filled with water.
- B. Store fittings indoors in their original cartons.
- C. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements that have exceeded the shelf life marked on the storage container.
- D. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section of pipe.
- E. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it.

3.02 SOLVENT-WELDED JOINTS

- A. Before solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least 1 hour.
- B. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent-welded pipe ends as recommended by the pipe manufacturer.
- C. Wipe away loose dirt and moisture from the inside and outside of the pipe end and the inside of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.
- D. The pipe and fitting socket shall have an interference fit. The diametrical clearance between pipe and entrance of the fitting socket shall not exceed 0.04 inch. Check the fit at every joint before applying solvent cement.
- E. Make up solvent-welded joints in accordance with ASTM D2855. Application of cement to both surfaces to be joined and assembly of these surfaces shall produce

a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire circumference.

- F. Allow at least 8 hours of drying time before moving solvent-welded joints or subjecting the joints to any internal or external loads or pressures.
- G. Acceptance criteria for solvent-welded joints shall be as follows:
 - 1. Unfilled Areas in Joint: None permitted.
 - 2. Unbonded Areas in Joint: None permitted.
 - 3. Protrusion of Material into Pipe Bore, Percent of Pipe Wall Thickness: Cement, 50%.

3.03 FLANGED JOINTS

- A. Lubricate carbon steel bolt threads with graphite and oil before installation.
- B. Tighten bolts on PVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be as shown in the following table:

Pipe Size (inches)	Final Torque (foot-pounds)
1/2 to 1-1/2	10 to 15
2 to 3	20 to 30

3.04 INSTALLATION OF STAINLESS STEEL BOLTS AND NUTS

- A. See Section 15055, Piping Systems—General.

3.05 THREADED JOINTS

- A. Cut threaded ends on PVC to the dimensions of ASME B1.20.1. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe hold-down methods, saw cutting blade size, and saw cutting speed.
- B. Pipe or tubing cutters shall be specifically designed for use on PVC pipe. Use cutters manufactured by Reed Manufacturing Company, Ridge Tool Company, or equal.
- C. If a hold-down vise is used when the pipe is cut, insert a rubber sheet between the vise jaws and the pipe to avoid scratching the pipe.

- D. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.
- E. Apply Teflon® thread compound or Teflon® tape lubricant to threads before screwing on the fitting.

3.06 INSTALLING UNIONS

- A. Provide unions on exposed (above grade and in vaults) piping 3 inches and smaller as follows:
 - 1. At every change in direction (horizontal and vertical).
 - 2. Six to 12 inches downstream of valves.
 - 3. Every 40 feet in straight pipe runs.
 - 4. Where shown on the Drawings.

3.07 INSTALLING BURIED PIPE

- A. Install in accordance with Section 02305, Earthwork for Utilities, and as follows.
- B. Trench bottom shall be continuous, smooth, and free of rocks. See the details on the Drawings for trench dimensions, pipe bedding, and backfill.
- C. After the pipe has been solvent-welded and the joints have set, snake the pipe in the trench according to the pipe manufacturer's recommendations to allow for thermal expansion and contraction of the pipe.
- D. Do not backfill the pipe trench until the solvent-welded joints have set. Support the pipe uniformly and continuously over its entire length on firm, stable soil. Do not use blocking to change pipe grade or to support pipe in the trench.
- E. Install buried PVC pipe in accordance with ASTM D2774 and the pipe manufacturer's recommendations. Backfill materials in the pipe zone shall be imported sand as specified in Section 02305, Earthwork for Utilities. If water flooding is used, do not add successive layers unless the previous layer is compacted to 90% relative compaction.

3.08 INSTALLING ABOVEGROUND OR EXPOSED PIPING

- A. See Section 15055, Piping Systems—General.
- B. Fill empty piping with water, provide temporary shading, or use other means to keep the surface temperature of the pipe below 100°F.

3.09 PAINTING AND COATING

- A. Coat piping that is exposed to sunlight as specified Section 09900, Painting and Coating, System No. 41 or 42.

3.10 PIPE LABELS AND COLOR CODING

- A. Label and color code exposed piping and piping inside concrete pipe trenches with flow stream identification labels and banding in accordance with Section 15075, Process Equipment, Piping, and Valve Identification, and the Piping Schedule on the Drawings.

3.11 HYDROSTATIC TESTING

- A. Perform hydrostatic testing for leakage in accordance with Section 15144, Pressure Testing of Piping.

END OF SECTION

SECTION 15291
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the work necessary to furnish, install, and complete the AWWA C900 DR 18 PVC pipe and ductile iron fittings specified.

1.02 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. All PVC pipe and fittings to be installed under this Contract shall be inspected and tested at the location where the material for this project is manufactured. The Contractor shall submit certificates of such tests and their results.
- B. The Contractor shall submit the pipe manufacturer's certification of compliance with the applicable sections of the Specifications.

1.03 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society of Testing Materials (ASTM)
 - 1. ASTM A242/A242M—Standard Specification for High-Strength Low-Alloy Structural Steel.
 - 2. ASTM A536—Standard Specification for Ductile Iron Castings.
 - 3. ASTM D2241—Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - 4. ASTM F477—Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- B. American Water Works Association (AWWA)
 - 1. AWWA C900—Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-Inch Through 60-Inch (100 mm Through 1,500 mm).

PART 2 PRODUCTS

2.01 LARGE PVC PRESSURE PIPE

A. Large PVC Pressure Piping

1. Unless otherwise noted, PVC pressure pipe for nominal diameters 4 inches and larger shall conform to the requirements of AWWA C900 DR 18 up to 12 inches and with gasketed integral bell ends. Pipe shall be designed for maximum working pressure of not less than 150 psi. Pipe shall be made to ductile iron pipe ODs instead of IPS.

B. Bell and Spigot

1. Pipe joints shall be made with integral bell and spigot pipe ends. The bell shall consist of an integral thickened wall section designed to be at least as strong as the pipe wall. The bell shall be supplied with a factory glued rubber ring gasket that conforms to the manufacturer's standard dimensions and tolerances. The gasket shall meet the requirements of ASTM F477 "Elastomeric Seals (Gaskets) for Joining Plastic Pipe." PVC joints shall be "Ring-Tite" as manufactured by J-M Manufacturing Company, Inc. or an equal approved by the Engineer. Nontoxic gasket lubricant shall be as specified by the pipe manufacturer.

C. Restrained Joints

1. The following pipe joints and fittings restraint methods can be used to prevent pipe joints and fittings from separating under pressure. No additional financial compensation will be provided to the Contractor for providing the following methods of restraint:
 - a. C-900 PVC pipe bell and spigot joints (4-inch- through 12-inch-diameter pipe) shall be restrained with the EBAA Iron MEGALUG® Series 1600 Restrainer or an equal approved by the Engineer. The Series 1600 restrainers shall provide a minimum of 150-psi restraint to DR 18 (Class 150) pipe with a 3 to 1 safety factor. C-905 PVC pipe bell and spigot shall be restrained with the EBAA Iron MEGALUG® Series 2800 Restrainer or an equal approved by the Engineer. The Series 2800 restrainers shall provide a minimum of 200 psi restraint to DR 18 (Class 235) pipe with a 2-to-1 safety factor. The restraining device and tee head bolts shall be manufactured of high-strength ductile iron meeting ASTM A536, Grade 65-42-10. Clamping bolts and nuts shall be

- manufactured of corrosion-resistant, high-strength, low-alloy CORTEN steel meeting the requirements of ASTM A242/A242M.
- b. Mechanical joint fittings used with PVC pipe (3-inch- through 36-inch-diameter DR 18 pipe) shall be restrained with the EBAA Iron MEGALUG® Series 2000 PV Restrainer or an equal approved by the Engineer. The Series 2000 PV restrainers shall provide a minimum of 150-psi restraint with a 2 to 1 safety factor. The restraining device and Tee head bolts shall be manufactured of high-strength ductile iron meeting ASTM A536, Grade 65-42-10. Clamping bolts and nuts shall be manufactured of corrosion-resistant, high-strength, low-alloy CORTEN steel meeting the requirements of ASTM A242/A242M.
 - c. All parts of the joint restraint systems shall be coated with coal tar epoxy as in Section 09900, Painting and Coating, Mega-Bond coating system by EBAA Iron, Inc. or Engineer-approved equal.

2.02 LARGE PVC PRESSURE PIPE FITTINGS

- A. Fittings for use with large PVC pipe shall be ductile-iron fittings conforming to the requirements of mechanical joint fittings as specified in Section 15155, Ductile Iron Pipe and Fittings.
- B. Exterior Coating
 - 1. Exterior coating for fittings shall be as specified in Section 15155, Ductile Iron Pipe and Fittings.
- C. Lining
 - 1. Lining for fittings shall be as specified in Section 15155, Ductile Iron Pipe and Fittings.
 - 2. Any damaged lined areas shall be repaired in accordance with the manufacturer's recommendations so that the repaired area is equal to the undamaged lined areas.

2.03 SMALL PVC PRESSURE PIPE

- A. See Section 15250, Small-Diameter Piping, for Schedule 40 and Schedule 80 PVC pipe.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The Contractor shall examine pipe and appurtenances shall be examined at the point of delivery. Material found to be defective due to manufacture or damage in shipment shall be rejected. Tests as specified in the applicable material standard may be performed to ensure conformance with the standard.

3.02 PIPE INSTALLATION

- A. Proper implements, tools, and facilities shall be provided and used for the safe and convenient performance of the work. All pipe, fittings, and valves shall be lowered carefully into the trench using suitable tools or equipment to prevent damage to pipeline materials. Under no circumstances shall pipeline materials be dropped or dumped into the trench. The trench shall be dewatered before installing the pipe in accordance with the Specifications.
- B. The sealing surface of the pipe, the inside of the bell, and the inside of the gasket shall be cleaned immediately before assembly.
- C. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. During laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe.
- D. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.
- E. At all times when pipe laying is in progress, except when joining another piece of pipe, the open ends of the pipe shall be closed by a watertight plug or other means approved by the Engineer to prevent the entrance of objectionable materials. Care shall be taken to prevent pipe flotation.
- F. Trench width at the top of the pipe, bedding conditions, and backfill placement and compaction shall be in accordance with the Contract Documents.
- G. Joint Assembly
 - 1. Pipe joints shall be assembled in accordance with the manufacturer's instructions.

H. Pipe Deflection

1. When it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane, the amount of deflecting shall not exceed 75% of that recommended by the manufacturer.

I. Pipe Cutting

1. Cutting pipe for the insertion of valves, fittings, or closure pieces shall be done in a neat, workmanlike manner without creating damage to the pipe. Ends shall be cut square and perpendicular to the pipe axis.
2. Burrs shall be removed from spigots, and ends shall be smoothly beveled. Field cut ends shall be marked for proper depth of joint assembly.

J. Thrust Restraint

1. All pipe, tees, valves, bends, etc., unless otherwise specified, shall be restrained using mechanical means as specified. Pipe restraint using the specified mechanical restraining system with the restrained joint schedule or tie-rods is also acceptable. Reaction blocking shall not be used on this project.
2. All ductile iron fittings, valves, mechanical restraint harnesses, and other forms of mechanical restraint shall be installed and wrapped in polyethylene tube material as specified in Section 15155, Ductile Iron Pipe and Fittings.

3.03 LOCATION AND IDENTIFICATION

- A. All non-metallic mains shall be installed with a continuous, insulated 14-gauge copper wire installed directly on top of pipe for location purposes. Detectable tape may be used in lieu of copper wire and shall be placed 1 foot above the top of the pipe.
- B. All PVC mains shall be a dark olive color. All lettering shall appear legibly on pipe and shall run the entire length of the pipe. Lettering shall be appropriate for the intended use.
- C. All DIP mains shall be marked with a continuous stripe located within the top 90° of the pipe and shall be a minimum of 2 inches in width and shall be dark olive in color. Backfill shall not be placed for 30 minutes following paint application.

3.04 TESTING

- A. All lines shall be tested at the pressures listed on the table in the Contract Drawings.
- B. See Section 15144, Pressure Testing of Piping, for the requirements of pipe flushing, cleaning, pressure and leakage testing, and inspection requirements.

END OF SECTION

DIVISION 16
ELECTRICAL

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.

1.02 CODES

- A. The work shall be in conformance with the latest adopted version of the following:
 - 1. Florida Building Code (FBC)
 - 2. National Fire Protection Association (NFPA)
 - a. NFPA 70—National Electric Code.
- B. The installation shall also comply with all applicable rules and regulations of local and state laws and ordinances. Include in the work, without extra cost, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations. Inform the engineer of any work or materials which conflict with any of the applicable codes, standards, laws, and regulations before submitting their bid.

1.03 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 15 for rough-in requirements.

1.04 ELECTRICAL INSTALLATIONS

- A. Existing services shall not be interrupted without prior consent of the Owner's authorized representative and may be interrupted only at, and for, the specific time designated by the owner's authorized representative.

- B. Make a thorough examination of the site and the contract documents. No claim for extra compensation will be recognized if difficulties are encountered which an examination of site conditions and contract documents prior to executing contract would have revealed.
- C. Coordinate electrical equipment and materials installation with other building components.
- D. Verify all dimensions by field measurements.
- E. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- F. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- G. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- H. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
- J. Temporary electrical service and construction lighting shall be provided under this Section. Provide all Temporary electrical equipment as shown on the drawings for the duration of the project. All Temporary electrical equipment and its installation shall not interfere with the operation of the facility and shall not interfere with access to the existing facility's equipment. Provide for all electrical service for construction period, making all connections and removal of same at job conclusion. Furnish and install temporary lighting for construction period. At job completion, all temporary lamps shall be removed and replaced with new lamps; and all temporary electrical equipment shall be disconnected and removed from the project site.
- K. All existing and new conduit/raceways within the project area shall be properly (maximum of 6 feet between supports) supported. Add support to existing conduit as required to comply with the NEC.

- L. All enclosures for new electrical equipment shall be NEMA 4X stainless (316) steel. All enclosures shall have internal mounting plates for components and an interior safety door.
- M. There shall be no penetrations of existing clarifier tank or process basin walls. All conduits shall be run surface mounted or on top of walls. Conduit supports or associated hardware shall NOT penetrate existing clarifier tank walls or process basin walls.

1.05 CUTTING AND PATCHING

- A. Do not endanger or damage installed work through procedures and processes of cutting and patching.
- B. Arrange for repairs required to restore other work because of damage caused as a result of electrical installations.
- C. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.
- D. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - 1. Uncover work to provide for installation of ill-timed work.
 - 2. Remove and replace defective work.
 - 3. Remove and replace work not conforming to requirements of the contract documents.
 - 4. Remove samples of installed work as specified for testing.
 - 5. Install equipment and materials in existing structures.
 - 6. Upon written instructions from the engineer, uncover and restore work to provide for engineer observation of concealed work.
- E. Cut, remove and legally dispose of, selected electrical equipment, components, and materials as indicated; including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new work.
- F. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

- H. Locate, identify, and protect electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When transit services must be interrupted, provide temporary services for the affected areas and notify the owner prior to changeover.

1.06 ELECTRICAL SUBMITTALS

- A. Refer to Section 01330, Submittals and Acceptance, for submittal definitions, requirements, and procedures.
- B. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the contractor. Data submitted from subcontractors and material suppliers directly to the engineer will not be processed.
- C. Submit Operation and Maintenance Manuals with part lists as specified in Section 01830, Operations and Maintenance Manuals; for the following electrical equipment: Panel boards, Control Panels, Variable Frequency Drives, Soft Starters, Motor Starters, Motors, Transformers, and Programmable Logic Controllers.

1.07 PRODUCT LISTING

- A. Prepare listing of major electrical equipment and materials for the project.
- B. When two or more items of the same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.
- C. Provide products which are compatible within systems and other connected items.
- D. No substitution will be considered unless written request has been submitted to the engineer at least 10 days prior to the date for receipt of bids.
- E. If the engineer approves any proposed substitutions, such approval will be set forth in an addendum.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installation.

1.09 RECORD DOCUMENTS

- A. Refer to the Section 01785, Record Documents, for requirements. The following paragraphs supplement the requirements of Division 1, General Requirements.
- B. Mark drawings to indicate revisions to conduit size and location, both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; change orders; concealed control system devices.
- C. Mark Specifications to indicate approved substitutions; change orders; actual equipment and materials used.
- D. Contractor shall provide engineer with record drawings (AutoCAD compatible file format) and one set of blueprints.

1.10 WARRANTIES

- A. Refer to the Section 01780, Warranties and Bonds, for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 16, Electrical, into a separated set of vinyl-covered, three-ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment; date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.11 CLEANING

- A. Refer to Section 01740, Final Cleaning, and Section 01770, Project Closeout, for general requirements for final cleaning.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 16110 RACEWAYS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section making reference to electrical raceways specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of raceway work is indicated by drawings and schedules.
- B. Types of raceways specified in this Section include the following:
 - 1. Heavy Wall Aluminum.
 - 2. PVC Schedule 80.
 - 3. Liquid-tight flexible PVC coated metal conduit.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes require, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.
- C. Codes and Standards:
 - 1. UL Compliance Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL listed and labeled.

PART 2 PRODUCTS

2.01 METAL CONDUIT AND TUBING

- A. General: Provide aluminum conduit, tubing and fittings of types, grades, sizes and weights (wall thickness) for each service indicated.
- B. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements and comply with applicable portions of NEC for raceways.
- C. Rigid aluminum Conduit: Provide rigid aluminum, heavy wall, threaded type.
- D. Liquid-Tight Flexible PVC-Coated Metallic Conduit: Provide liquid-tight flexible PVC-coated metallic conduit for all motor connections.
- E. Conduit Fittings: Couplings and connectors for conduit sizes 2 inches and smaller shall be aluminum hex-nut, expansion-gland type. Aluminum set screw type fittings may be used for conduit sizes 2½ inches and larger.

2.02 NONMETALLIC CONDUIT AND DUCTS

- A. General: Provide nonmetallic conduit, ducts and fittings of types, sizes and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements which comply with provisions for NEC for raceways.
- B. Electrical Plastic Conduit:
 - 1. Heavy Wall Conduit: Schedule 80, 90°C, UL-rated, constructed of Schedule 80, 90 polyvinyl chloride. For direct burial, UL listed and in conformity with NEC Article 347.
 - 2. Standard Wall Conduit: PVC UL rated, constructed of Schedule 40 polyvinyl chloride. For exterior above grade exposure, direct exposure to sunlight, UL listed for direct sunlight and in conformity with NEC Article 352.
- C. Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.
- D. Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Construct

conduit bodies with threaded conduit-entrance ends, removable covers, either cast or galvanized steel and corrosion-resistant screws.

PART 3 EXECUTION

3.01 OBSERVATION

- A. Examine areas and conditions under which raceways are to be installed and substrate which will support raceways. Notify contractor in wiring of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.02 INSTALLATION OF RACEWAYS

- A. General: Raceways run below grade, under floors on grade or in concrete shall be PVC heavy wall type (Schedule 80) conduit, provided rigid aluminum conduit is used on elbows and risers to boxes, cabinets, etc.
- B. Sizes of raceways shall be not less than NEC requirements and shall not in any case be less than indicated on drawings. Larger size raceways and/or pull boxes shall be installed if there is excessive length unbroken run or excessive number of bends. Combining of circuits other than those indicated on the drawings will not be permitted.
- C. Coordinate with other work, including wires/cables, boxes and panel work as necessary to interface installation of electrical raceways and components with other work.
 - 1. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
 - 2. Use roughing-in dimensions of electrically operated unit furnished by supplier. Set conduit and boxes for connection to units only after receiving review of dimensions and after checking location with other trades.
 - 3. Provide nylon pullcord in empty conduits where indicated. Test all empty conduits with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.

4. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:
 - a. Exterior location.
 - b. Moist or humid atmosphere where condensate can be expected to accumulate.
 - c. Corrosive atmosphere.
 - d. Subjected to water spray or dripping oil, water or grease.
- D. Cut conduits straight, ream properly and cut threads for heavy wall conduit deep and clean.
- E. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
- F. Fasten conduit terminations in sheet metal enclosures by two locknuts and terminate with bushing. Install lock nuts inside and outside enclosure.
- G. Conduits are not to cross pipe shafts or ventilating duct openings.
- H. Keep conduits a minimum distance of 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Do not install horizontal raceway runs below water and steam piping.
- I. Support riser conduit at each floor level with clamp hangers.
- J. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split couplings.
- K. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
- L. Concealed Conduits:
 1. Metallic raceways installed underground or in floors below grade, or outside are to have conduit threads painted with corrosion-inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure water tightness.
 2. For floors-on-grade, install conduits under concrete slab.
 3. Install underground conduits a minimum of 24 inches below finished grade.
 4. All conduits installed below grade or under concrete slab to be minimum of 3/4 inch.

M. Conduits in Concrete Slab:

1. Place conduits between bottom reinforcing steel and top reinforcing steel. Place conduits either parallel or at 90° to main reinforcing steel.
2. Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond.
3. Conduits crossing in slab must be reviewed for proper cover by engineer.
4. Embedded conduit diameter is not to exceed one-third of slab thickness.

N. Install conduits as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.

O. Exposed Conduits:

1. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with or at right angles to walls of building.
2. Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.
3. Support exposed conduits by use of hangers, clamps or clips. Support conduits minimum of 18 inches on each side of bends and outlet boxes and on spacing not to exceed 6 feet-0 inches.
4. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
5. Above requirements for exposed conduits also apply to conduits installed in space above hung ceilings and in crawl spaces.

P. Non-Metallic Conduits:

1. Make solvent cemented joints in accordance with recommendations of manufacturer.
2. Install PVC conduits in accordance with NEC and in compliance with local utility practices.

Q. Conduit Fittings:

1. Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal and ridged outside circumference for proper fastening.
2. Bushings for terminating conduits smaller than 1 inch and are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
3. Install insulated type bushings for terminating conduits 1 inch and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.

4. Bushing of standard or insulated type to have screw type grounding terminal.
5. Miscellaneous fittings such as reducers, chase nipples, three-piece unions, split couplings and plugs to be specifically designed for their particular application.

3.03 FIELD QUALITY CONTROL

- A. General: Mechanically assemble metal enclosures and raceways for conductors to form continuous electrical conductor and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.
- B. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion-inhibiting compound before assembling.
- C. Install expansion fittings in all raceways wherever structural expansion joints are crossed.
- D. Make changes in direction of raceway run with proper fittings supplied by raceway manufacturer. No field bends of raceway sections will be permitted.
- E. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported.
- F. Use boxes as supplied by raceway manufacturer wherever junction, pull, or device boxes are required. Standard electrical “handy” boxes, etc. shall not be permitted for use with surface raceway installations.
- G. Raceway penetrations of fire-rated walls and/or floors shall be sealed to maintain integrity of construction. All products, materials and methods of installation shall be UL approved and meet NFPA requirements.
- H. Unless otherwise noted on drawings, notified by the Engineer and/or authorities having jurisdiction, the following materials may be used:
 1. Rock Wool: Minimum 4-pound cubic foot density; flame spread 15, smoke developed 0, fuel contribution 0 by ASTM 384; minimum melting point 2,000°F.
 2. Concrete and masonry are also approved fire stop materials by NFPA 90A.
 3. UL approved products such as Nelson Type CLK Silicon Sealant. Manufacturer’s recommendations shall be strictly followed.

- I. Submit complete data on fire-stopping materials and construction methods for review by the Engineer before proceeding with work.

END OF SECTION

SECTION 16120 WIRES AND CABLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section making reference to wires and cables specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of electrical wire and cable work is indicated by drawings and schedules.
- B. Types of electrical wire, cable, and connectors specified in this Section include the following:
 - 1. Copper conductors.
 - 2. Split-bolt connectors.
 - 3. Wirenut connectors.
- C. Applications of electrical wire, cable, and connectors required for project are as follows:
 - 1. For power distribution circuits.
 - 2. For lighting circuits.
 - 3. For motor-branch circuits.
 - 4. For control circuits.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than five years.
- B. Installer's Qualifications: Firm with at least three years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

- C. NEC Compliance: Comply with NEC requirements as applicable to construction, installation, and color-coding of electrical wires and cables.
- D. IEEE Compliance: Comply with applicable requirements of IEEE Std. 82, "Test Procedures for Impulse Voltage Tests on Insulated Conductors", and Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to wiring systems.
- E. ASTM Compliance: Comply with applicable requirements of ASTM B1, 2, 3, 8, and D753. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
- F. The following systems of color-coding shall be strictly adhered to:
 - 1. Grounded Leads Green
 - 2. Grounded Neutral Leads White
 - 3. 277/480-Volt, Ungrounded Phase Wires Brown, Orange and Yellow
 - 4. 120/208-Volt, Ungrounded Phase Wires Red, Blue, Black
- G. The color code assigned to each phase wire shall be consistently followed throughout.
- H. Where existing base building color-coding differs from color-coding assigned herein. Contractor shall use existing color coding as required to maintain consistency. Advise engineer in writing of color-coding to be used.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wire and cable properly packaged in factory-fabricated type containers or wound on NEMA specified type wire and cable reels.
- B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 PRODUCTS

2.01 BUILDING WIRES

- A. Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated.

- B. Conductor insulation shall be dual type THHN/THWN 75°C (167°F) for dry, damp, and wet locations. Conductor insulation with single type marking THHN 90°C (194°F) may be used for dry locations only.

PART 3 EXECUTION

3.01 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation" and in accordance with recognized industry practices.
- B. Unless otherwise noted, all branch circuit conductors shall be No. 12 AWG. Branch circuits over 75 feet in length shall be No. 10 AWG unless noted otherwise.
- C. Install UL Type THWN or THHN wiring in conduit, for feeders and branch circuits.
- D. Pull conductors simultaneously where more than one is being installed in same raceway.
- E. Use pulling compound or lubricant, where necessary. Compound used must not deteriorate conductor or insulation.
- F. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceway.
- G. Keep conductor splices to minimum.
- H. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced. Use splices and tap connectors which are compatible with conductor material.

3.02 FIELD QUALITY CONTROL

- A. Prior to energization of circuitry, check installed feeder wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled. A list of feeders tested shall be submitted to the engineer indicating the insulation resistance level for each cable.
- B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

- C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

SECTION 16135
ELECTRICAL BOXES AND FITTINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is a part of each Division 16 section making reference to electrical wiring boxes and fittings specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of electrical box and associated fitting work is indicated by drawings and schedules.
- B. Types of electrical boxes and fittings specified in this Section include the following:
 - 1. Control panels.
 - 2. Outlet boxes.
 - 3. Junction boxes.
 - 4. Pull boxes.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of electrical boxes and fittings of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.
- C. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- D. UL Compliance: Comply with applicable requirements of UL 50, UL 514 Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL listed and labeled.

PART 2 PRODUCTS

2.01 FABRICATED MATERIALS

- A. Outlet Boxes: Provide aluminum outlet wiring boxes, of shapes, cubic inch capacities, and sizes (including box depths as indicated), suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides.
 - 1. Outlet Box Accessories: Provide outlet box accessories as required for each installation; including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations.
- B. Device Boxes: Provide aluminum, non-gangable device boxes, of shapes, cubic inch capacities, and sizes (including box depths as indicated), suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps and for equipment type grounding.
 - 1. Device Box Accessories: Provide device box accessories as required for each installation; including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations.
 - 2. Flush mounted wall outlets shall be 4-inch square boxes or gang boxes, not less than 1½ inches deep. Boxes shall be provided with extension rings and/or covers with sufficient depth to bring the covers flush with the finished wall.
 - 3. Boxes for flush mounting in concrete block work with one or two devices shall have covers with square corners on the raised portion of the cover. The covers shall have a sufficient amount of depth to be flush with the face of the block. The bottom side of the covers or boxes shall be installed at the masonry course nearest to the dimension specified or noted.
 - 4. Outlet boxes for exposed wall mounting and outdoor installation shall be cast aluminum boxes with suitable cast aluminum covers. Weatherproof receptacle covers shall have spring hinged lids.

- C. Rain-Tight Outlet Boxes: Provide corrosion-resistant, cast-aluminum, rain-tight outlet wiring boxes; of types, shapes and sizes (including depth of boxes), with threaded conduit holes for fastening electrical conduit, cast- aluminum face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion- resistant plugs and fasteners.
- D. Junction and Pull Boxes: Provide aluminum junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers. All junction boxes shall be designated with permanent marker circuit numbers and panelboard numbers of circuits contained within.
- E. Control Panels/Enclosures:
 - 1. The control panel/enclosures shall contain, as a minimum, devices and equipment indicated on the drawings or other sections of these specifications. All control panel/enclosures shall contain interior mounting plate.
 - 2. The control panel enclosure shall be NEMA 4X stainless steel, Underwriters Laboratories (UL) 50 Type 4 listed.
 - 3. The control panel enclosure shall be NEMA 9 (Explosion Proof) for Class 1, Div. 1 and 2 environment.
 - 4. There shall be permanently affixed to the interior side of the exterior enclosure door both a nameplate and a 10-inch x 12-inch pocket for drawing storage. The nameplate shall contain the following information: voltage, phase, date manufactured and intended use – equipment service or function.
 - 5. Inner safety door (dead front) shall be aluminum.
 - 6. Provide surge arrestor per county requirements.
 - 7. Contractor shall furnish shop drawings for control panel. Include dimension, mounting and material requirements of control panel. Furnish wiring diagrams of all internal components and devices. Schematic diagram of system and PLC connection diagrams and data sheet and programming functions. Furnish operating and maintenance and programming manuals.

PART 3 EXECUTION

3.01 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, and in accordance with recognized industry practices to fulfill project requirements.

- B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- C. Provide weather-tight outlets for interior and exterior locations exposed to weather or moisture.
- D. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- E. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. All existing and new junction boxes within the project area shall be made accessible. Relocate existing junction boxes as required to comply with the NEC.
- F. Metallic and approved nonmetallic electrical outlet boxes may be installed in vertical fire resistive assemblies classified as 2-hour or less without affecting the fire classification, provided such openings occur on one side only in each framing space and that openings do not exceed 16 square inches. Boxes located opposite sides of walls or partitions shall be separated by a horizontal distance of 24 inches.
- G. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.
- H. Subsequent to installation of boxes, protect boxes from construction debris and damage.

END OF SECTION

SECTION 16142
ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section making reference to electrical connections for equipment specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Electrical connections for equipment, not furnished as integral part of equipment, are specified in other Division 16 sections and are work of this Section.
- C. Motor starters and controllers not furnished as integral part of equipment are specified in applicable Division 16 sections and are work of this Section.
- D. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections and are work of this Section.
- E. Electrical identification for wire/cable conductors is specified in Section 16195, Electrical Identification, and is work of this Section.
- F. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections and are work of this Section.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties; whose products have been in satisfactory use in similar service for not less than 5 years.

- B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.
- C. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices) for junction boxes, motor starters, and disconnect switches.
- D. UL Compliance: Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL listed and labeled.

PART 2 PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. General: For each electrical connection indicated, provide complete assembly of materials; including, but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, cable ties, solderless wirenuts, and other items and accessories as needed to complete splices and terminations of types indicated. Metal shall not be used for outdoor applications. The contractor shall use aluminum for outdoor installations.
- B. Metal Conduit, Tubing and Fittings, General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division 16 Basic Electrical and in accordance with the following listing of metal conduit, tubing and fittings:
 - 1. Rigid aluminum conduit.
 - 2. Rigid metal conduit fittings.
 - 3. Electrical metallic tubing.
 - 4. EMT fittings.
 - 5. Flexible metal conduit.
 - 6. Flexible metal conduit fittings.
 - 7. Liquid-tight flexible metal conduit.
 - 8. Liquid-tight flexible metal conduit fittings.

- C. Wires, Cables, and Connectors:
 - 1. General: Provide wires, cables, and connectors complying with Division 16 Basic Electrical Materials and Methods Section 16120, Wires and Cables.
 - 2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match (including sizes and ratings) wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
- D. Connectors and Terminals: Provide electrical connectors and terminals which mate and match (including sizes and ratings) with equipment terminals and are recommended by equipment manufacturer for intended applications.

PART 3 EXECUTION

3.01 OBSERVATION

- A. Observe area and conditions under which electrical connections for equipment are to be installed and notify contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

3.02 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions, with recognized industry practices, and complying with applicable requirements of UL and NEC to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway, and equipment installation as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Maintain existing electrical service and feeders to occupied areas and operational facilities unless otherwise indicated, or when authorized otherwise in writing by owner or engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been

successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

- E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- F. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing, and maintenance.
- H. Provide flexible conduit for motor connections and other electrical equipment connections where subject to movement and vibration.
- I. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration; and also where connections are subjected to one or more of the following conditions:
 - 1. Exterior location.
 - 2. Moist or humid atmosphere where condensate can be expected to accumulate.
 - 3. Corrosive atmosphere.
 - 4. Water spray.
 - 5. Dripping oil, grease, or water.

3.03 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION

SECTION 16143 WIRING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section making reference to wiring devices specified herein.

1.02 DESCRIPTION OF WORK

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this Section include the following:
 - 1. Receptacles.
 - 2. Ground-fault circuit interrupters.
 - 3. Switches.
 - 4. Wallplates.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wiring devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.
- C. NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.
- D. UL Compliance: Provide wiring devices which are UL listed and labeled.

1.04 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on electrical wiring devices.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers providing wiring devices which may be incorporated in the work include; but are not limited to, the following (for each type and rating of wiring device):
 - 1. Arrow-Hart, Cooper Industries.
 - 2. Eagle Electric Manufacturing Co., Inc.
 - 3. Harvey Hubbell Inc.
 - 4. Pass and Seymour Inc.

2.02 FABRICATED WIRING DEVICES

- A. General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and which comply with NEMA Standards. Pub/No. WD1. Provide ivory color devices except as otherwise indicated.
- B. Receptacles:
 - 1. All receptacles shall be the grounding type with ground connection made through an extra pole that shall be permanently connected to the green grounding conductor.
 - 2. Duplex receptacles for 20-ampere, 120-volt service shall be two-pole, three-wire receptacles, rated 20 amperes at 125 volts. Receptacles shall be Harvey Hubbell, Inc., Catalog No. 5362-W.
 - 3. Single receptacles for 20 amps, 120 volts service shall be two-pole, three-wire rated 20 amperes at 125 volts. Receptacles shall be Harvey Hubbell Inc., Catalog No. 5361-W.
- C. Switches:
 - 1. Snap: Provide toggle switches, rated 20 amperes at 120/277 volts, quiet type, and shall be UL approved without derating for tungsten lamp loads or inductive loads. All switches shall have a grounding terminal, which

shall be connected to the green grounding conductor. The following catalog numbers are Harvey Hubbell, Inc.

<u>Type</u>	<u>Catalog No.</u>
Single Pole	HBL 1221-W

2.03 WIRING DEVICE ACCESSORIES

- A. 'In Use' covers for exterior receptacles.
- B. Weatherproof caps for switches.

PART 3 EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

- A. Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.
- C. Install wiring devices after wiring work is completed.
- D. Install wallplates after painting work is completed.

3.02 PROTECTION OF WALLPLATES AND RECEPTACLES

- A. Upon installation of wallplates and receptacles, advise contractor regarding proper and cautious use of convenience outlets. At time of substantial completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.03 GROUNDING

- A. Provide equipment grounding connections for all wiring devices, unless otherwise indicated.

3.04 TESTING

- A. Prior to energizing circuitry, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

END OF SECTION

SECTION 16170
CIRCUIT AND MOTOR DISCONNECTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section making reference to circuit and motor disconnects specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of circuit and motor disconnect switch work is indicated on drawings and schedules.
- B. Types of circuit and motor disconnect switches in this Section include the following:
 - 1. Equipment disconnects.
 - 2. Appliance disconnects.
 - 3. Motor-circuit disconnects.
- C. Wires/cables, raceways, and electrical boxes and fittings required in connection with circuit and motor disconnect work are specified in other Division 16 Basic Electrical Materials and Methods sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of circuit and motor disconnect switches of types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing circuit and motor disconnect work similar to that required for this project.
- C. NEC Compliance: Comply with NEC requirements pertaining to construction and installation of electrical circuit and motor disconnect devices.

- D. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches." Provide circuit and motor disconnect switches which have been UL listed and labeled.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub No. KS 1, "Enclosed Switches" and 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on circuit and motor disconnect switches.
- B. Submit shop drawings in booklet form with separate sheet for each circuit and motor disconnect with proposed switch and accessories clearly identified on each sheet. Identify each device with corresponding names, abbreviations (numbers and lettering) to match terminology of contract documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering circuit and motor disconnects which may be incorporated in the work are limited to:
 - 1. Square D Company.
 - 2. Westinghouse/Cutler-Hammer.
 - 3. General Electric Co.

2.02 FABRICATED SWITCHES

- A. Heavy-Duty Safety Switches: Provide surface-mounted, heavy-duty type, NEMA 4X stainless steel enclosed safety switches, of types, sizes and electrical characteristics indicated; incorporating quick-make, quick-break type switches. Construct so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable, and is padlockable in OFF position. Construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts and positive pressure type reinforced fuse clips.
 - 1. All fuses for safety switches shall be dual element, cartridge type. Fuses shall be Bussman "Fusetron" or Chase-Shawmut "Trionic." The contractor shall furnish and install proper size fuses where required for all fusible

equipment and shall furnish to the owner one spare fuse for each fuse installed.

PART 3 EXECUTION

3.01 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Install disconnect switches for use with motor-driven appliances and motors and controllers within sight of controller position unless otherwise indicated.
- C. Unless otherwise indicated, protective devices shall be mounted with top of cabinet or enclosure 6 feet-6 inches above finished floor; shall be properly aligned; and shall be adequately supported independently of the connecting raceways and other equipment. All steel shapes, etc., necessary for the support of the equipment shall be furnished and installed where the building structure is not suitable for mounting the equipment directly thereon. Unless otherwise indicated, all branch circuit protective devices enclosures shall be NEMA type I, general purpose type. Branch circuit protective devices installed outdoors or exposed to the weather shall have weatherproof enclosures, NEMA Type 4X.

3.02 GROUNDING

- A. Provide equipment grounding connections sufficiently tight to assure a permanent and effective ground for electrical disconnect switches where indicated.

3.03 FIELD QUALITY CONTROL

- A. Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance. Otherwise remove and replace with new units and retest.

END OF SECTION

SECTION 16190 SUPPORTING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is a part of each Division 16 section making reference to electrical supporting devices specified herein.

1.02 DESCRIPTION OF WORK

- A. Extents of supports, anchors, sleeves, and seals are indicated by drawings and schedules and/or specified in other Division 16 sections.
- B. Types of supports, anchors, sleeves, and seals specified in this Section include the following:
 - 1. Clevis hangers.
 - 2. One-hole conduit straps.
 - 3. Two-hole conduit straps.
 - 4. Round steel rods.
 - 5. Expansion anchors.
 - 6. Toggle bolts.
 - 7. Wall and floor seals.
 - 8. Corn Clamps.
- C. Supports, anchors, sleeves, and seals furnished as part of factory fabricated equipment are specified as part of that equipment assembly in other Division 16 sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical supporting device work similar to that required for this project.
- C. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation", pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
- D. UL Compliance: Provide electrical components which are UL listed and labeled.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on supporting devices, including catalog cuts, specifications, and installation instructions for each type of support, anchor, sleeve, and seal.

PART 2 PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES

- A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction, in accordance with published product information and as required for complete installation and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is installer's option.
- B. Supports: Provide supporting devices of types, sizes, and materials indicated and having the following construction features:
 - 1. Clevis Hangers: For supporting conduit; aluminum with 1/2-inch-diameter hole for round steel rod, approximately 54 pounds per 100 units.
 - 2. Reducing Couplings: Aluminum rod reducing coupling, 1/2-inch by 5/8-inch, approximately 16 pounds per hundred 100 units.
 - 3. One-Hole Conduit Straps: For supporting conduit; aluminum.
 - 4. Two-Hole Conduit Straps: For supporting conduit; aluminum.
 - 5. Hexagon Nuts: For 1/2-inch rod size, aluminum.
 - 6. Round Aluminum Rod: 1/2-inch diameter.
 - 7. Offset Conduit Clamps: For supporting 2-inch rigid metal conduit; aluminum.

- C. Anchors: Provide anchors of types, sizes, and materials indicated with the following construction features: (all aluminum).
 - 1. Expansion Anchors: 1/2 inch.
 - 2. Toggle Bolts: Springhead, 3/16 inch by 4 inches.
- D. Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:
 - 1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated, suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws. Seals shall be fire-rated where required.
- E. U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment; aluminum of types and sizes indicated. Construct with 3/16-inch-diameter holes, 8-inch O.C. on top surface, and with the following fittings which mate and match with U-channel:
 - 1. Fixture hangers.
 - 2. Channel hangers.
 - 3. End caps.
 - 4. Beam clamps.
 - 5. Wiring studs.
 - 6. Thinwall conduit clamps.
 - 7. Rigid conduit clamps.
 - 8. Conduit hangers.

2.02 FABRICATED SUPPORTING DEVICES

- A. Pipe Sleeves: Provide pipe sleeves of Aluminum Pipe: Fabricate from Schedule 40 galvanized aluminum pipe. Remove burrs.
- B. Sleeve Seals: Provide sleeves for piping which penetrate foundation walls below grade or exterior walls. Caulk between sleeve and pipe with nontoxic, UL classified caulking material to ensure watertight seal. Seals shall be fire-rated where required.

PART 3 EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves, and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

END OF SECTION

SECTION 16195 ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section making reference to electrical identification specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of electrical identification work is indicated by drawings and schedules.
- B. Types of electrical identification work specified in this Section include the following:
 - 1. Equipment/system identification signs.

PART 2 PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIALS

- A. Engraved Plastic-Laminate Signs:
 - 1. General: Provide engraving stock melamine plastic laminate in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated; black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 2. Signs shall be black face with white core plies (letter color).
 - a. Thickness: 1/16 inch, except as otherwise indicated.
 - b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot, or should not, penetrate substrate.
 - c. Nameplates for essential electrical systems shall be red with white letters.

B. Conduit Labels

1. Products and Manufacturers: Provide one of the following:
 - a. Stainless Steel Laser Etched Conduit Tags by Marking Services Incorporated.
 - b. Or equal.
2. Shall be 316 stainless steel construction.
3. Attach with stainless steel straps.
4. Shall be 1 inch x 4 inches minimum, and custom made to match conduit labels as identified in the Contract drawings.
5. Custom Labels:
 - a. Shall have black laser etched lettering on stainless steel background.

2.02 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations, and other designations used in electrical identification work with corresponding designations shown, specified, or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

PART 3 EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.
 2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
 3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Equipment/System Identification:

1. General: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/ control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access panels/doors to electrical facilities.
 - c. Transformers.
 - d. Fire alarm equipment cabinets.
 - e. Disconnect switches, motor starters, contactors, including current origination.
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not, or cannot, penetrate substrate.

END OF SECTION

SECTION 16452 GROUNDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Materials and Methods section and is part of each Division 16 Section making reference to grounding specified herein.

1.02 SUMMARY

- A. The extent of electrical grounding and bonding work is indicated by drawings and schedules, and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment. All new grounding electrodes (rods) and new ground conductors shall be bonded to the existing grounding grid at four locations, minimum. All new control panels, electrical panels and cabinets shall be grounded with new ground rods and shall also be bonded to the existing grounding grid. All new connections to the existing grounding grid shall be made by exothermic weld process. The Contractor shall obtain approval the grounding connections from owner before installation. The Contractor shall furnish and install one grounding test station. Test station shall include in grade box with removable lid to exposed top of ground rod and grounding conductor; all connections in test station shall be mechanical type – not exothermic weld.
- B. The type of electrical grounding and bonding work specified in this Section includes the following:
 - 1. Solidly grounded.
- C. Applications of electrical grounding and bonding work in this Section includes the following:
 - 1. Electrical power systems.
 - 2. Grounding electrodes.
 - 3. Separately derived systems.
 - 4. Raceways.
 - 5. Service equipment.
 - 6. Enclosures/control panels.
 - 7. Equipment.

- D. Refer to other Division 16 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this Section.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of grounding and bonding products, of types and ratings required, and ancillary grounding materials; including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers; whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits, and equipment.
 - 2. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467, "Electrical Grounding and Bonding Equipment", and 869, "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products that are UL listed and labeled for their intended usage.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING

- A. Materials and Components, General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than

one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated, provide products that comply with NEC and UL, requirements, and with established industry standards for those applications indicated.

- B. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
- C. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for indicated applications.
- D. Ground Electrodes: Solid copper, 5 ohms, 3/4-inch-diameter by 20 feet.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify the Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

3.02 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. General: Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions; applicable portions of NEC, NECA's "Standard of Installation," and in accordance with recognized industry practices, to ensure that products comply with requirements.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. Ground electrical service system neutral at service entrance to the building cold water line and to three 3/4-inch-diameter, 20-foot-long ground rods spaced 10 feet apart.
- D. Ground each separately-derived system neutral to separate grounding electrode.
- E. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

- F. All raceways with No. 10 or 12 AWG phase conductors for receptacles, lighting fixtures, and similar circuits shall be provided with a parity-sized green equipment ground conductor. Ground conductor shall be installed in entire raceway system, including wall switches and flexible conduit to light fixtures. Equipment ground conductor sizes for circuits with phase conductors larger than No. 12 AWG are indicated on drawings. Ground conductors shall be connected to ground buss in panelboards. All power, lighting, control circuits shall have a fully sized insulated copper conductor run the entire length of the circuit. The raceway/conduit system shall not be used as a means of the grounding system.
- G. Terminate feeder and branch circuit insulated equipment-grounding conductors with grounding lug, bus, or bushing. Conductors looped under screw or bolt heads will not be permitted.
- H. Connect grounding electrode conductors to 1-inch-diameter or greater metallic cold-water pipe, using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.
- I. Install clamp-on connectors on clean metal contact surfaces to ensure electrical conductivity and circuit integrity.
- J. Provide a grounding bushing and a continuous copper bonding jumper from the bushing to the equipment ground bus in all feeders. The bonding jumper shall be the same size as the equipment ground conductor.

3.03 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms or less by driving additional ground rods then retest to demonstrate compliance.
- B. Submit test results (three copies) to engineer of record. Test results shall include grounding test method used, equipment used (manufacturer and model number) with certification of calibration and data results.

END OF SECTION

SECTION 16460 TRANSFORMERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section making reference to transformers specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of transformer work is indicated by drawings and schedules.
- B. Types of transformers specified in this Section include the following:
 - 1. Dry-Type Transformers.
- C. Electrical wiring connections for transformers are specified in applicable Division 16 sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of power/distribution transformers of types and ratings required; whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing electrical power and distribution transformers similar to those required for this project.
- C. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.
- D. ANSI Compliance: Comply with applicable requirements of ANSI Standards C57-Series pertaining to power/distribution transformers.
- E. NEMA Compliance: Comply with requirements of NEMA Std Pub/Nos. ST 20; "Dry-Type Transformers for General Applications," TR 1, and TR 27.

- F. UL Compliance: Comply with applicable requirements of ANSI/UL 506; "Safety Standard for Specialty Transformers".
- G. NESC Compliance: Comply with applicable requirements of National Electrical Safety Code (ANSI Std C2) pertaining to indoor and outdoor installation of transformers.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data; including rated kVA, frequency, primary and secondary voltages, and percent taps.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work, but are not limited to, the following:
 - 1. General Electric Co.
 - 2. Square D Co.
 - 3. Cutler Hammer/Eaton.

2.02 POWER/DISTRIBUTION TRANSFORMERS

- A. General: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Dry-Type Distribution Transformers:
 - 1. Transformers sized 15 kVA and below shall have two 2-1/2% taps above and below rated primary voltage.
 - 2. Transformers 15 kVA and below shall be 115°C temperature rise above 40°C ambient, unless noted otherwise.
 - 3. Limit transformer surface temperature rise to maximum of 50°C rise above a 40°C ambient. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 dB for transformers 15 to 45 kVA and 50 dB for 50 to 150 kVA as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap.

Provide transformers with fully-enclosed sheet-steel enclosures. Provide transformers suitable for wall mounting.

- C. Equipment/System Identification: Provide equipment/system identification nameplates complying with Division 16 Basic Electrical Materials and Methods Section 16195, Electrical Identification, in accordance with the following listing:
 - 1. Equipment/System Identification.
- D. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 EXECUTION

3.01 INSPECTION

- A. Installer must examine areas and conditions under which power/distribution transformers and ancillary equipment are to be installed and notify the Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to installer.

3.02 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NESC, NEMA, ANSI, and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

3.03 GROUNDING

- A. Provide equipment grounding connections for power/distribution transformers as indicated.

3.04 TESTING

- A. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications.
- B. Prior to energization, check circuitry for electrical continuity and for short-circuits.
- C. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source, and test transformers;

including (but not limited to) audible sound levels, to demonstrate capability and compliance with requirements.

- D. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units or components, and proceed with retesting.

END OF SECTION

SECTION 16470 PANELBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is a part of each Division 16 section making reference to panelboards specified herein.

1.02 SUMMARY

- A. Extent of panelboard and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules and as specified herein.
- B. Types of panelboards and enclosures required for the project include the following:
 - 1. Power Distribution Panelboards.
 - 2. Lighting and Appliance Panelboards.
- C. Refer to other Division 16 sections for wires/cables, electrical boxes and fittings and raceway work required in conjunction with installation of panelboards and enclosures.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's data on panelboards and enclosures. Shop drawings shall indicate arrangement of busses, branch circuits, enclosures, dimensions, etc.

1.04 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of panelboards and enclosures, of types, sizes, and ratings required; whose products have been in satisfactory use in similar service for not less than 5 years.

- B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects utilizing panelboards similar to those required for this project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Article 384 as applicable to the installation and construction of electrical panelboards and enclosures.
 - 2. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL codes 50, 869, and 1053 pertaining to panelboards, accessories and enclosures. Provide panelboard units that are UL listed and labeled.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering electrical panelboard products that may be incorporated in the work include, but are not limited to, the following:
 - 1. General Electric Company.
 - 2. Square D Company.
 - 3. Cutler-Hammer/Eaton Corp.

2.02 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with the design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
- B. Power Distribution Panelboards: Provide dead-front, safety-type power distribution panelboards as indicated; with panelboard switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn, solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with copper bus bars with not less than 98 percent conductivity, and with full-sized neutral bus. Provide suitable lugs on neutral bus for outgoing feeders requiring neutral

connections. Provide bolt-on, molded-case circuit breaker types for each circuit, with toggle handles that indicate when tripped. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards which mate and match properly with panelboards.

1. Power panelboards shall be General Electric type 'Spectra', Square D type 'I Line', or Cutler-Hammer type 'PRL3a'. Voltage shall be as indicated.
- C. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated; with switching and protective devices in quantities, ratings, types and arrangements shown; with anti-burn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel. Equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, circuit breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required, and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards that mate and match properly with panelboards.
1. Panelboards shall be General Electric A-Series, Square D type "NQ", or Cutler-Hammer type PRL2. Panelboard boxes shall be 5-3/4 inches deep. Voltage shall be as indicated.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet-type enclosures, in sizes and NEMA types as indicated; code-gauge, minimum 16-gauge thickness. Cabinets shall be furnished without knockouts and all holes for raceways shall be drilled and punched on the job. Panelboard enclosures shall be 5-3/4 inches deep. Provide fronts with adjustable trim clamps and doors with flush locks and keys; all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed mounting. Provide enclosures that are fabricated by same manufacturer as panelboards that mate and match properly with panelboards to be enclosed.
- E. All panelboards shall be connected distributed phase with circuit numbering as indicated on the drawings. Panelboards shall be numbered with odd numbers on the left side of the panel and even numbers on the right side of the panel. Panelboards shall have a circuit directory card mounted in a frame with plastic cover, mounted on the inside of the door, and directory cards shall be completed with a typewriter to indicated areas and/or devices served by each circuit. All new and existing panelboards being used for this project shall have new typed directories.

- F. Molded-Case Circuit Breakers: Provide factory-assembled, bolt-on, molded-case circuit breakers of frame sizes, characteristics, and ratings, including RMS symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection; ampere ratings as indicated. Multi-pole breakers shall have a common trip bar so that the tripping of one pole will automatically trip all poles of the breaker. Construct with over-center, trip-free, toggle-type operating mechanisms with quick-make, quick-break action, and positive handle trip indication. Construct breakers for mounting and operating in any physical position and operating in an ambient temperature of 40°C. Provide breakers with mechanical screw type removable connector lugs; AL/CU rated.
 - 1. Individual Enclosed Circuit Breakers: Circuit breakers shall be molded case type. Breakers shall have thermal-magnetic trip units and magnetic trip shall be adjustable. Breakers shall have a common trip bar so that the tripping of one pole will automatically trip all poles of the breaker. Breakers shall be trip free and trip indicating and shall have quick-make, quick- break contacts. Enclosure shall have insulated, groundable neutral.
- G. Panelboards shall be installed complete with connectors and associated hardware for all circuit breakers and circuit breaker spaces listed in the panelboard schedule.
- H. When connecting equipment to existing panelboards, the new and existing circuit breakers shall be identified. A new circuit directory card shall be provided.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which panelboards and enclosures are to be installed and notify contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

3.02 INSTALLATION OF PANELBOARDS

- A. Install panelboards and enclosures as indicated, in accordance with manufacturer's written instruction, applicable requirements of NEC standards, NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque-tightening values for equipment connectors.
- C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

3.03 GROUNDING

- A. Provide equipment grounding connections for panelboard enclosures as indicated.
- B. Prior to energization, check panelboards for electrical continuity of circuits and for short-circuits.

3.04 ADJUSTING AND CLEANING:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.

END OF SECTION

SECTION 16480 MOTORS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install the motors as hereinafter specified and as called for in other sections of these Specifications.

1.02 QUALIFICATIONS

- A. Motor shall be sufficient size for the duty to be performed and shall not exceed their full-rated load when the driven equipment is operating at specified capacity.

1.03 SUBMITTALS

- A. The motor manufacturer shall submit to the Engineer certified dimension prints showing nameplate data and outline dimensions within three weeks of the date they receive the order.
- B. Submit Operation and Maintenance Manual and parts lists as specified in Section 01770, Project Closeout.
- C. Guarantee: All equipment furnished and installed under this Section shall be guaranteed against defects of workmanship, materials and improper installation for a period of eighteen month from date of acceptance. All such equipment or parts proven defective, due to the above noted causes, shall be replaced in the machines by the Contractor at no expense to the Owner.
- D. Provide equipment warranty in accordance with Section 01780, Warranties and Bonds.

PART 2 PRODUCTS

2.01 RATING

- A. Unless otherwise noted, all motors shall be of the low voltage type. All motors 2 through 100 horsepower shall be rated 230/460 volt, three-phase, 60 Hertz A.C.; motors 125 horsepower through 300 horsepower shall be rated 460-volt, three-phase, 60 Hertz, and motors below 2 horsepower shall be rated 115/230-volt, one-phase, 60 Hertz A.C.

2.02 THREE PHASE INDUCTION MOTORS

- A. Motors 25 HP and larger shall have a 120-volt space heater for moisture control.
- B. Unless specifically noted in other sections of these Specifications, all motors shall have an efficiency as indicated in the table below. Motors shall be "premium efficiency" type.

TABLE 1

Motor HP	Min. Eff.	Max. dba	Motor HP	Min. Eff.	Max. dba
1-2	84.0%	74	25-30	92.0%	92
3-5	86.5%	79	40-50	93.0%	97
7.5-10	90.2%	84	60-75	94.0%	100
15-20	91.0%	89	100	94.1%	102

- C. Motors operating with variable frequency drives shall indicate on the nameplate that they are suitable for their intended applications (Inverter duty Rated) and they shall be provided with an integral temperature switch that opens on high temperature. Motors operating with Variable Frequency Drives (VFD's) shall meet the requirements of NEMA MG1 Part 31.

2.03 CONSTRUCTION

- A. General:
 - 1. All drip-proof and weather protected Type I motors shall have epoxy encapsulated windings. Totally enclosed motors shall not be encapsulated. Motors not readily available with encapsulated windings may be standard type. Motors exposed to the outside atmosphere shall be totally enclosed fan cooled (TEFC) unless otherwise specified.
 - 2. Squirrel-cage rotors shall be made from high-grade steel laminations adequately fastened together and to the shaft or shall be cast aluminum or bar-type construction with brazed end rings.
- B. Low Voltage, Three Phase Motors:
 - 1. Motors shall be of the squirrel-cage induction type, NEMA design B. Horizontal, vertical solid shaft, vertical hollow shaft, normal thrust and high thrust types shall be furnished as specified herein. All motors shall be

built in accordance with current NEMA, IEEE, ANSI and AFBMA standards where applicable. Motors shall be of the type and quality described by these Specifications, fully capable of performing in accordance with manufacturer's nameplate rating, and free from defective material and workmanship.

2. Motors shall have normal or high starting torque (as required), low starting current (not to exceed 600 percent full load current), and low slip.
3. Outdoor motors shall be totally enclosed fan-cooled construction with 1.15 service factor unless otherwise noted. Indoor motors shall be ODP unless otherwise noted.
4. Outdoor motors shall be mill and chemical duty suitable for operation in moist air with hydrogen sulfide gas present.
5. The output shaft shall be suitable for direct connection or belt drive as required.
6. Motors shall have a Class B nonhygroscopic insulation system. Class F insulation may be used but shall be limited to Class B temperature rise.
7. All motors shall have a final coating of chemical resistant corrosion and fungus protective epoxy fortified enamel finish sprayed over red primer over all interior and exterior surfaces. Stator bore and rotor of all motors shall be epoxy coated.
8. All fittings, bolts, nuts, and screws shall be 316 stainless steel. Bolts and nuts shall have hex heads.
9. All machine surfaces shall be coated with rust inhibitor for easy disassembly.
10. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.
11. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.
12. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures will have stainless steel screen and motors shall be protected for corrosion, fungus and insects.

13. Low voltage, three phase motors shall be manufactured by General Electric, U.S. Motors, Westinghouse or approved equal.
14. Fractional Horsepower:
 - a. Fractional horsepower motors shall be rigid, welded-steel, designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be reinforced, lightweight die-cast aluminum. Windings shall be of varnish-insulated wire with slot insulation of polyester film, baked-on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses and other hazards.
 - b. Motor shaft shall be made from high-grade, cold-rolled shaft steel with drive-shaft extensions carefully machined to standard NEMA dimensions for the particular drive connection.
 - c. All motors shall be equipped with vacuum-degassed (sealed) antifriction bearings made to AFBMA Standards and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of lubricant out of the bearing cavity.
15. Integral Horsepower:
 - a. Motor frames and end shields shall be cast iron or heavy fabricated steel of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.
 - b. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.
 - c. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating. Bearing journals shall be ground and polished.
 - d. Rotors shall be made from high-grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel-cage windings may be copper or bar-type construction with brazed end rings.
 - e. All motors shall be equipped with vacuum-degassed (sealed) antifriction bearings made to AFBMA Standards and be of ample capacity for the motor rating. The bearing housing shall be large

enough to hold sufficient lubricant to minimize the need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of lubricant out of the bearing cavity.

- f. Bearings of high thrust motors will be locked for momentary up thrust of 30% down thrust. All bearings shall have a minimum B10 life rating of 100,000 hours in accordance with AFBMA life and thrust values.
- g. Vertical hollow-shaft motors will have nonreverse ratchets to prevent backspin.

C. Low Voltage, Single Phase Motors:

- 1. Single phase motors shall be split-phase and capacitor-start induction types rated for continuous horsepower at the rpm called for on the Drawings. Motors shall be rated 115/230 volts, 60 Hertz, single phase, open drip proof, or totally enclosed fan cooled as called for on the Drawings, with temperature rise in accordance with NEMA Standards for Class B insulation.
- 2. Totally enclosed fan cooled motors shall be designed for severe-duty.
- 3. Motors shall have corrosion and fungus protective finish on internal and external surfaces. All fittings shall have a corrosion protective plating.
- 4. Mechanical characteristics shall be the same as specified for polyphase fractional horsepower motors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Motor Connections: All motors shall be connected to the conduit system by means of a short section of flexible conduit, 18 inches minimum and 60 inches maximum, unless otherwise indicated. For all motor connections, the Contractor shall install a grounding conductor in the conduit and terminate at the motor control center with an approved grounding clamp.
- B. Connection to motor leads shall be compression type with 3M brand heat shrink boot.

3.02 TESTS AND CHECKS

A. The following tests shall be performed on all motors after installation but before putting motors into service.

1. The Contractor shall megger each motor winding before energizing the motor, and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor. The Contractor shall check direction of rotation of all motors and reverse connections if necessary. The following table gives minimum acceptable insulation resistance in megohms at various temperatures and for various voltages with readings being taken after one minute of megger test run.

TABLE 2

Degree Winding Temperature		Voltage		
°F	°C	115V	230V	460V
37	3.9	60	108	210
50	10	32	60	120
68	20	13	26	50
86	30	5.6	11	21
104	45	2.4	4.5	8.8
122	50	1	2	3.7
140	60	.5	.85	1.6

2. The Contractor shall check each motor for correct clearances and alignment and for correct lubrication and shall lubricate if required in accordance with manufacturer's instructions.

END OF SECTION

SECTION 16482 MOTOR STARTERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 Section referencing motor starters herein.

1.02 DESCRIPTION OF WORK

- A. Extent of motor starter work is indicated by the Drawings and Schedules.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of motor starters of types, ratings, and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects using motor starters similar to that required for this project.
- C. NEC Compliance: Comply with NEC as applicable to wiring methods, construction, and installation of motor starters.
- D. UL Compliance: Provide motor starters and components which are UL listed and labeled.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on motor starters.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering motor starters which may be incorporated in the work include, but are not limited to, the following:
 - 1. Allen-Bradley Co.
 - 2. General Electric Co.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D Co.
 - 5. Westinghouse Corp.

2.02 MOTOR STARTERS

- A. General: Except as otherwise indicated, provide motor starters and ancillary components which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation.
- B. Manual motor starters for 115 volts, single-phase motors, one horsepower and smaller shall be single-pole, horsepower-rated switches with thermal overload units and heaters. Starters shall be Square D Class 2510 with stainless steel cover plates.
- C. Magnetic full voltage starters for three-phase motors shall be three-pole, horsepower-rated, magnetically operated, with three thermal overload units and four extra auxiliary contacts. Control voltage shall be 120 volts supplied from a control power transformer. A Hand-Off-Automatic, HOA switch shall be mounted in the front cover. Starters shall be Square D Class 8536.
- D. Combination magnetic, full voltage starters for three-phase motors shall be three-pole horsepower-rated, magnetically operated switches, with three thermal overload units and four extra auxiliary contacts. Control voltage shall be 120 volts supplied from a control power transformer. A three-pole horsepower-rated, non-fusible disconnect switch shall also be included in the enclosure. An HOA switch shall be mounted in the front cover. Starters shall be Square D Class 8538.
- E. Phase loss protection shall be provided on all starters serving motors 15 horsepower or larger.
- F. Provide 0- to 15-minute on-delay auto restart function on each starter.

- G. Provide PLC contact. Coordinate with PLC controls contractor.

PART 3 EXECUTION

3.01 INSTALLATION OF MOTOR STARTERS

- A. Install motor starters as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices, complying with applicable requirements of NEC, UL, and NEMA standards to ensure that products fulfill requirements.
- B. Motor starters or any other electrical equipment located in smoke or fire rated walls shall be mounted on Unistrut channels. Channels shall be supported from the floor and the structure above ceiling. There shall be no penetrations of the fire rated assembly pursuant to the equipment installation.
- C. Unless otherwise indicated, motor starters shown on the Drawings shall be furnished and installed under this Section. The full load current and starting characteristics of each motor shall be verified for proper selection of motor over load devices.
- D. Furnish and install all steel shapes, etc., necessary for a support of all motor starters.
- E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors.

3.02 ADJUSTING AND CLEANING

- A. Inspect electrical starter's operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.03 FIELD QUALITY CONTROL

- A. After connecting wires/cables, energize motor starter circuitry and demonstrate functioning of equipment in accordance with requirements. Where necessary, correct malfunctioning units and retest to demonstrate compliance. Ensure that the direction of rotation of each motor fulfills requirements.

END OF SECTION

SECTION 16620 SURGE SUPPRESSION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is a part of each Division 16 section referencing electrical surge suppression specified herein.

1.02 DESCRIPTION OF WORK

- A. The work required under this division shall include all materials, labor, and auxiliaries required to furnish and install complete surge suppression for the protection of building electrical and electronics systems from the effects of line-induced transient voltage surge and lightning discharge, as indicated on the Drawings or specified in this Section.
- B. Types of surge suppression specified in this Section include the following:
 - 1. Service entrance type.
 - 2. Distribution and branch circuit panels.
 - 3. Point of use type (receptacle and plug-in units).

1.03 QUALITY ASSURANCE

- A. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electrical and electronics systems equipment.
- B. The surge suppressor manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor.
- C. Submittals: Surge suppression submittal shall include:
 - 1. Manufacturer's performance data on each suppressor type.
 - 2. Dimensioned drawing of each suppressor type.

- D. To establish the type and operating characteristics of the surge suppression devices, equipment manufactured by Atlantic Scientific is used as a guide in determining the functions of the surge suppression system. Other equipment will be considered for approval provided the following is submitted in writing to the Architect/Engineer in accordance with the specifications.
- E. Equipment Certification: Items shall be listed by Underwriters' Laboratories, shall bear the UL seal, and be marked in accordance with referenced standard.
- F. Surge suppression devices shall be installed and located in accordance with requirements of all applicable National Fire Protection Association (NFPA) Codes.

1.04 WARRANTY

- A. All surge suppression devices shall be warranted to be free from defects in materials and workmanship under normal use in accordance with the instructions provided for 5 years.
- B. Any suppressor which shows evidence of failure or incorrect operating during the warranty period shall be repaired or replaced by the manufacturer and installer.

1.05 CODES AND STANDARDS

- A. The following standards and publications are referenced in various parts of this specification and shall apply:
 - 1. UL 1449-1987 (Second Edition, August 17, 1998): Standard for Safety, Transient Voltage Surge Suppressors.
 - 2. ANSI/IEEE C62.41-1991 (IEEE 587): Guide for Surge Voltages in Low-Voltage AC Power Circuits.
 - 3. ANSI/IEEE C62.33-1982: Standard Test Specifications for Varistor Surge Protection Devices.
 - 4. ANSI/IEEE C62.45-1992: IEEE Guide for Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

1.06 REQUIRED SUPPRESSORS

- A. Provide surge suppression for the equipment described herein:
 - 1. On main electrical service entrance panels as shown in the Project Drawings.
 - 2. On distribution and branch circuit panels as shown in the Project Drawings.

3. On 120-volt power connections for the fire alarm control panel, intercom, television and sound equipment, telephone power supplies, nurse call equipment, and other dedicated circuits, as identified in the Project Drawings.
4. At point of use locations (receptacles, plug-in units) as shown on the Project Drawings.
5. On all equipment identified in the Project Drawings.

PART 2 PRODUCTS

2.01 SUPPRESSORS

- A. The surge suppressor manufacturer shall offer a complete line of surge suppression products to support the required suppressors listed in Part 1.
- B. The service entrance surge suppressors shall be designed with replaceable modules for purposes of in-service replacement. The unit suppressor shall be designed with redundant back-up surge protection in the event of a module failure.
- C. Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.
- D. Unit status indicators shall be provided to indicate the status of the complete unit suppressor. The LED status indicators shall be on the hinged front cover to redundantly indicate module or unit failure. The unit suppressor shall include alarm contacts (one N.O. and one N.C.) for remote annunciation of unit status.
- E. Suppressors shall be designed for the specific type and voltage of electrical service and shall provide clamping action for both normal (L-N) and common (L-N-G) mode protection.
- F. Service entrance suppressors shall use normal and common modes of protection – each phase line to neutral, each phase line to ground, and neutral to ground.
- G. Distribution and branch circuit panel suppressors shall use protection of each phase line to ground and neutral to ground (if neutral conductor is present).
- H. Suppressors shall be of a hybrid design and include circuitry with tight, wave-tracking clamping characteristics.
- I. Suppressors shall be designed to withstand a maximum continuous operating voltage of not less than 115% of nominal RMS line voltage.

- J. Suppressors shall use internal safety fusing or a UL/IEEE approved method to disconnect the suppressor from the electrical source if the suppressor fails. The suppressor shall be internally protected from fault current damage resulting from a suppressor failure.
- K. Each suppressor shall have an internal disconnect switch when not connected to a separate circuit breaker or fused disconnect switch, which is dedicated specifically for the suppressor.
- L. Suppressors shall be failsafe, shall allow no follow-through current, shall have repeated surge capability, shall be solid state, shall be self-restoring, and shall be fully automatic.
- M. Suppressors shall be UL 1449 listed and shall be approved for the location in which they are installed.
- N. Suppressors shall have an operating temperature range of -40°C to +85°C.

2.02 SUPPRESSOR CRITERIA

- A. Suppressors shall meet or exceed the following criteria:
 - 1. Service Entrance: Zonemaster 150 (Zonemaster PE) Nema 1 or approved equal. 277/480-volt, three-phase, four-wire, wye: Minimum surge capacity of 150,000 Amps per phase.
 - 2. Distribution secondary: Zone Defender Pro Series or approved equal. Minimum surge capacity of 120KA amps per phase.
 - 3. Sub panels Zone Defender Pro Series 80kA.
- B. Suppressors shall be sequential surge tested in accordance with IEEE C62.45-1992 and shall withstand 1,000 test cycles at 3 KA.
- C. Suppressors shall have a minimum phase to ground clamping voltage of 400V for 120V applications and 800V applications.
- D. Dedicated 120-volt, 20-amp power plug-in suppressors shall be Atlantic Scientific MA Series or approved equal. Provide hardwire or receptacle type device to match equipment when required.

2.03 ACCEPTABLE MANUFACTURERS

- A. Atlantic Scientific.
- B. LEA International.
- C. Joslyn.

- D. Current Technology.
- E. Liebert.

PART 3 EXECUTION

3.01 INSTALLATION OF SUPPRESSORS

- A. Suppressors shall be installed as close as practical to the electric panel or electronic equipment to be protected, consistent with available space. Suppressors shall be close nipped to the device being protected in a position near the point of connections, which will minimize lead length between suppressor and the buses or control breaker to which the suppressor connects. Suppressor leads shall not extend beyond the suppressor manufacturer's recommended maximum lead length without specific approval of the engineer.
- B. Suppressors shall be installed in a neat, workmanlike manner. Lead dress shall be as short and as straight as possible and be consistent with recommended industry practices for the system on which these devices are installed.
- C. Supplementary grounding and bonding connections required between the bonding bus or ground plane for each equipment cluster and other locations as indicated herein shall be accomplished using #6 AWG core copper conductor and approved connections, unless otherwise noted, referenced to a common earth ground.
- D. Suppressors shall be installed in a manner that allows simple replacement within short periods of downtime.
- E. Service entrance and panel type suppressors shall be installed with a means of disconnecting the suppressor. If no dedicated circuit breaker is included in panel, manufacturer shall provide an integral fused disconnect.
- F. The surge suppression equipment shall be UL listed and installed in accordance with the NEC and the manufacturer's specifications.

END OF SECTION

SECTION 16670
LIGHTNING PROTECTION SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents and Division 1 Specification Sections apply to work of this Section.
- B. This Section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 Section referencing lightning protection systems specified herein.

1.02 DESCRIPTION OF WORK

- A. The extent of lightning protection system work is indicated on the Project Drawings.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of early streamer emission lightning protection system components of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years, and who are certified with ETL and listed with UL.
- B. NEC Compliance: Comply with NEC requirements pertaining to lightning (surge) arresters, grounding, grounding electrodes, and down-conductor clearances.
- C. The lightning protection manufacturer shall provide a \$10,000,000.00, 100-year guarantee to the original building owner to provide lightning protection for the protected area as shown and installed in accordance with the manufacturer's shop drawings.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on lightning protection systems and associated components.
- B. Shop Drawings: Submit layout drawings of lightning protection system equipment and components including, but not limited to, air terminals, mounting details, conductor routing, connections, and grounding.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, the manufacturer of lightning protection components shall be Lightning Preventor of America.

2.02 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. General: Provide material and components, of types, sizes, ratings, for early streamer emission (ESE) lightning protection of buildings and property, which comply with manufacturer's standard materials, design, and construction in accordance with published product information and as required for complete installation. Where type components or materials are not otherwise indicated, comply with proposed NFPA 781 standards. Unless noted otherwise, all air terminals, conductors, connectors, and ground rods shall be copper.
- B. ESE Air Terminal: The complete assembly shall consist of a stainless steel air terminal, 5/8-inch-diameter minimum, stainless steel housing, with the ESE initiator, sensing mechanism, triggering mechanism, to be completely sealed. Provide threaded base for connection to mast and nameplate.
- C. Copper conductors shall be 28 strands of 14-gauge wire rope lay, with a net weight of 375 pounds per 1,000 feet, minimum, or copper strip of equivalent capacity.
- D. Aluminum mast height to be determined by the area of protection, with threaded connections for the ESE air terminal and bonding plate for cable connection. Wind and safety factors shall be engineered to comply with geographic location, to determine the size and structure of mast. All masts are to be ETL listed.
- E. Ground rods shall be copper-clad 3/4-inch x 20-foot minimum. One set of tripod (DELTA) grounds shall be installed for each down conductor, two minimum per system with allowed exceptions.
- F. Provide all connectors, fittings, fasteners, hardware, clamps, lugs, crimps, etc. as required to connect and install all parts of the system. All material shall be ESE system certified by ETL and listed.
- G. All equipment shall be fabricated from copper and/or bronze, stainless steel, and be ESE system certified by ETL for the type of installation.
- H. All connections between dissimilar metals shall have connectors that are ESE system certified by ETL for the type of installation.

PART 3 EXECUTION

3.01 INSTALLATION OF LIGHTNING PROTECTION SYSTEMS

- A. Installation of equipment shall be performed under the direct supervision of a manufacturer's certified installer and in accordance with the equipment manufacturer's written instructions.
- B. All work shall be installed in accessible locations and properly guarded and protected.
- C. All material shall be installed in a manner to prevent electrolytic action under presence of moisture.
- D. All wall or other building penetrations shall be made in a manner to prevent the ingress of water or moisture.
- E. PVC sleeves shall be provided where conductors pass through all floors.
- F. All conductors shall be secured every 3 feet 0 inch maximum. Fasteners and clips used shall be of equal corrosion resistance as the material being secured to.
- G. Bonding of all conductive material within 6 feet of the conductor shall be accomplished via secondary conductors no smaller than #6 copper.
- H. Bare copper material shall not be installed on dissimilar metals. Corrosion-resistant copper or bronze equipment shall be used where these conditions exist. Corrosion-resistant copper conductors and fittings shall be used where corrosive atmospheres are present.
- I. Conductors shall be installed so that a conductor shall always have a horizontal or downward path, free of "U" or "V" pockets, with the exception that an 8-inch maximum rise or a rise of 3 inches maximum from every 12 inches of conductor length shall be permitted in a main conductor run.
- J. Each ESE terminal shall have two paths to ground from the base plate of the mast.
- K. The electrical contractor shall furnish and install all necessary PVC conduit (1-inch) for concealed down conductors.
- L. No bend of a conductor shall be less than 90 degrees and shall not have a radius of bend of less than 8 inches. Exceptions are through roof and wall assemblies and "T" connections.

- M. Notify Architect/Engineer before installation if lightning protection equipment and/or installation will conflict with other building materials.
- N. Coordinate with other work, including electrical wiring and roofing work, as necessary to interface installation of lightning protection system with other work.
- O. The complete lightning protection system shall be fully tested in the presence of the Engineer, and a certified ground test is to be performed and witnessed by the Engineer with all documents to be completed and forwarded to the ESE manufacturer and Engineer for evaluation, certification, archiving, and documentation.
- P. The completed system shall be videotaped and documented during installation. Documentation and videotape is to be returned to manufacturer for certification and issuance of manufacturer's guarantees and warranties, and for archiving and system documentation.

3.02 GROUNDING AND BONDING

- A. Provide equipment grounding and bonding connections, sufficiently tight to assure permanent and effective grounds and bonds, for lightning protection connection devices as indicated.
- B. Ground rods, ground plates, and ground loop conductors shall be installed a minimum of 2 feet below grade and a minimum of 2 feet away from the foundation.
- C. A minimum of one inspection and test well, rated for the traffic of the installation area, shall be installed for each down conductor or two minimum per ground loop.
- D. Bonding of grounded systems shall be via main size conductors. The bonding shall be accomplished to achieve equal potential of all grounds. All grounding connections shall be via Burndy high compression crimps, or Cadweld, or via a pre-approved connection suitable for direct burial.
- E. All ground grids are to have a ground resistance of 10 ohms or less. Testing method shall be of the "Fall of Potential Method" as described by IEEE. Delta grids shall be tested without the service ground connection, and documented as such, then connection to the service ground can be made, retested, and documented for future testing and trends.

- F. The ground resistance of the completed system shall be tested in the presence of the Engineer and shall be so noted on a Certified Ground Test document.

END OF SECTION

SECTION 16775
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Drawings and Division 1 Specification Sections apply to work of this Section.

1.02 DESCRIPTION OF WORK

- A. The extent of variable frequency drives (VFDs) work required by this Section is indicated on the Drawings and Schedules, and by the requirements of this Section:
 - 1. All VFDs shall be provided with the complete control and protective functions listed in Part 2 of this Section.
 - 2. To ensure proper coordination with the motor and provide unit responsibility for the complete pump system, all VFDs shall be provided by the pump equipment supplier.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's drive specifications and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Maintenance Data: Submit Operation and Maintenance Manual and parts lists as specified.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle variable frequency drives and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged VFDs or components; replace with new.
- B. Store VFDs and components in a clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

- C. Comply with manufacturer's installation instructions for unloading VFDs and moving them to final location.

1.05 WARRANTY

- A. All units shall be warranted for 12 months from the date of Engineer's acceptance and beneficial use of the system by the Owner. Any warranty expense during that time shall be born entirely by the manufacturer, including any travel costs or living expenses necessary to repair in warranty equipment.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVE

- A. The speed control for variable speed equipment shall be VFDs suitable for installation as shown on the Drawings.
- B. The VFDs shall include all internal auxiliaries required to meet the functional specifications.
- C. The VFDs shall conform to all requirements stipulated in this Section and Division 16, Electrical, and shall be designed for an extended speed range of 60% to 100% of full load motor speed.
- D. Each VFD shall have the following design features:
 - 1. The VFD shall be provided in a Type 12 ventilated and filtered enclosure. All harmonic correction components as well as controls as shown on applicable Drawings shall be provided within the enclosure.
 - 2. The VFD shall employ microprocessor-based inverter logic isolated from power circuits.
 - 3. The VFD shall employ a diode bridge on the input. SCR inputs are not acceptable.
 - 4. All VFDs above 30 horsepower (HP) shall employ a DC bus inductor to reduce line harmonics and improve power factor.
 - 5. The VFD shall employ a common Main Control Board from 5HP to 500HP.
 - 6. The VFD shall employ a Pulse Width Modulated (PWM) inverter system using third generation IGBT's to minimize audible motor noise and increase overall performance.
 - 7. The VFD shall employ a switching logic power supply operating from the DC bus.
 - 8. The VFD shall employ phase-to-phase and phase-to-ground MOV protection.

9. The VFD shall have a documented 28 years mean time between failure. A letter certifying this shall be provided with the bid and as part of the formal submittals.
10. The VFD shall be provided with Ethernet IP serial communications.
11. The VFD shall be designed to have a minimum of 2kHz carrier frequency without de-rating and provide selectable PWM Swing carrier patterns to minimize audible motor noise.
12. All VFDs 50HP and above shall be provided as 12-pulse minimum multi-rectifier input design. Passive harmonic filters are not acceptable. Active harmonic rectification technology is not acceptable.
13. The VFD shall be designed to operate on an AC line which may contain line notching and up to 10% harmonic distortion.
14. The VFD shall be designed to shut down with no component failure in the event of an output phase-to-phase or phase-to-ground short-circuit and provide annunciation of the fault condition.
15. The VFD shall be designed with a common control connection diagram for all ratings.
16. The VFD shall be designed such that the inverter section power semiconductors do not require commutation capacitors.
17. The VFD shall be designed to be variable torque rated. The drive shall supply 150% of rated current for up to 1 minute.
18. The VFD shall be designed to allow all parameter adjustments to be made with the door closed.
19. VFDs located indoors shall be provided in a ventilated and filtered NEMA Type 1 enclosure.
20. The VFD shall be designed with a common Customer Interface for all horsepower ratings. The Interface shall include an LCD digital display, programming keypad, and operator keys option.
21. The VFD shall provide multiple programmable stop modes, including ramp, coast, brake, and S-curve.
22. The VFD shall be designed to have an adjustable output frequency up to 60 Hz $\pm 10\%$.

E. The VFDs shall have the following features:

1. Interface: The VFD shall provide a removable Human Interface Module with integral display to show VFD operating conditions, adjustments, and fault indications. The display shall be removable under power without causing a VFD fault and be visible and operable without opening the enclosure door. The display shall consist of three lines of 16-character, alphanumeric, back-lit LCD with the display being configurable for three display values simultaneously with customized multi-lingual test, all scaled to user units.

2. Volts per Hertz Adjustment: VFD programming shall provide the ability to fully configure the volts per hertz for squared, cubed, straight line, or full custom patterns.
3. Current Limit: The VFD shall provide a programmable current limit from 20% to 150% of variable torque rating. Current limit shall be active for all VFD states; accelerating, constant speed, and decelerating. The VFD shall employ PI Regulation for smooth transition.
4. Acceleration/Deceleration: The Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 seconds to 600 seconds. The VFD shall provide a second set of remotely selectable Accel/Decel settings.
5. Speed Regulation: The VFD shall be capable of operating in a variety of speed regulation modes, including slip compensation with 0.5% speed regulation.
6. Speed Profiles: The VFD shall be capable of producing speed profiles with linear acceleration/deceleration or 'S-Curve' profiles that provide changing Accel/Decel rates. S-Curve profiles shall be selectable for fixed or adjustable values.
7. Adjustments: The digital interface shall be used for all set-up, operation, and adjustment settings. All adjustments shall be stored in non-volatile memory for factory default values as well as a programmable set of user defaults.
8. Auto Commissioning: The VFD shall be capable of automatically determining the motor's stator resistance by outputting both an AC and DC voltage to the motor and monitoring motor current. Stator resistance shall be stored in drive memory for determining proper voltage and current requirements.
9. IR Compensation (DC Boost): The VFD shall provide a selectable range for offsetting motor losses at low frequency operation DC Boost shall be current regulated and shall automatically adjust, on each start, to load changes. DC Boost shall be programmable from 15% to 120% of drive rated current.
10. Fault Reset/Run: The drive shall provide up to four automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.

11. Skip Frequencies: The VFD shall provide three adjustable setpoints to lock out continuous operation at frequencies which may produce mechanical resonance. The setpoints shall have an adjustable bandwidth of 0 Hz to 60 Hz.
12. Run On Power Up: The VFD shall provide for automatic restart of equipment after restoration of power after an outage.
13. Fault Memory: The VFD shall provide a means to store the last four faults as well as operating frequency, VFD status, and power mode at time of fault. Information shall be maintained in the event of power loss.
14. Overload Protection: The VFD shall provide NEC motor overload protection testing in accordance with UL Standard 991.
15. Terminal Blocks: The VFD shall provide separate terminal blocks for control and power wiring.
16. Operator's Devices: The VFD shall be provided with the following door-mounted pilot devices in addition to the door-mounted Human Interface Module:
 - a. Hand/Off/Auto selector switch.
 - b. Power On pilot light.
 - c. Run pilot light.
 - d. Fault pilot light.
17. Control Inputs: The VFD shall provide a separate control input terminal block for customer wiring to remote start, stop, auxiliary, remote speed reference access, and enable inputs. Four additional inputs shall be provided as programmable for functions such as preset speed access, job, second Accel and Decel time access, and local control selection. Inputs shall be programmable to configure the VFD for standard three-wire, two-wire, EC, and serial operation requirements.
18. Ride Through: The VFD shall be capable of control logic ride through in the event of power outages up to 2 seconds in duration.
19. Loss of Reference: In the event of loss of the 4 mA to 20 mA reference signal, the VFD shall be user programmable to the following:
 - a. Fault and stop.
 - b. Alarm and maintain last reference (within 10%).
 - c. Alarm and got to preset speed.

- d. Alarm and go to minimum speed.
 - e. Alarm and go to maximum speed.
20. Analog Output: The VFD shall supply two analog outputs selectable 0 volt DC to 10 volt DC or 0 mA to 20 mA, which shall be user programmable such that is proportional to output frequency, output current, bus voltage or output power, KW, output volts, or output current.
21. Digital I/O: The VFD contact output ratings shall be 115-volt AC/30-volt DC, 5.0 amps resistive, 2.0 amps inductive. The three contacts provided shall be as follows:
- a. Form C Fault Contact.
 - b. Two programmable Form A contacts.
22. Reference Signals:
- a. Digital: The VFD shall be capable of operating from a pulse input with programmable Phase Lock Loop for input/output synchronization.
 - b. Analog: The VFD shall be capable of operating from the following speed reference signals:
 - (1) VFD Human Interface Module (Hand)
 - (2) 4 mA to 20 mA signal (Auto).
 - (3) Internal set-point controller with 4-20mA process variable input signal from external transducer.
23. Internal pump Controller Capability: In addition to ability to follow an analog input related for speed control the VFD shall be able to operate in the following control modes:
- a. Simplex controller: The VFD shall Accept a 4-20ma input proportional to the process variable (flow, pressure, or as indicated in other sections of the Plans and Specifications). The drive shall accept direct keypad entry or analog input entry of desired setpoint. The VFD shall utilize PI setpoint control to continuously modulate output speed to maintain setpoint.
 - b. Multi-plex controller: The VFD shall be capable of being operated as a multiplex controller operating as in simplex mode with same system inputs but provide lead-lag control of up to six pumps such

that setpoint is controlled via operation of one or more pumps while alternating pumps to evenly distribute operation time.

- c. Digital inputs shall be programmable to include the following functions and digital display shall indicate the following condition status using the following English messages:

- (1) Check valve input alarm/fault.
- (2) High or low level alarm/fault.
- (3) High or low input pressure alarm/fault.
- (4) High pressure alarm/fault.
- (5) External fault.
- (6) Pump precharge.

- d. Analog inputs shall be programmable to include the following functions and digital display shall indicate the following condition status using the following English messages:

- (1) Process variable input (pressure, flow, level, or other).
- (2) Setpoint.
- (3) Speed reference.

- 24. The following pump specific control and protective features shall be provided. Protective features shall provide English language display on drive digital display when active:

- a. Loss of prime protection.
- b. Over cycling protection.
- c. No flow detection.
- d. Thrust bearing start.
- e. Low input pressure.
- f. Low/high flow level.
- g. Anti-jam protection.
- h. De-scale operation.

- 25. In addition to the above functionality, provide control, power, and logic functionality as shown in applicable Project Drawings.

- F. Acceptable manufacturer for the variable frequency drive units is Yaskawa IQ 1000 by ICON Technologies, no equal.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which VFDs are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF VFDS

- A. General: Install variable frequency drives where indicated in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that system complies with requirements and services intended purposes.
- B. Access: Provide access space around VFDs for service as indicated, but in no case less than that recommended by the manufacturer.

3.03 START-UP

- A. The Contractor shall provide the services of the manufacturer to inspect installation of the VFDs and provide complete start-up and programming. Start-up shall be performed by manufacturer authorized warranty service organization. A complete start-up report is to be supplied as part of final operation and maintenance manual.

END OF SECTION

Appendix A
FDEP UIC Permit to Construct



**FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION**

BOB MARTINEZ CENTER
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32399-2400

Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Ryan E. Matthews
Interim Secretary

SENT VIA ELECTRONIC MAIL:

In the Matter of an Application for Permit by:

February 27, 2017

Mark Hammond, Resource Management Director
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604
mark.hammond@swfwmd.state.fl.us

Manatee County UIC
UIC Permit Number **344918-001-UC/1R**
WACS ID **102926**
Class V Aquifer Recharge Well
Construction and Testing Permit

NOTICE OF PERMIT

Enclosed is Permit Number 344918-001-UC/1R to construct and operationally test: One Class V, Group 2 Aquifer Recharge well (RW-1) will be constructed at the Flatford Swamp in Manatee County, Florida, to investigate the feasibility of recharging excess natural surface water into the upper Floridan aquifer during wet weather flows and anthropogenic dry season flows to aid in the recovery of aquifer water levels and, to the extent practical, restore the natural hydroperiod of the swamp.

Any party to this Order (permit) has the right to seek judicial review of the permit pursuant to Section 120.68, Florida Statutes, by the filing of a Notice of Appeal pursuant to Rules 9.110 and 9.190, Florida Rules of Appellate Procedure, with the Clerk of the Department in the Office of General Counsel, 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000, agency_cleck@dep.state.fl.us; and by filing a copy of the Notice of appeal accompanied by the applicable filing fees with the appropriate District Court of Appeal. The Notice of Appeal must be filed within 30 days from the date this Notice is filed with the Clerk of the Department.

Executed in Leon County, Florida.

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL
PROTECTION

A handwritten signature in cursive script that reads "Joseph Haberfeld".

Joseph Haberfeld, P.G.
Environmental Administrator
Aquifer Protection Program

PERMITTEE: Mark Hammond, Res. Mgmt. Director
SWFWMD
Flatford Swamp Recharge Well

Permit Number: 344918-001-UC/1R
WACS ID: 102926

CERTIFICATE OF SERVICE

The undersigned designated clerk hereby certifies that this **NOTICE OF PERMIT** and all copies were mailed before the close of business on Monday, February 27, 2017 to the listed persons.

FILING AND ACKNOWLEDGMENT

FILED, on this date, pursuant to Section 120.52, Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.



Clerk

February 27, 2017

Date

Copies Furnished To:

Joseph Haberfeld, FDEP/TLH
Douglas Thornton, FDEP/TLH
Michael Lynch, FDEP/SWD
Chris Baggett, JEA/Tampa
Lisann Morris, SWFWMD
Mark McNeal, ASRus
Pete Larkin, ASRus
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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

BOB MARTINEZ CENTER
2600 BLAIR STONE ROAD
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Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Ryan E. Matthews
Interim Secretary

Underground Injection Control Class V Aquifer Recharge Injection Well System Construction and Testing Permit

Permittee:

Mark Hammond, Resource Management Director
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604
mark.hammond@swfwmd.state.fl.us

Permit/Certification

Permit Number: **344918-001-UC/1R**
WACS ID: **102926**
Date of Issuance: February 27, 2017
Date of Expiration: February 26, 2022
Permit Processor: Douglas Thornton

Facility

Flatford Swamp Recharge Well
Wauchula Road and Taylor Road
Manatee County, Florida

Location

County: Manatee County UIC
Latitude: 27° 25' 09" N
Longitude: 82° 08' 18" W

Project: Class V Injection Well System RW-1.

This permit is issued under the provisions of Chapter 403, Florida Statutes, and the rules adopted thereunder. The above named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawing(s), plans, and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows.

TO CONSTRUCT AND OPERATIONALLY TEST: One Class V, Group 2 Aquifer Recharge well (RW-1) will be constructed at the Flatford Swamp in Manatee County, Florida, to investigate the feasibility of recharging excess natural surface water into the upper Floridan aquifer during wet weather flows and anthropogenic dry season flows to aid in the recovery of aquifer water levels and, to the extent practical, restore the natural hydroperiod of the swamp. RW-1 will be constructed with a 24-inch casing set to 950 feet below land surface (bls) and a total depth of 1500 feet bls. A monitor well will be completed in the recharge zone approximately 1100 feet northeast of RW-1, and a monitor well will be completed in an overlying aquifer approximately 150 feet north of RW-1. An optional second recharge zone monitor well will be constructed approximately 400 feet northeast of RW-1.

IN ACCORDANCE WITH The Application to Construct DEP Form No. 62-528.900(1) received, June 9, 2016, response to the Department's July 12, 2016, request for additional information, and supporting information submitted to this agency.

PERMITTEE: Mark Hammond, Res. Mgmt. Director
SWFWMD
Flatford Swamp Recharge Well

Permit Number: 344918-001-UC/1R
WACS ID: 102926

LOCATION: Flatford Swamp Recharge Well, Wauchula Road and Taylor Road, Manatee County, Florida, in the county of Manatee.

The injection and monitoring wells at this facility are designated as follows:

Injection Wells:

<i>Well Name</i>	<i>WACS Effluent Testsite ID</i>	<i>Total Well Depth *</i>	<i>Casing Diameter (inches)</i>	<i>Casing or Tubing Type</i>	<i>Casing or Interval*</i>
RW-1	14066	1500	42	Steel	60
			34	Steel	350
			24	Steel	950
			Open hole		From 950 to 1500

*Feet Below Land Surface

Monitoring Wells

<i>Well Name</i>	<i>WACS Monitoring Well Testsite ID</i>	<i>Monitoring Zone</i>	<i>Casing Diameter (OD)</i>	<i>Casing Type</i>	<i>Casing Depth*</i>	<i>Monitoring Depth*</i>
SLMW-1			20	Steel	60	
			14	Steel	350	
			6	Steel	550	
	30111	Upper Zone				From 550 to 600
RZMW-1			20	Steel	60	
			14	Steel	350	
			6	Steel	950	
	30110	Lower Zone				From 950 to 1150
RZMW-2 <i>Optional</i>			20	Steel	60	
			14	Steel	350	
			6	Steel	950	
	30169	Lower Zone				From 950 to 1150

*Feet Below Land Surface

SUBJECT TO: Specific Conditions 1-V and General Conditions 1-24.

PERMITTEE: Mark Hammond, Res. Mgmt. Director
SWFWMD
Flatford Swamp Recharge Well

Permit Number: 344918-001-UC/1R
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Specific Conditions

I. GENERAL REQUIREMENTS

1. This permit is for Southwest Florida Water Management District to construct and operationally test One Class V, Group 2 Aquifer Recharge well (RW-1) and monitor wells SLMW-1, RZMW-1, and an optional RZMW-2 to be constructed at the Flatford Swamp to investigate the feasibility of recharging excess natural surface water into the upper Florida aquifer during wet weather flows and anthropogenic dry season flows to aid in the recovery of aquifer water levels and, to the extent practical, restore the natural hydroperiod of the swamp.. This permit does not authorize the construction or operational testing of any other well or wells. [62-528.440(2)(a)]
2. No underground injection is allowed that causes or allows movement of fluid into an underground source of drinking water (USDW) if such fluid movement may cause a violation of any Primary Drinking Water Standard outside a permitted Zone of Discharge or may otherwise affect the health of persons. [62-528.630(3)]
3. In the event a well must be plugged or abandoned, the permittee shall obtain a permit from the Department as required by Chapter 62-528, Florida Administrative Code. When no longer used for their intended purpose, these wells shall be properly plugged and abandoned. Within 180 days of well abandonment, the permittee shall submit to the Department the proposed plugging method, pursuant to Rule 62-528.460, F.A.C. [62-528.435(6) and 62-528.460(1)]
4. If injection is to continue beyond the expiration date of this permit the permittee shall apply for, and obtain an operation permit. If necessary to complete the operational testing period, the permittee shall apply for renewal of the construction permit at least 60 days prior to the expiration date of this permit. [62-528.307(2)(a)]
5. Zone of Discharge
 - a. A zone of discharge under Rule 62-520.465(2)(b), F.A.C, is established for this injection project. The zone of discharge extends to the permittee's property boundary. [62-520.465(2)(b)]
 - b. Compliance with the zone of discharge shall be demonstrated at monitor wells RZMW-1 and SLMW-1; primary and secondary drinking water standards and sodium must be met at these compliance wells. If the concentration for any standard in the natural background quality is greater than that which is listed in Rule 62-520.420(1), F.A.C., or in the case of pH is also less than the minimum, the representative natural background quality shall be the prevailing standard. [62-520.420, 62-520.600]
 - c. Should ground water monitoring during operation indicate drinking water parameters are not met at compliance wells RZMW-1 and SLMW-1, the permittee

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SWFWMD
Flatford Swamp Recharge Well

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shall, upon the Department's request, submit a report addressing the results of the collected ground water monitoring data. The report shall be submitted to the Department no later than 90 days after the request and shall include a discussion of the changes in water quality for parameters exceeding maximum contaminant levels. The report shall also address the adequacy of the zone of discharge and the steps to be taken to come into compliance. [62-520.700, 62-528.610(1)]

II. SITE REQUIREMENTS

1. A drilling pad shall be provided to collect spillage of contaminants and to support the heaviest load that will be encountered during drilling. [62-528.410(9)(b)]
2. No drilling operations shall begin without an approved disposal site for drilling fluids, cuttings, or waste. It shall be the permittee's responsibility to obtain the necessary approval(s) for disposal prior to the start of construction. A detailed disposal plan shall be submitted to the Department prior to the commencement of drilling activities for the injection and monitoring wells. [62-528.410(9)(a)]
3. Specific drilling pad dimensions and design drawings for Department record shall be provided prior to commencing construction and shortly after selection of the drilling contractor. [62-528.410(9)(b)]
4. The water table monitoring wells surrounding the well pads shall be sampled and analyzed prior to drilling the test injection or monitoring wells and then weekly thereafter upon the beginning of drilling operations. Sampling shall include specific conductance (umhos/cm), pH (standard units), chloride (mg/L), temperature (C), and water level (feet or PSI). [62-528.410(9)(b)]
5. Hurricane Preparedness – Upon the issuance of a “Hurricane Watch” by the National Weather Service, the preparations to be made include but are not necessarily limited to the following:
 - a. Secure all on-site salt and stockpiled additive materials to prevent surface and/or groundwater contamination.
 - b. Properly secure drilling equipment and rig(s) to prevent damage to well(s) and on-site treatment process equipment.[62-528.307(1)(f)]

III. CONSTRUCTION AND TESTING REQUIREMENTS

A. General

1. Any construction, modification, repair, or abandonment of a well shall be performed by a Florida licensed water well contractor, licensed under Chapter 62-532, F.A.C., to engage in the business of construction, modification, repair, or abandonment of a well. [62-532.200]
2. Well construction shall follow the requirements of Rule 62-532.500 for Water Well Construction Standards. [62-532.500]

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3. The measurement points for drilling and logging operations shall be surveyed and referenced to the North American Vertical Datum of 1988 (NAVD 88) prior to the onset of drilling activities for the injection and monitoring wells. *[62-160.240(3)(b)3.]*
4. Blow-out preventers or comparable flow control devices shall be installed on the injection and monitoring wells prior to penetration of the Floridan aquifer system. *[62-528.410(9)(c)]*
5. The Department shall be notified 7 days prior to the mobilization of drilling operations to the site. *[62-528.430(1)]*
6. Waters spilled during construction or testing of the injection well system shall be contained and properly disposed. *[62-528.307(1)(e) and (f), and 62-528.410(9)(b)]*
7. If additives that were not approved in the permit application are used during grouting, for lost circulation, or for any other reason, information on their properties shall be submitted to the Department prior to their use for review and approval. *[62-528.410(5)(c)]*
8. No more than 6% bentonite gel shall be used to cement any casing or tubing unless advance approval is received from the Department due to conditions found during the drilling and logging of the well. *[62-528.410(5)(f) and 62-528.420(5)(c)]*

B. Evaluation and Testing

1. The construction, geophysical logging, and packer testing programs shall be implemented in accordance with this permit and as proposed in the following submittals:
 - June 9, 2016, "Well Construction Application";
 - August 12, 2016, Response to RAI;
 - Other approved submittals received by the Department.*[62.528.307(1)(b)]*
2. Exact depths of casing seats and monitoring intervals shall be determined based on field conditions and the results obtained during the construction and testing program, and are subject to the conditions of this permit. The injection well will be constructed first followed by the monitoring wells. In the case of a multi-well injection system, at least one injection well shall be constructed first. *[62-528.410(4)(c)]*
3. Packer tests shall be conducted in the injection well to identify confinement and the base of the USDW (if applicable) and to collect hydraulic data and water quality data.

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- a. The program shall include the number of packer tests identified in the permit application, at intervals which are to be field determined.
 - b. Water samples shall be collected from each packer test, and analyzed for total dissolved solids (TDS), chlorides, specific conductance, ammonia, total Kjeldahl nitrogen, and sulfate.
[62-528.405(1)(a) and (2)(a), and 62-528.420(6)(f)]
4. Department approval is required prior to the following stages of construction and testing:
- a. Final (24-inch) casing seat in each injection well
 - b. Final (6-inch) casing seat in the monitoring wells
 - c. Monitoring zone selection
 - d. Operational testing
[62-528.410(4)(c) and 62-528.420(4)(c)]
5. The depth of the USDW (if applicable) and the background water quality of the monitoring zones shall be determined during drilling and testing using the following information:
- a. Water samples from packer test data with analysis and interpretation.
 - b. Geophysical logging upon reaching the total depth of the appropriate pilot hole interval including the following logs at a minimum: caliper, gamma ray, dual induction, and borehole compensated sonic. Other logs as identified in the permit application documents shall be run.
[62-528.405(1)(a) and 62-528.405(3)(b)]
6. The data and analysis supporting the selection of the monitoring intervals shall be submitted to the Department after the collection, interpretation, and analysis of all pertinent cores, geophysical logs, packer tests and analysis of fluid samples. The Department shall approve the final selection of the specific upper and lower monitoring intervals prior to monitor well completion. *[62-528.420(4)(c)]*
7. To identify the upper and lower monitoring zones, the following information from the injection and monitoring wells and all available on-site sources of data shall be analyzed, interpreted and submitted for Department review and approval:
- a. The characteristics of the transition zone (especially regarding TDS) in the vicinity of the base of the USDW, if applicable.
 - b. Packer test data including water quality (TDS, chlorides, sulfate, specific conductance, ammonia, and total Kjeldahl nitrogen, at a minimum).
 - c. The specific capacity or productivity of the proposed upper and lower monitoring zones based on packer testing results or other methods.
 - d. The identification of the base of the USDW, if applicable.
[62-528.420(4)(c)]
8. Test results pertaining to formation testing shall include and/or specifically reference the following informational and quality control items:

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- a. Information that documents the calibration of tools, including field checks prior to testing.
- b. The conditioning/development of the borehole prior to logging, including the techniques used and the time periods in which they were applied, and
- c. Pertaining to packer/pump testing - recording the pumping rate regularly throughout the test to account for possible variations in the pumping rate, and providing information regarding the detection of packer leaks, if any, during testing.

[62-528.405(2) and (3)]

9. Representative samples of circulation fluid shall be collected when drilling with water, air, or reverse air during the drilling of the pilot holes of injection and monitoring wells. Representative samples of circulation fluid shall be collected at a minimum of every 90 feet during drilling. The circulation fluid samples shall be analyzed for chloride and specific conductance at a minimum.

[62-528.405(1)(a), 62-528.420(6)(g)]

C. Mechanical Integrity

1. Mechanical integrity of each injection well shall be determined through the performance of a pressure test pursuant to Rule 62-528.300(6)(b)(2), F.A.C. *[62-528.300(6)(b)]*
2. Verification of pressure gauge calibration must be provided to the Department in the certified well completion report. *[62-528.300(6)(f)]*

D. Surface Equipment

1. The integrity of the monitoring zone sampling systems shall be maintained at all times. Sampling lines shall be clearly and unambiguously identified by monitoring zone at the point at which samples are drawn. All reasonable and prudent precautions shall be taken to ensure that samples are properly identified by monitoring well name or zone and that samples obtained are representative of those zones. Sampling lines and equipment shall be kept free of contamination with independent discharges and no interconnections with any other lines. *[62-528.307(1)(f) and 62-528.307(2)(b)]*
2. The surface equipment for each injection well disposing of domestic (municipal) effluent shall maintain compliance with Chapter 62-600.540(4), F.A.C., for water hammer control, screening, access for logging and testing, and reliability and flexibility in the event of damage to the well and effluent piping. *[62-600.540(4), 62-528.307(1)(f), and 62-528.307(2)(b)]*
3. Injection wells not disposing of domestic (municipal) effluent shall maintain compliance with Chapter 62-528.450(2)(j), F.A.C., for water hammer control, as well as access for logging and testing, and reliability and flexibility in the event of damage to the well and effluent piping.

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[62-528.450(2)(j), 62-528.307(1)(f), and 62-528.307(2)(b)]

4. The surface equipment and piping for the injection and monitoring wells shall be kept free of corrosion at all times. *[62-528.307(1)(f) and 62-528.307(2)(b)]*
5. Spillage onto the injection well pad(s) during construction activities, and any waters spilled during mechanical integrity testing, maintenance, testing, or repairs to the system(s) shall be contained on the pad(s) and directed to a sump which in turn discharges to the pumping station wet well, or via other approved means to the injection well system, or by another method approved by the Department. *[62-528.307(1)(f) and 62-528.307(2)(b)]*
6. After well construction activities are complete, the injection well pads are not, unless specific approval is obtained from the Department, to be used for storage of any material or equipment at any time. *[62-528.307(1)(f) and 62-528.307(2)(b)]*
7. Four surficial aquifer monitoring wells, identified as Pad Monitoring Wells (PMWs), shall be located near the corners of the pads to be constructed for the injection and monitoring wells, and shall be identified by number or pad location, i.e. NW, NE, SW, and SE. If located in a traffic area the well head(s) must be protected by traffic bearing enclosure(s) and cover(s). Each cover must lock and be specifically marked to identify the well and its purpose. The PMWs shall be sampled as follows:
 - a. During the construction and associated testing phases, the PMWs shall be sampled weekly for chlorides (mg/L), specific conductance ($\mu\text{mho}/\text{cm}$ or $\mu\text{S}/\text{cm}$), field temperature, and water level relative to the North American Vertical Datum of 1988 (NAVD 88). Initial PMW analyses shall be submitted prior to the onset of drilling activities.
 - b. The PMWs shall also be sampled for total dissolved solids (mg/L) during the first four weeks of PMW sampling and at all times when specifically requested by the Department.
 - c. The results of the PMW analyses shall be submitted to the Department in the weekly progress report. The PMWs shall be retained in service throughout the construction phase of the project. Upon completion of construction, the permittee may submit a request to the Department for cessation of sampling followed by capping, or plugging and abandonment of these wells.

[62-528.410(9)(b)]

IV. QUALITY ASSURANCE/QUALITY CONTROL

1. The permittee shall ensure that the construction and operational testing of this injection well system shall be as described in the application and supporting documents. Any proposed modifications to the permit, construction procedures, testing procedures, completion procedures, operation procedures, or any additional work not described in the application or supporting documents shall be submitted in writing to the Tallahassee office of the Aquifer Protection Program for review and clearance prior to implementation. Changes of negligible impact to the environment and staff time will

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be reviewed by the program manager, cleared when appropriate and incorporated into this permit. Changes or modifications other than those described above will require submission of a completed application and appropriate processing fee as per Rule 62-4.050, F.A.C. [62-528.100, 62-4.050]

2. Proper operation and maintenance include effective performance and appropriate quality assurance procedures; adequate operator staffing and training; and adequate laboratory and process controls. [62-528.307(2)(b)]
3. All water quality samples required by this permit shall be collected in accordance with the appropriate Department Standard Operation Procedures (SOP), pursuant to Chapter 62-160, F.A.C., Field Procedures. A certified laboratory shall conduct the analytical work, as provided by Chapter 62-160, F.A.C., Laboratory Certification. Department approved test methods shall be utilized, unless otherwise stated in this permit. All calibration procedures for field testing and laboratory equipment shall follow manufacturer's instrumentation manuals and satisfy the requirements of the Department SOPs. A listing of the SOPs pertaining to field and laboratory activities is available at the FDEP website at: <http://www.dep.state.fl.us/water/sas/sop/sops.htm>. [62-4.246, 62-160]
4. All indicating, recording and totalizing devices associated with the injection well system shall be maintained in good operating condition and calibrated annually at a minimum. The pressure gauges, flow meter, and chart recorders shall be calibrated using standard engineering methods. [62-528.307(1)(f) and 62-528.307(2)(b)]
5. All reports submitted to satisfy the requirements of this permit shall be signed by a person authorized under Rule 62-528.340(1), F.A.C., or a duly authorized representative of that person under Rule 62-528.340(2), F.A.C. All reports required by this permit which are submitted to the Department shall contain the following certification as required by Rule 62-528.340(4), F.A.C.:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.
[62-528.340(1), (2), and (4)]

6. Analyses shall be conducted on unfiltered samples, unless filtered samples have been approved by the Southwest District as being more representative of ground water conditions. [62-520.310(5)]
7. A professional engineer registered pursuant to Chapter 471, F.S., shall be retained throughout the construction period to be responsible for the construction operation and

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to certify the application, specifications, completion report, and other related documents. The Department shall be notified immediately of any change of engineer.
[62-528.440(5)(b)]

8. Continuous on-site supervision by qualified personnel (engineer and/or geologist, as applicable) is required during all testing and geophysical logging operations.
[62-528.440(5)(b)]

V. REPORTING REQUIREMENTS

1. The drilling and construction schedule, site layout of drilling pad, and pad monitoring well locations shall be submitted to the Department during site preparation but prior to drilling operation commencement for the injection well system. [62-528.430(2)(a)]
2. Weekly progress reports shall be submitted to the Department's Tallahassee and Southwest District offices throughout the construction period for each well. These reports, which may be submitted by electronic mail, shall be submitted within 48 hours of the end of the period of record and shall include at a minimum the following information:
 - a. A cover letter summary of the daily engineer report, driller's log, and a projection for activities in the next reporting period.
 - b. Daily engineer's reports and driller's work logs with detailed descriptions of all drilling progress, cementing, testing, logging, and casing installation activities.
 - c. Description of daily footage drilled by diameter of bit, size of hole opener, or reamer being used.
 - d. Collection of drilling cuttings every 10 feet and at every formation change.
 - e. Description of work during installation and cementing of casing, including amounts of casing and cement used. Details of cementing operations shall include the number of cementing stages, and the following information for each stage of cementing: the volume and type of cement pumped, the theoretical fill depth, and the actual tag depth. From both the physical tag and the geophysical logs, a percent fill shall be calculated. An explanation of any deviation between actual versus theoretical fill shall be provided.
 - f. Details of the additions of salt or other materials to suppress well flow, including the date, depth, and amount of material used.
 - g. Description of testing accomplished including (but not limited to) pumping and packer tests.
 - h. Lithologic logs and core descriptions with cuttings description, formation and depth encountered.
 - i. Geophysical logs, video logs, and deviation survey results.
 - j. Water quality analyses, including but not limited to the weekly water quality analysis and water levels for the PMWs.
 - k. Well development records.
 - l. Description of any construction problems that developed during the reporting period and current status.

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- m. Interpretations included with all test results and logs submitted.
 - n. Documentation of disposal of drilling fluids, cuttings, formation water, or waste as per specific condition II.2.
[62-528.410(9)(a) and 62-528.430(1)]
3. The final selection of specific injection and monitoring intervals must be approved by the Department. In order to obtain an approval, the permittee shall submit a written request to the Department's Tallahassee office. All casing seat requests for the injection and monitoring wells shall be accompanied by technical justification. To the extent possible, each casing seat request should address the following items:
- a. Lithologic and geophysical logs with interpretations, as the interpretations relate to the casing seat.
 - b. Water quality data (including but not necessarily limited to TDS concentrations).
 - c. Identification of confining units, including hydrogeologic data and interpretations.
 - d. Identification of monitoring zones.
 - e. Casing depth evaluation (mechanically secure formation, potential for grout seal).
 - f. Lithologic drilling rate and weight on bit data, with interpretations (related to the casing seat).
 - g. Identification of the base of the USDW, if applicable, using water quality and geophysical log interpretations.
 - h. A certified (P.E. or P.G.) evaluation of all logging and test results submitted with test data.
 - i. Transmissivity or specific capacity of proposed monitoring zone, or alternative evaluation of the zone's productivity.
 - j. Packer test drawdown curves and interpretation.
[62-528.410(4)(c), 62-528.420(4)(c)]
4. Upon completion of analysis of cores and sample cuttings recovered during the construction of wells covered by this permit (when no longer needed by the well owner), the permittee shall contact the Geological Sample Acquisition and Management Section of the Florida Geological Survey (FGS) to arrange for the transfer of the cores and cuttings. The FGS shall also be contacted to arrange for the collection of 100 ml water samples, with nitric acid preservative for metal analysis, at the end of each packer test (where sufficient water is available) and aquifer background sample collection events. *[62-528.450(5)]*
5. All cores, cuttings, and water samples for FGS shall be shipped to the Florida Geological Survey, Geological Sample Acquisition and Management Section, 3915 Commonwealth Boulevard, Tallahassee, Florida 32399. All cores and samples shall clearly identify the site name, well name/number, depths of samples/cores, and the latitude/longitude location of the well(s) using the form in this permit.
[62-528.450(5)]

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6. A final report of the construction and testing of the injection and monitoring wells shall be submitted no later than 120 days after commencement of operational testing, pursuant to Rule 62-528.430(1)(e), F.A.C. In addition, a copy of the cover letter for the report shall be sent to the U. S. Environmental Protection Agency, Region 4, UIC program, 61 Forsyth St. SW, Atlanta, GA 30303-8909, or R4_gwuic@epa.gov. This report shall include as a minimum, definitions of the injection interval, all relevant confining units, the depth of the base of the USDW, and all monitoring zones, including all relevant data and interpretations. [62-528.450(5)]

VI. OPERATIONAL TESTING AND MONITORING REQUIREMENTS

A. Operational Testing

1. The permittee shall conduct operational testing of the injection well system to demonstrate that the well can absorb the design and peak daily flows that are expected, prior to granting approval for operation. [62-528.450(3)(a)]
2. The operational testing of the Class I injection well system under this permit shall not commence without written authorization from the Department. [62-528.450(3)(b)]
3. Prior to operational testing approval, the following items must be submitted with the request for operational testing approval for Department review and approval:
 - a. Lithologic and geophysical logs with interpretations.
 - b. A copy of the borehole television survey(s) or borehole televiewer log(s) of the injection well with interpretation.
 - c. Certification (P.E. or P.G.) of mechanical integrity and interpreted test data.
 - d. Results of the short-term variable-rate pumping test or recirculation test with interpretation of the data.
 - e. A description of the actual injection procedure including the anticipated maximum pressure or water level and flow rate at which the well will be operated under normal and high discharge conditions.
 - f. Certification of completion of well construction from water well contractor and certification by the Engineer of Record that permit conditions are met.
 - g. Calibration certificates for pressure gauges and flow meters, as applicable.
 - h. Demonstration of confinement and definition of the injection and confining sequences shall utilize data collected during the drilling, logging, and testing of the injection and monitoring wells. This submittal shall be prepared, signed, and sealed by a Florida Registered Professional Geologist or appropriately qualified Florida Registered Professional Engineer.
 - i. Background water quality data from the monitoring and injection zones, analyzed for primary and secondary drinking water standards (62-550, F.A.C.) excluding pesticides, PCB's, asbestos, dioxin, butachlor, acrylamide, and epichlorohydrin.
 - j. A wastestream analysis for the same parameters as in condition VI.A.4.m., above. Unless already submitted, this analysis shall be submitted within 60 days after the beginning of operational testing.

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- k. Other data obtained during well construction needed by the Department to evaluate whether the injection well system will operate in compliance with Department rules.
[62-528.450(3)(a)3.]

5. Prior to operational testing approval and pursuant to Rule 62-528.450(2)(j) F.A.C., submit engineering drawings of the surface and subsurface construction details of the system, including design features for surge control and water hammer protection. These drawings shall be a minimum size of 18 x 24 inches and a maximum size of 36 x 42 inches but photographically reproduced drawings with a reduced size as small as 11 inches by 17 inches are acceptable if the original drawings are drawn to a scale that will permit all necessary information to be plainly seen on the reduced-size reproductions. The drawings shall be signed and sealed by a professional engineer registered in the State of Florida as required by Rule 62-528.440(5)(b), F.A.C.

The engineering drawings, each signed and sealed by the professional(s) who prepared or approved it, should include, but not limited to, the following:

- Facility location plan;
- Process flow diagram; Flow control arrangement for the injectate flow to the injection well(s);
- Injection well(s) construction and well(s) head details;
- Monitoring well(s) construction and well(s) head details;
- Inlet piping from the piping header to the well(s);
- Location of sampling points for the effluent on the piping to the well(s);
- Flow equalization system, if any; wet well(s) or effluent storage tanks;
- Pump station and surface/subsurface suction/discharge piping to the injection well(s), filters; valves etc.; Flow control arrangement, if any;
- Conveyance of surface water from intake point to injection well;
- Surface/subsurface piping from the piping header to the injection well(s), valves etc.
- Design features for surge control and water hammer protection;
- Instruments and other devices;
- Monitor well(s) purge piping, sample points and separation of sampling lines from other lines to prevent cross connection and intended disposal method of purge water.

The drawings shall be legible and shall give sufficient detail to clearly appraise the Department of the work to be undertaken.

6. Prior to operational testing approval and pursuant to Rule 62-528.425(1)(b), F.A.C., submit document(s) showing the installation of:
- a. Continuous indicating, recording, and totalizing devices to monitor flow rate and volume.

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- b. Continuous indicating and recording devices to monitor the injection pressure or water level, and water level or pressure of the monitor wells.
7. Pressure gauges or water level indicators, and flow meters shall be installed on the injection wells prior to initiating injection activities at the site. [62-528.450(3)(a)]
8. Prior to the authorization of operational testing by the Department, the permittee shall contact the Southwest District office to arrange a site inspection. The inspection will determine if the conditions of the permit have been met and to verify that the injection well system is operational. During the inspection, emergency procedures and reporting requirements shall be reviewed. [62-528.450(3)(c)]
9. The Engineer of Record or designated qualified representative must be present for the start-up operations and the Department must be notified in writing of the date operational testing commenced for the subject wells. [62-528.440(5)(b)]

Monitoring

1. The permittee shall submit monthly to the Department the results of all recharge well and monitoring well data required by this permit no later than the last day of the month immediately following the month of record. The report shall include:
 - a. A cover page summarizing the current status of all monthly activities, including the certification and signature required in condition IV.5.;
 - b. Operational and water quality data in a tabular format. The following identifying information must be included on each data sheet:
 - i. Facility Name
 - ii. Well Name
 - iii. UIC Permit Number
 - iv. WACS Facility ID
 - v. WACS Testsite ID (on appropriate data sheet) as provided on the Recharge Well and Monitoring Well tables on page 2 of this permit.
 - c. Laboratory pages and supporting documentation.[62-528.307(3)(d)]

2. The report may be sent via electronic mail in Adobe™ (.pdf) format to the following Program e-mail addresses:

Southwest District	SWD_UIC@dep.state.fl.us
Tallahassee - UIC Program	TAL_UIC@dep.state.fl.us

If a paper copy of the report is submitted, it should be sent to Department staff at the following addresses:

Southwest District	13051 N. Telecom Parkway Tampa, Florida 33637
Tallahassee - UIC Program	2600 Blair Stone Road, MS 3530 Tallahassee, Florida, 32399-2400

[62-528.307(3)(d)]

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3. The recharge system shall be monitored in accordance with Rules 62-528.425(1)(g) and 62-528.430(2), F.A.C. The following recharge well performance data and monitor zone data shall be recorded and reported in the Monthly Operating Report (MOR) as indicated below. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

[62-528.307(2)(d), 528.430(2), and 62-528.450(3)(b)5.]

PARAMETER	UNIT	RECORDING FREQUENCY OR SAMPLING METHOD	FREQUENCY OF ANALYSES		
			RW-1	SLMW-1 <i>Upper Zone</i>	RZMW-1, 2 <i>Lower Zone</i>
Injection Pressure or water level, max.	Psi or ft. NAVD	continuous	D/M ^a		
Injection Pressure or water level, min.	Psi or ft. NAVD	continuous	D/M ^a		
Injection Pressure or water level, avg.	Psi or ft. NAVD	continuous	D/M ^a		
Total Volume (Injected)	mg	daily/monthly	D/M ^a		
Flow Rate, max.	gpm	continuous	D/M ^a		
Flow Rate, min.	gpm	continuous	D/M ^a		
Flow Rate, avg.	gpm	continuous	D/M ^a		
Water Level or Pressure max.	ft NAVD or psi	continuous		D/M ^a	D/M ^a
Water Level or Pressure min.	ft NAVD or psi	continuous		D/M ^a	D/M ^a
Water Level or Pressure avg.	ft NAVD or psi	continuous		D/M ^a	D/M ^a
Biochemical Oxygen Demand (BOD)	mg/L	grab	W	W	W
Dissolved Oxygen ^b	mg/L	grab	W	W	W
Fecal Coliform	#/100 ml	grab	W	W	W
pH ^b	std. units	grab		W	W
Oxidation-Reduction Potential ^b	mV	grab	W	W	W
Specific Conductance ^b	µmhos/cm	grab	W	M	M
Total Coliform	#/100 ml	grab	W	W	W
E. coli	cfu/100 ml	grab	M	M	M
Enterococci	#/100 ml	grab	M	M	M
Gross Alpha	pCi/L	grab	M	M	M
Uranium	pCi/L	grab	M	M	M
Uranium	mg/L	grab	M	M	M
Temperature ^b	°C	grab		W	W
Arsenic	µg/L	grab	W	W	W
Chloride	mg/L	grab	M	M	M
Color	color units	grab	W	W	W
Nitrate (as N)	mg/L	grab	M	M	M
Odor	TON	grab	W	W	W
Sulfate	mg/L	grab	W	W	W
Total Alkalinity	mg/L	grab	W	W	W
Total Dissolved Solids	mg/L	grab	W	W	W
Total Suspended Solids	mg/L	grab	W	W	W
Total Iron	mg/L	grab	W	W	W
Cryptosporidium	oocysts/100 ml	grab	A	A	A
<i>Giardia lamblia</i>	cysts/100 ml	grab	A	A	A
Source Water, Primary and Secondary Standards		Composite	A	A	A

See injection well and monitoring well tables at beginning of permit for more information.

W – Weekly; M – Monthly; A – Annually

^a – Operational data reporting for flows, pressures and water levels: daily max, min and average from continuous reporting; monthly max, min and average (calculated from daily averages).

^b – Field samples

Sampling schedule may be adjusted after sufficient data has been collected to support a written request to do so, and with written Department approval.

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4. Pertaining to the evacuation (purging) of the monitoring well(s), which is required prior to the collection of samples for the Monthly Operating Reports (MORs), the facility may elect to follow either one of the following two purging protocols:

a. The protocol stated below:

A minimum of three well volumes of fluid shall be evacuated from the monitoring systems prior to sampling for the chemical parameters listed above. Sufficient purging shall have occurred when either of the following has occurred:

- 1) pH, specific conductance and temperature when sampled, upon purging the third or subsequent well volume, each vary less than 5% from that sampled upon purging the previous well volume; or
- 2) Upon purging the fifth well volume.

b. The following protocol taken from DEP-SOP-001/01(Field Procedures):

- 1) Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one well volume, and then collect the first set of stabilization parameters, namely pH, specific conductance and temperature;
- 2) Thereafter, collect stabilization parameters \geq every $\frac{1}{4}$ well volume;
- 3) Purging shall be complete when either of the following have occurred:
 - a) 3 consecutive readings of the parameters listed below are within the following ranges^[1]:
 - pH \pm 0.2 Standard Units
 - Specific Conductance \pm 5.0% of reading
 - Temperature \pm 0.2°C
 - b) Upon purging the fifth well volume.

[62-160.210(1) and 62-528.430(2)]

VII. ABNORMAL EVENTS

1. In the event the permittee is temporarily unable to comply with any of the conditions of a permit due to breakdown of equipment, power outages or destruction by hazard of fire, wind, or by other cause, the permittee of the facility shall notify the Southwest District office. [62-528.415(4)(a)]
2. Notification shall be made in person, by telephone, or by electronic mail (e-mail) within 24 hours of breakdown or malfunction to the Southwest District office. [62-528.307(1)(x)]
3. A written report of any noncompliance referenced in Specific Condition VII 1. above shall be submitted to the Southwest District office and the Tallahassee office within five days after its occurrence. The report shall describe the nature and cause of the breakdown or malfunction, the steps being taken or planned to be taken to correct the problem and prevent its reoccurrence, emergency procedures in use pending correction of the problem,

^[1] Provided dissolved oxygen in the groundwater of the zone being monitored is \leq 20% of saturation for the measured temperature and turbidity is \leq 20 NTUs. This assumption holds true for groundwater in most zones of the Floridan aquifer.

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and the time when the facility will again be operating in accordance with permit conditions. [62-528.415(4)(b)]

General Conditions

1. The terms, conditions, requirements, limitations and restrictions set forth in this permit are "permit conditions" and are binding and enforceable pursuant to section 403.141, F.S. [62-528.307(1)(a)]
2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action. [62-528.307(1)(b)]
3. As provided in subsection 403.087(7), F.S., the issuance of this permit does not convey any vested rights or exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor infringement of federal, state, or local laws or regulations. This permit is not a waiver of or approval of any other Department permit that may be required for other aspects of the total project which are not addressed in this permit. [62-528.307(1)(c)]
4. This permit conveys no title to land, water, does not constitute State recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title. [62-528.307(1)(d)]
5. This permit does not relieve the permittee from liability for harm to human health or welfare, animal, or plant life, or property caused by the construction or operation of this permitted source, or from penalties there from; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department. [62-528.307(1)(e)]
6. The permittee shall properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed and used by the permittee to achieve compliance with the conditions of this permit, or are required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules. [62-528.307(1)(f)]
7. The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law and at reasonable times, access to the premises where the permitted activity is located or conducted to:
 - a. Have access to and copy any records that must be kept under conditions of this permit;

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- b. Inspect the facility, equipment, practices, or operations regulated or required under this permit; and
 - c. Sample or monitor any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules.
 - d. Reasonable time will depend on the nature of the concern being investigated.
- [62-528.307(1)(g)]
- 8. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:
 - a. A description of and cause of noncompliance; and
 - b. The period of noncompliance, including dates and times; or, if not corrected the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate, and prevent the recurrence of the noncompliance. The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.
- [62-528.307(1)(h)]
- 9. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except where such use is proscribed by sections 403.111 and 403.73, F.S. Such evidence shall only be used to the extent it is consistent with the Florida Rules of Civil Procedure and appropriate evidentiary rules. [62-528.307(1)(i)]
- 10. The permittee agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance; provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules.
- [62-528.307(1)(j)]
- 11. This permit is transferable only upon Department approval in accordance with rules 62-4.120 and 62-528.350, F.A.C. The permittee shall be liable for any non-compliance of the permitted activity until the transfer is approved by the Department.
- [62-528.307(1)(k)]
- 12. This permit or a copy thereof shall be kept at the work site of the permitted activity.
- [62-528.307(1)(l)]
- 13. The permittee shall comply with the following:
 - a. Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records shall be extended automatically unless the Department determines that the records are no longer required.

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- b. The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application for this permit. These materials shall be retained at least three years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule.
 - c. Records of monitoring information shall include:
 - i. the date, exact place, and time of sampling or measurements;
 - ii. the person responsible for performing the sampling or measurements;
 - iii. the dates analyses were performed;
 - iv. the person responsible for performing the analyses;
 - v. the analytical techniques or methods used;
 - vi. the results of such analyses.
 - d. The permittee shall furnish to the Department, within the time requested in writing, any information which the Department requests to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit.
 - e. If the permittee becomes aware that relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be corrected promptly.
- [62-528.307(1)(m)]
14. All applications, reports, or information required by the Department shall be certified as being true, accurate, and complete. [62-528.307(1)(n)]
15. Reports of compliance or noncompliance with, or any progress reports on, requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each scheduled date. [62-528.307(1)(o)]
16. Any permit noncompliance constitutes a violation of the Safe Drinking Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application. [62-528.307(1)(p)]
17. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. [62-528.307(1)(q)]
18. The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit. [62-528.307(1)(r)]
19. This permit may be modified, revoked and reissued, or terminated for cause, as provided in 40 C.F.R. sections 144.39(a), 144.40(a), and 144.41 (1998). The filing of a request by the permittee for a permit modification, revocation or reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition. [62-528.307(1)(s)]

PERMITTEE: Mark Hammond, Res. Mgmt. Director
SWFWMD
Flatford Swamp Recharge Well

Permit Number: 344918-001-UC/1R
WACS ID: 102926

20. The permittee shall retain all records of all monitoring information concerning the nature and composition of injected fluid until five years after completion of any plugging and abandonment procedures specified under rule 62-528.435, F.A.C. The permittee shall deliver the records to the Department office that issued the permit at the conclusion of the retention period unless the permittee elects to continue retention of the records. *[62-528.307(1)(t)]*
21. All reports and other submittals required to comply with this permit shall be signed by a person authorized under rules 62-528.340(1) or (2), F.A.C. All reports shall contain the certification required in rule 62-528.340(4), F.A.C. *[62-528.307(1)(u)]*
22. The permittee shall notify the Department as soon as possible of any planned physical alterations or additions to the permitted facility. In addition, prior approval is required for activities described in rule 62-528.410(1)(h). *[62-528.307(1)(v)]*
23. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or injection activity which may result in noncompliance with permit requirements. *[62-528.307(1)(w)]*
24. The permittee shall report any noncompliance which may endanger health or the environment including:
 - a. Any monitoring or other information which indicates that any contaminant may cause an endangerment to an underground source of drinking water; or
 - b. Any noncompliance with a permit condition or malfunction of the injection system which may cause fluid migration into or between underground sources of drinking water.

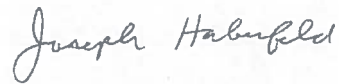
Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. *[62-528.307(1)(x)]*

PERMITTEE: Mark Hammond, Res. Mgmt. Director
SWFWMD
Flatford Swamp Recharge Well

Permit Number: 344918-001-UC/1R
WACS ID: 102926

Issued this 27st day of February 2017

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL
PROTECTION



Joseph Haberkfeld
Environmental Administrator
Aquifer Protection Program
Division of Water Resource Management

Appendix B

Geotechnical Report

Geotechnical Engineering Services Report

Aquifer Recharge at Flatford Swamp
for Saltwater Intrusion Minimum Aquifer Level (SWIMAL)
Recovery and Natural Systems Improvement (H089)

Manatee County, Florida

Prepared for: **Jones Edmunds & Associates, Inc.**
324 South Hyde Park Avenue, Suite 250
Tampa, Florida 33606

JonesEdmunds 

and

Southwest Florida Water Management District (SWFWMD)
Agreement 18CC0000003 between
SWFWMD and Jones Edmunds & Associates, Inc.



Prepared by: **MC Squared, Inc.**
5808-A Breckenridge Parkway
Tampa, Florida 33610

Project No. T071726.162
June 13, 2018





May 15, 2018
(Revised June 13, 2018)

Ms. Michelle R. Hays, MS, PG
Project Scientist
Jones Edmunds & Associates, Inc.
324 South Hyde Park Avenue, Suite 250
Tampa, Florida 33606

Subject: Geotechnical Engineering Services Report
Flatford Swamp Aquifer Recharge
Manatee County, Florida
MC² Proposal Number T071726.162

Dear Ms. Hays:

MC Squared, Inc. (MC²) has completed our Geotechnical Engineering Services Report for the referenced project. This study was performed in general accordance with **MC²** proposal No. T071726.162, dated October 5, 2017. These services included a subsurface exploration, laboratory testing, evaluation of the field and laboratory testing data and our geotechnical recommendations for project design and construction. The accompanying report documents all of our findings and recommendations.

We trust that this report will assist you in further design development and construction of the subject project. We appreciate the opportunity to be of service to you on this project. Should you have any questions and/or require further information, please do not hesitate to contact us.

Respectfully submitted,
MC²

A handwritten signature in blue ink, appearing to read "Steven Nason".

Steven Nason, EI
Staff Engineer

A handwritten signature in blue ink, appearing to read "Winston L. Stewart".

Winston L. Stewart, PE
Vice President/Chief Engineer
Florida PE No. 81643

A handwritten signature in blue ink, appearing to read "Bradley A. Crowson".

Bradley A. Crowson, EI
Associate Project Manager

A handwritten signature in blue ink, appearing to read "Jeffery L. Hooks".

Jeffery L. Hooks, PE
Project Engineer
Florida PE No. 67882

EXECUTIVE SUMMARY

MC Squared, Inc. (MC²) has performed a subsurface soil exploration via the drilling of three (3) Standard Penetration Test (SPT) borings ranging in depths from 20-ft. to 25-ft. In conjunction with the fieldwork, laboratory testing was done on selected representative soil samples collected from the soil test borings to determine their physical properties. Using the results of the subsurface soil exploration and laboratory testing, as well as our knowledge of the project site, we developed soil recommendations for use in the design and construction of the planned lightweight structures (well pads, intake structures, and pumps). Based on our evaluations and analyses, it is our opinion that shallow foundations would be suitable for supporting these structures., provided that our recommendations for site preparation are followed.

We recommend a maximum allowable foundation bearing pressure of 2,000 pounds per square foot (psf). Under this condition, we estimate that the total and differential settlements of the shallow foundations would be about 1-in. and 0.5-in., respectively. The majority of the settlements will likely occur during construction, with the rest occurring over the long-term.

Groundwater may be an issue during construction of the proposed improvements. Consequently, the contractor should determine the groundwater depth before the beginning of construction. Dewatering may be necessary during trench excavation for utility installations as well as foundation excavations. Depending on the amount of groundwater, a system of sump pumps and/or well points should be sufficient to control the groundwater to the levels that allow the construction to proceed effectively.

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Boring Location Map – Sheet 2
USDA Soil Survey/USGS Topographic Map – Sheet 3
Subsurface Boring Profiles – Sheet 4
Subsurface Boring Profile USCS Legend – Sheet 5
Individual Soil Profiles (3 Sheets)
Test Procedures

1 INTRODUCTION

1.1 Purpose

The purpose of the geotechnical services was to evaluate the subsurface conditions at the project site for a proposed well pad and structure at the Recharge Well (RW-1) location and water intake structure(s) in order to develop geotechnical recommendations for these structures. This report describes the exploratory and testing procedures and includes the following items:

- (a) Scope of Services Performed
- (b) The Results of the Subsurface Exploration
- (c) The Results of the Laboratory Testing
- (d) Engineering Evaluations of the Data Gathered
- (e) Soil Parameters for Design and Construction Considerations

1.2 Project Authorization

Authorization to proceed with this project was issued by Ms. Michelle R. Hays of **Jones Edmunds & Associates, Inc. (JEA)** through a Standard Subcontract for Professional Services dated February 16, 2018. The project was performed in general accordance with our proposal dated October 5, 2017.

2 PROJECT INFORMATION

2.1 Project Description

Based on our understanding, the **Southwest Florida Water Management District (SWFWMD)** plans to construct a well pad and water intake structure(s). Project information has been provided by Ms. Michelle Hays of **JEA**, through e-mailed communications including a proposed site plan (**Figure 1**) showing the proposed construction area(s).

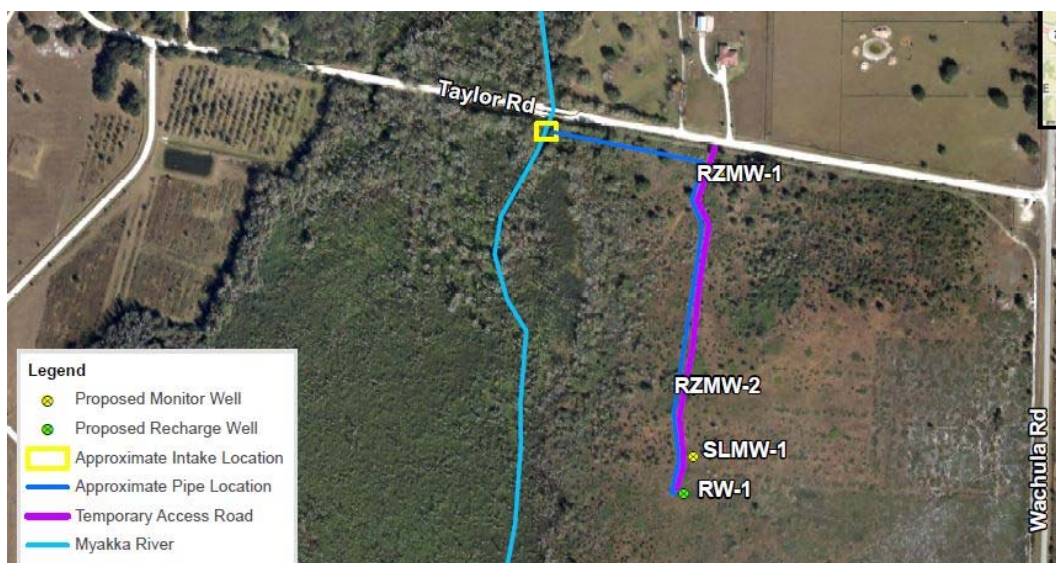


Figure 1: Project Site (provided by JEA)

2.2 Site Description

The project site is located in the Flatford Swamp Preserve at the intersection of Taylor Road and Wachula Road in Manatee County, Florida. The majority of the site consists of freshwater marsh and bottomland swamp with small shrubs and trees. There are rangelands, hardwood forests and pine flatwoods scattered along the periphery of the site. An access road was constructed recently by others that allowed access to the site with only minimal clearing necessary.



Figure 2: View facing west from RW-1 near SPT-03 (photographed April 12, 2018)

2.3 Scope of Services

Our scope of services consisted of the following:

1. Conducted a visual reconnaissance of the project site. Reviewed the USDA Soil Survey for Manatee County and the USGS topographic maps. Boring locations were determined and staked by JEA representatives.
2. Cleared utilities in the vicinity of the proposed boring locations via Sunshine811.
3. Performed three (3) Standard Penetration Test (SPT) borings to depths of 20, 23 and 25- ft. below the ground surface (bgs) as shown on the **Boring Location Map** on **Sheet 2** in the **Appendix**. Fieldwork was performed at the staked locations, except SPT-03, which was offset approximately 45-ft. southeast due to the staked location being inaccessible.

4. Measured the depth to groundwater at the boring locations.
5. Visually examined all recovered soil samples in the laboratory. Laboratory tests were performed on selected representative samples to develop the soil legend for the project using the Unified Soil Classification System (USCS). The laboratory testing consisted of percent passing the No. 200 sieve, organic content, Atterberg Limit determinations and natural moisture content determinations.

Using the data generated from our geotechnical services, we developed the following:

1. General assessment of area geology based on our experience, study of geological literature and boring information.
2. General suitability of materials within the site for use as engineered fills and general backfill.
3. General location and description of potentially deleterious materials encountered in the boring, which may interfere with future construction or performance, including existing fills or surficial organics.
4. Critical design and/or construction considerations based on the soil and groundwater conditions developed from the borings.
5. Groundwater levels in the borings, where encountered and estimate of seasonal high groundwater table (SHWT).
6. Soil subgrade preparation procedures, including site preparation and compaction. Engineering criteria for the placement and compaction of fill materials and recommendations for typical shallow foundation design.

The scope of our services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of our Client. Additionally, this was not a sinkhole investigation. Accordingly, our field exploration was not designed to address sinkhole-related issues. Any mention of geological characteristics in relation to karst conditions is for informational purposes only.

3 SUBSURFACE EXPLORATION

3.1 General

The field exploration program consisted of performing three (3) SPT borings. The borings were performed on April 17, 2018. The field exploration services were performed under direct supervision of MC²'s qualified staff engineers and overseen by a licensed Florida professional engineer.

3.2 Standard Penetration Test Borings

The SPT borings were completed at the site in general accordance with ASTM D1586 (Standard Test Method for Penetration Test and Split Barrel Sampling of Soils) using a track-mounted drill rig and wet-rotary procedure. Soil samples were obtained using the split-barrel sampling procedure for each boring performed. In this procedure, a 2-in. outer-diameter split-barrel sampler is driven into the soil by a 140-lb hammer operating over a free-fall of 30-in. The number of blows required to drive the sampler through a 12-in. interval, after initial penetration of 6-in., is termed the Standard Penetration Resistance, or "N" value, and is indicated for each sample on the boring log. The "N" value provides an empirical assessment of the relative density (cohesionless soils) or consistency (cohesive soils) of soils in-situ.



Figure 3: Performing SPT-01 (photographed April 17, 2018)

4 LABORATORY TESTING

4.1 Soil Classification Testing

A representative set of soil samples was selected from each of the soil borings and tested in the laboratory to assist in the classification and determination of engineering characteristics of the soils based on their mechanical and physical behavior. Laboratory testing was accomplished in general accordance with applicable ASTM standards. Laboratory tests completed on soil samples retrieved for this project included:

- Six (6) moisture content determinations (ASTM D2216),
- Six (6) percent passing the No. 200 US standard sieve tests (ASTM D1140),

- One (1) Atterberg limit determination tests (ASTM D4318),
- One (1) organic content determination (ASTM D2974) and
- Visual classification in general accordance with USCS procedures

Results for each of these laboratory tests are summarized in **Table 1** and are also presented on the **Individual Soil Profile** logs provided in the **Appendix**.

Table 1: Summary of Laboratory Testing

Sample ID and Depth (ft)	Moisture Content (%)	Percent Passing -200 Sieve (%)	Organic Content (%)	Plastic Limit	Liquid Limit	Plasticity Index	USCS Classification
SPT-01 (8-10)	22.8	8.0	2.7	-	-	-	SP-SM
SPT-01 (18.5-20)	25.1	11.6	-	-	-	-	SP-SC
SPT-02 (18.5-20)	22.7	7.9	-	-	-	-	SP-SM
SPT-02 (20-21.5)	35.6	24.3	-	20	30	10	SC
SPT-03 (6-8)	20.3	13.0	-	-	-	-	SM
SPT-03 (18.5-20)	27.2	8.2	-	-	-	-	SP-SM

4.2 Moisture Content

The laboratory moisture content test consists of the determination of the percentage of moisture contents in selected samples in general accordance with ASTM test designation D-2216 (Standard Test Methods for Laboratory Determination of Water Content of Soil and Rock by Mass). Briefly, natural moisture content is determined by weighing a sample of the selected material and then drying it in a warm oven. Care is taken to use a gentle heat so as not to destroy any organics. The sample is then removed from the oven and reweighed. The difference of the two weights is the amount of moisture removed from the sample. The weight of the moisture divided by the weight of the dry soil sample is the percentage by weight of the moisture in the sample.

4.3 Percent Passing the No. 200 Sieve

The wash gradation test measures the percentage of a dry soil sample passing the No. 200 sieve. By definition in the Unified Soil Classification System, the percentage by weight passing the No. 200 sieve is the silt and clay content. The amount of silt and clay in a soil influences its properties, including permeability, workability and suitability as fill. This test was performed in general accordance with ASTM D-1140 (Standard Test Methods for Amount of Material Finer than the No. 200 (75 µm) Sieve).

4.4 Atterberg Limits

The laboratory Atterberg limits test measures the liquid limit, plastic limit, and plastic index of soils in accordance with ASTM D4318 (Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils). These characteristics are used in multiple engineering classification systems to specify the fine-grained fractions of soils. By classifying, other characteristics of soils

can also be correlated with engineering behavior such as compressibility, permeability, compactibility, shrink-swell, and shear strength.

4.5 Organic Content

The organic content test consists of determining the percentage of organic materials in selected samples, in general accordance with ASTM test designation D-2974. Briefly, the organic content is determined by weighing a sample of the selected material and then burning off the organic material in a hot oven. The sample is removed from the oven and reweighed. The difference of the two weights is the amount of organic material removed from the sample. The weight of the organic material divided by the weight of the dry, before burn, soil sample is the percentage by weight of the organic material in the sample.

5 SITE AND SUBSURFACE CONDITIONS

5.1 Manatee County Soil Survey

We reviewed the USDA Soil Conservation Service's *Soil Survey of Manatee County, Florida* for general information on the shallow soils in the vicinity of the site. The survey area date is Version 14, October 2, 2017, with aerial images photographed from March 14 to 18, 2011. The USDA Soil Conservation Service Soil Survey outlines approximate areas dominated by a particular shallow soil type. Small areas of other soils may occur within the mapping unit.

The Project area is within two mapping units: Felda-Wabasso association, frequently flooded (24) and Waveland fine sand (52).

Felda-Wabasso association, frequently flooded (24) has a parent material of sandy and loamy marine deposits and the depth to water table is about zero to 12 inches. The typical profile of Felda is fine sand from zero to 24-in., sandy clay loam from 24 to 64-in. and fine sandy loam from 64 to 80-in. bgs. This material is poorly drained and has a moderately high to high capacity to transmit water. The typical profile for Wabasso is fine sand from zero to 37-in., sandy loam from 37 to 65-in. and sand from 65 to 80-in. bgs. This material is poorly drained and has a moderately low to moderately high capacity to transmit water.

Waveland fine sand (52) has a parent material of sandy marine deposits and a typical profile of fine sand from zero to 80-in. bgs. The material is poorly drained and has a moderately low to moderately high capacity to transmit water. The depth to water table is about 6 to 18 inches.

The USDA Soil Survey is not an exact representation of the soils on the site. The mapping by USGS is based on interpretation of aerial maps with scattered shallow borings for confirmation. Accordingly, borders between mapping units are approximate and the change may be transitional. Differences may also occur from the typical stratigraphy, and small areas of other similar and dissimilar soils may occur within the soil-mapping unit. As such, there may be differences in the mapped description and the boring descriptions obtained for this report. Development/urbanization can also cause differences in the typical stratigraphy. The survey is,

however, a good basis for evaluating the shallow soil conditions of the area. The USDA Soil Map is contained in the **Appendix** and summarizes the soil survey data within the project area.

5.2 USGS Topographic Maps

Based on our review of the USGS topographic quadrangles titled “Myakka City NW Quadrangle”, the existing site is at an approximate elevation range of 45 to 55-ft. (NAVD 1988). The general elevation of the site does not appear to have changed significantly overtime. We have included one of the **USGS Topographic Maps** in the **Appendix**, for reference.

5.3 Subsurface Conditions

The subsurface conditions were explored using three (3) SPT borings. Borings SPT-01, SPT-02 and SPT-03 were performed to depths of 25, 23 and 20-ft. bgs, respectively. The borings were located in the field by **MC²** personnel measuring distances from existing site features. The approximate boring locations are presented on the **Boring Location Plan** in the **Appendix**. Borings SPT-01 and SPT-02 were performed at proposed staked intake structure locations. Boring SPT-03 was performed adjacent to Recharge Well (RW-1) for a well pad and structure about 45-ft. southeast of the staked location. It is our opinion that the subsurface conditions encountered at this offset location and described herein are not different to the originally staked location.

The subsurface conditions described herein is of a generalized nature to highlight the major soil stratification features and material characteristics. The **Subsurface Boring Profiles**, included in the **Appendix** and **Individual Boring Profiles**, should be reviewed for specific information at individual boring locations. These profiles include soil description, stratification, penetration resistances, and laboratory test results. The stratification shown on the boring profiles represents the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations.

In general, the subsurface conditions encountered were relatively similar and consisted of very loose to dense, poorly-graded fine SAND to SAND with silt or clay (SP, SP-SM, SP-SC). Layers of loose to very dense, silty SAND (SM) were encountered in SPT-01 from 2 to 3-ft. and SPT-03 from 4 to 8-ft. bgs. Very loose to medium dense, clayey SAND (SC) was encountered in SPT-02 from 20 to 23-ft.

5.4 Groundwater Information

The groundwater depth was measured from 2 to 2.5-ft. bgs in the boreholes at the time of drilling. We estimate the seasonal high groundwater level to be at about 6-in. bgs. This estimate is based on the characteristics of the soil samples collected, primarily changes in color and moisture content.

In general, groundwater levels tend to fluctuate during periods of prolonged drought and extended rainfall. In addition, a seasonal effect will also occur in which higher groundwater levels are normally recorded in the rainy seasons. If the groundwater level is critical to design or construction, temporary observation wells should be installed strategically to monitor groundwater fluctuations over an adequate period of time to permit more accurate

determinations of wet and dry seasonal levels.

Fluctuations of the groundwater levels should be anticipated. We recommend that the Contractor determine the actual groundwater levels at the time of the construction to determine groundwater impact on the construction activities.

6 RECOMMENDATIONS

6.1 General

The following recommendations have been developed based on the previously described project characteristics, our review of published data, information provided by others, our site reconnaissance and the results of our subsurface exploration and associated laboratory testing.

6.2 Foundation Recommendations

Subsurface conditions encountered in the test borings in general are suitable for development of the proposed lightweight structures, (well pads, intake structures and pumps) utilizing conventional shallow foundations provided the site preparation recommendations outlined in this report are followed. The shallow foundations may be supported on either mechanically densified shallow existing sands and/or structural fill bearing at minimum depths below the finished floor or finished grade elevations. Footings that bear in densified soil may be designed based on a maximum allowable soil bearing pressure of 2,000 pounds per square foot. Column or spread footings should be a minimum of 24 inches wide and strip or wall footings should be a minimum of 18 inches wide embedded so that the bottom of the foundations is a minimum of 18 inches below adjacent compacted grade on all sides. Uplift forces due to wind loads should be considered in the foundation design.

Total settlements of less than 1 inch is expected for the anticipated lightweight structures and differential settlements are expected to be approximately half this amount. The majority of the settlement will occur during construction.

We suggest the placement of 4 inches of stone such as FDOT No. 57 or FDOT No. 67 beneath the slab(s) if conditions warrant (i.e., wet conditions). An impermeable vapor barrier may be utilized; however, the final decision to use a vapor barrier is left to SWFWMD and Designer. A filter fabric should be utilized between the soil and the stone to prevent migration of fines from the soil into the stone.

6.3 Site Preparation

Site preparation should include stripping/removal of surface organics (topsoil) where present prior to replacing with properly compacted structural fill [clean sands (SP/SP-SM)]. We recommend that any proposed structures to receive fill be evaluated by proofrolling prior to fill placement. Proofrolling should be performed by traversing the construction areas with a loaded dump truck or similar compaction equipment weighing at least 20 tons. Proofrolling operations

should be observed by a representative of **MC²**. Unstable soils which are revealed by proofrolling and which cannot be adequately densified in place should be removed and replaced under the recommendations of the **MC²** representative. Unstable soils include any soils that pump/heave during proofrolling or soils that contain deleterious material ($\geq 5\%$ organic content, debris, etc.)

After clearing, grubbing and proofrolling, the upper 12 inches of the subgrade in the area of any structure should be compacted to a minimum of 98% of the soil's modified Proctor maximum dry density and $\pm 2\%$ of the optimum moisture content, as determined by ASTM designation D-1557. The material in the upper foot should classify as a SAND with no more than 12% passing the US Standard No. 200 Sieve (SP, SP-SM or SP-SC). If fill is needed, the fill should be placed in level lifts not to exceed 12-inches loose thickness. The fill should be compacted to a minimum of 98% of the soil's modified Proctor maximum dry density and $\pm 2\%$ of the optimum moisture content.

In green areas, the subgrade and any subsequent fill should be compacted to 95% of the soil's modified Proctor maximum dry density and $\pm 2\%$ of the optimum moisture content. Fill placed in these areas should be placed in level lifts not to exceed 12-inches loose thickness.

Backfilling requiring additional excavation may also be done with a very lean concrete or with a well-compacted, suitable fill such as clean sand, gravel, or crushed #57 or #67 stone wrapped in a geotextile fabric.

6.4 Selection and Placement of Fill

After the stripped site has been proofrolled and accepted by the Geotechnical Engineer, the fill required to bring the site to the desired grade may be placed in properly compacted lifts as specified herein. Fill material should be inorganic, non-plastic granular soil (clean to slightly silty or slightly clayey sands: Unified Soil Classification: SP, SP-SM and SP-SC, with less than 12 percent passing the No. 200 sieve. Fill should be free of detrimental materials such as organics, clay clods, debris, roots, and rocks larger than 1 inch in greatest dimension, etc. The majority of the upper portion of the on-site, near surface, sandy soils, other than root-laden topsoil, will meet this requirement. The upper 15-ft. in borings SPT-01 and SPT-02 and the upper 6-ft. in boring SPT-03 should be suitable for fill placement. The **Subsurface Boring Profiles** in the **Appendix** of this report shows where this material was encountered within our borings. We recommend that silty or clayey SAND (soils with over 12% passing the No. 200 sieve) not be used as fill. Careful evaluation should be made of any slightly organic to organic soils and clayey soils prior to use.

In-place density tests should be performed on each compacted lift by an experienced engineering technician working under the direction of a licensed Geotechnical Engineer to verify that the recommended degree of compaction has been achieved. We suggest the following minimum testing frequency, per layer of fill placed: one test per 2,500 square feet of the structure area. This fill should extend a minimum of 10 feet beyond the perimeter of the structure to prevent possible erosion or undermining of footing bearing soils.

6.5 Reuse of Excavated Soils as Structural Fill

Most of the near surface native soils classified as SP, SP-SM excavated during construction should,

in our opinion, be suitable for reuse as structural fill materials provided they meet our requirements and recommendations presented in this report. Routine adjustment of moisture content may be necessary to allow compaction in accordance with project specifications. The planned fill soils should be evaluated to determine that they meet the recommended material properties.

6.6 Federal Excavation Regulations

In Federal Register Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P". This document was issued to better insure the safety of workers entering trenches or excavations. It is mandated by this federal regulation that all excavations, whether they be utility trenches, basement excavations, or footing excavations, be constructed in accordance with the revised OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

We are providing this information solely as a service to our client. **MC²** is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred. Additional Florida, Manatee County, or other local municipality criteria may also apply.

6.7 Drainage and Groundwater Considerations

Groundwater may be an issue for this project during construction of the proposed improvements. The contractor should determine the groundwater depth before the beginning of construction. If it is determined that dewatering will be necessary, we recommend that the following be taken into consideration:

- For limited, relatively small and shallow excavations (generally less than 2 to 4 feet deep) below the groundwater level, pumping from the excavation or sumps should be sufficient to control groundwater seepage. Deeper and larger excavations may require more extensive dewatering measures such as well points or cut-off walls. Recharge of groundwater a short distance from the dewatering location is recommended to avoid significant drawdowns, which may trigger undue subsidence/settlement of existing structures in the vicinity.
- Excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater or surface water runoff. Positive site drainage should be provided

to reduce infiltration of surface water around the perimeter of any aboveground structures and beneath slabs. All grades should be sloped away from the structures and surface drainage should be collected and discharged such that water is not permitted to infiltrate the immediate area surrounding the structures.

- Dewatering may also be needed during trench excavation for utility installation depending on the depth of invert of the pipe. Seepage may enter the excavated trenches from the bottom and sides, and may result in the loosening of the soils and create difficult working conditions. Groundwater should be kept at least 12 inches below the working area to facilitate proper material placing and compaction.

7 REPORT LIMITATIONS

The recommendations detailed herein are based on the available limited soil information obtained by **MC²** and information provided by **Jones Edmunds & Associates, Inc.**, for the proposed project. If there are any revisions to the plans for this project, **MC²** should be notified immediately to determine if changes to our recommendations are required. In the event that **MC²** is not retained to perform these functions, **MC²** cannot be responsible for the impact of those conditions on the performance of the project.

The geotechnical engineer warrants that the findings and recommendations 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 preliminary plans are more complete, the geotechnical engineer should be provided the opportunity to perform additional testing for specific recommendations for the proposed construction, if required. This report has been prepared for the exclusive use of **Jones Edmunds & Associates, Inc.** and their **client**.

Flatford Swamp Aquifer Recharge

Manatee County, Florida

MC² Project Number T071726.162

APPENDIX

Project Location Map – Sheet 1

Boring Location Map – Sheet 2

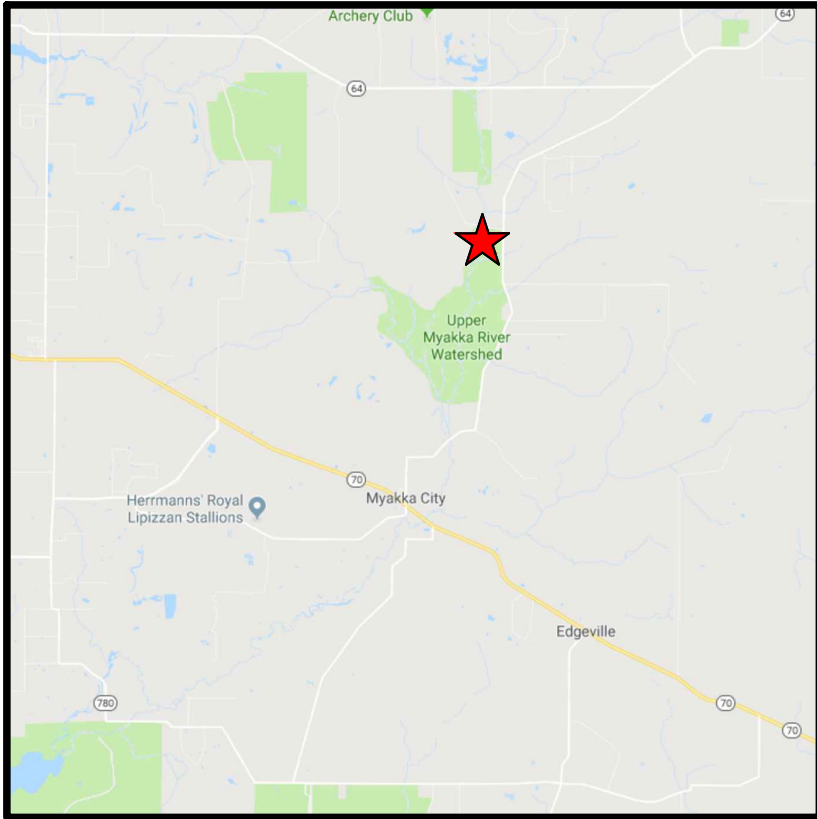
USDA Soil Survey/USGS Topographic Map – Sheet 3

Subsurface Boring Profiles – Sheet 4

Subsurface Boring Profile USCS Legend – Sheet 5

Individual Soil Profiles (3 Sheets)

Test Procedures



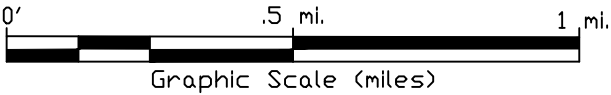
Approximate
Project Location




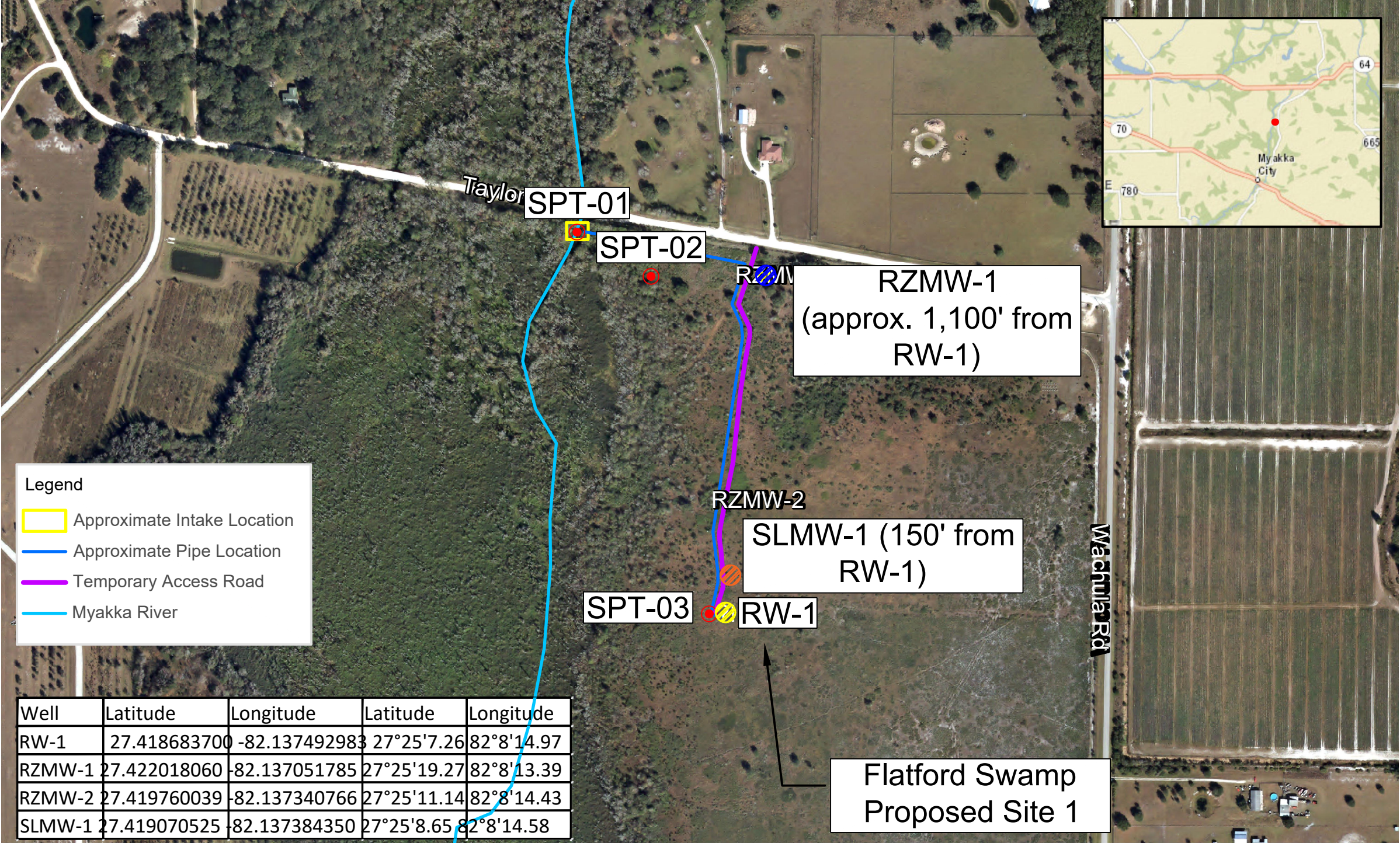
LEGEND:

★ Project Location

Source: Google Earth
Image Date: 1/7/2017



DATE		NAME		REVISION		APPROVED BY:		 <div>GEOTECHNICAL • ENVIRONMENTAL MATERIALS TESTING</div>	<div>MC SQUARED, INC. Geotechnical Consultants 5808-A Breckenridge Parkway Tampa, FL 33610 Ph:813-623-3399 Fax:813-623-6636</div>	<div>FLORIDA ENGINEERING CERTIFICATE OF AUTHORIZATION No. 9191 Jeffery L. Hooks, P.E. FLORIDA LICENSE No. 67882</div>	NAME DATE			Project Location Map		MC² PROJ. NO.	SHEET NO.	
															</			



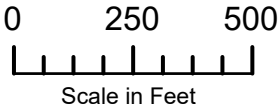
Legend

- Approximate Intake Location
- Approximate Pipe Location
- Temporary Access Road
- Myakka River

Well	Latitude	Longitude	Latitude	Longitude
RW-1	27.418683700	-82.137492983	27°25'7.26	82°8'14.97
RZMW-1	27.422018060	-82.137051785	27°25'19.27	82°8'13.39
RZMW-2	27.419760039	-82.137340766	27°25'11.14	82°8'14.43
SLMW-1	27.419070525	-82.137384350	27°25'8.65	82°8'14.58



2014 Aerial Source:
FDOT Land Boundary Information System (LABINS)
<http://www.labins.org>



For Informational Purposes Only Y:\19850-SWFWMD\041-01_Flatford Swamp Aquifer Recharge\Consult\GIS\mxd\SitePlan.mxd mhays 4/26/2018

LEGEND:

- Approximate SPT Location
- SLMW-1 Proposed Suwannee Limestone Monitoring Well
- RZMW-1 Proposed Recharge Zone Monitoring Well
- RW-1 Proposed Recharge Well

Source: Jones Edmunds

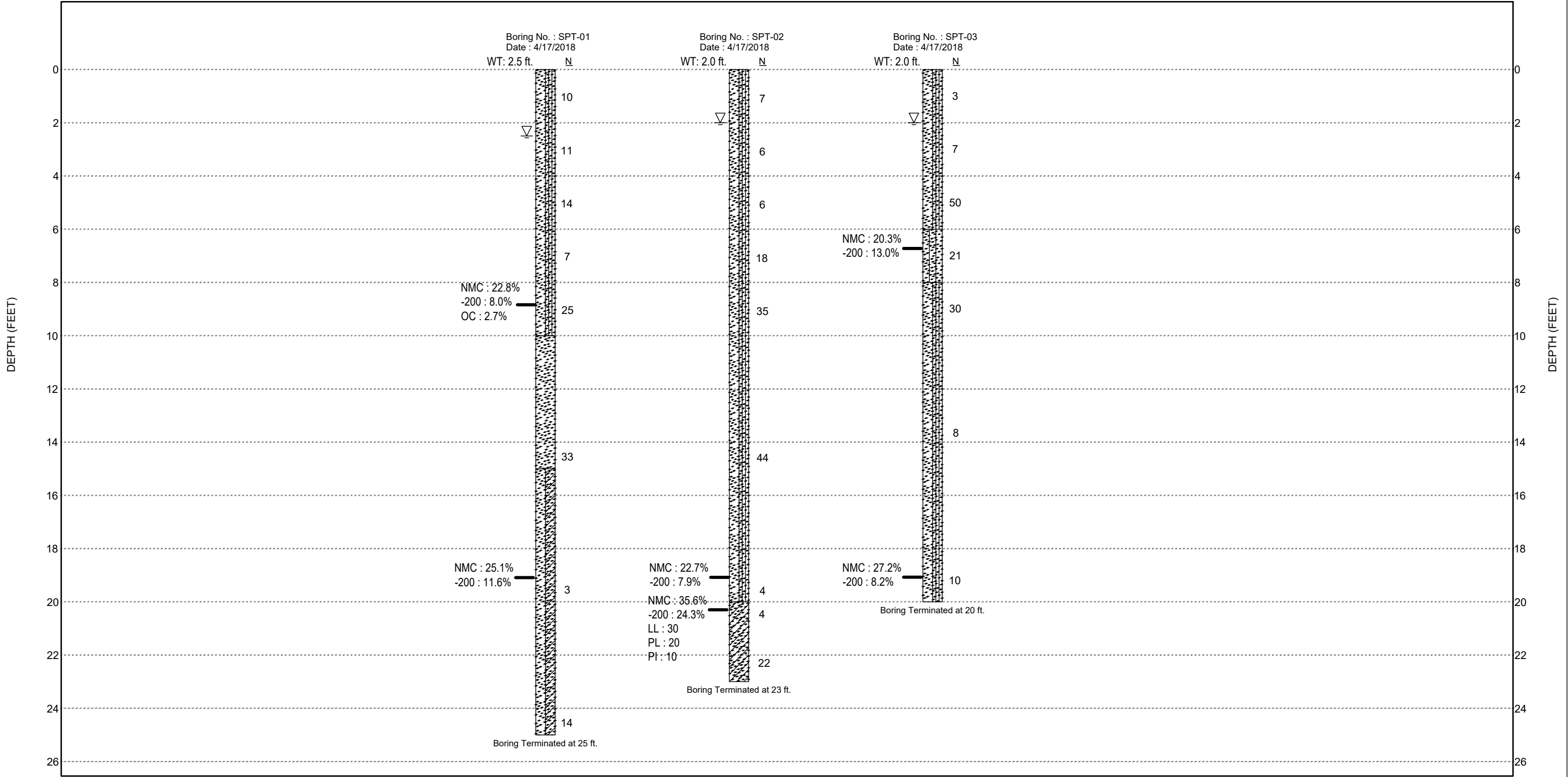
DATE	NAME	REVISION	APPROVED BY:		NAME	DATE	Boring Location Map	MC ² PROJ. NO.	SHEET NO.
					DESIGNED BY:	TC 11/01/2017			
					DRAWN BY:	KH 06/11/2018			
					CHECKED BY:	JH 06/12/2018			
					SUPERVISED BY:	WS			
							Flatford Swamp Aquifer Recharge Manatee County, Florida	T071726.162	2




MC SQUARED, INC.
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FLORIDA ENGINEERING CERTIFICATE OF
AUTHORIZATION No. 9191
Jeffery L. Hooks, P.E.
FLORIDA LICENSE No. 67882





*N Values Drawn At Top Of Interval

DATE	NAME	REVISION	APPROVED BY	 GEOTECHNICAL • ENVIRONMENTAL MATERIALS TESTING	MC SQUARED INC. Geotechnical Consultants 5808-A Breckenridge Parkway Tampa, FL 33610 Ph : 813-623-3399 Fax : 813-623-6636	FLORIDA ENGINEERING CERTIFICATE OF AUTHORIZATION No. 9191 Jeffery L. Hooks, P.E. FLORIDA LICENSE No. 67882		NAME	DATE	SUBSURFACE BORING PROFILES	MC² PROJ. NO.	SHEET NO.
							DESIGNED BY:	TC	11/7/17	Flatford Swamp Aquifer Recharge Manatee County, Florida	T071726.162	4
							DRAWN BY:	KH	4/19/2018			
							CHECKED BY:	JH	4/30/2018			
							SUPERVISED BY:	WS				

LEGEND



Top Soil



Asphalt



Concrete



(GAB) Graded Aggregate Base



Limerock Base



No. 57 Stone



Soil Cement



(SP) Poorly Graded Sand



(SP-SM) Poorly Graded Sand With Silt



(SP-SC) Poorly Graded Sand With Clay



(SM) Silty Sand



(SC) Clayey Sand



(MH) Elastic Silt



(ML) Silt



(CL-ML) Silty Clay



(CH) Fat Clay



(CL) Lean Clay



(OH) Organic Clay



(OL) Organic Silt



Peat



Fill



Bedrock



Limestone



(WLS) Weathered Limestone



(PWR) Partially Weathered Rock



Granite



Gneiss



Schist

NOTES:

- ≡ Water Table At Time Of Drilling
- ≡ Water Table After 24 Hours
- GNE Groundwater Not Encountered
- GNA Groundwater Not Apparent
- GNM Groundwater Not Measured
- CL Center Line
- RT Right Of Center Line
- LT Left of Center Line
- BGS Below Ground Surface
- HA Hand Auger
- PA Power Auger
- NMC Natural Moisture Content (%)
- 200 Fines Passing A No. 200 Sieve (%)
- PI Plasticity Index
- NP Non Plastic
- LL Liquid Limit
- PL Plastic Limit
- OC Organic Content (%)

- N SPT N-Value
- WOH Weight-Of-Hammer
- WOR Weight-Of-Rod
- CPT Cone Penetrometer Test
- SPT Standard Penetration Test
- DT Dilatometer Test
- LOC Loss Of Circulation
- ROC Regain Of Circulation
- REC Rock Core Recovery(%)
- RQD Rock Quality Designation
- ST Shelby Tube Sample
- qu Unconfined Compressive Strength From Pocket Penetrometer In tsf

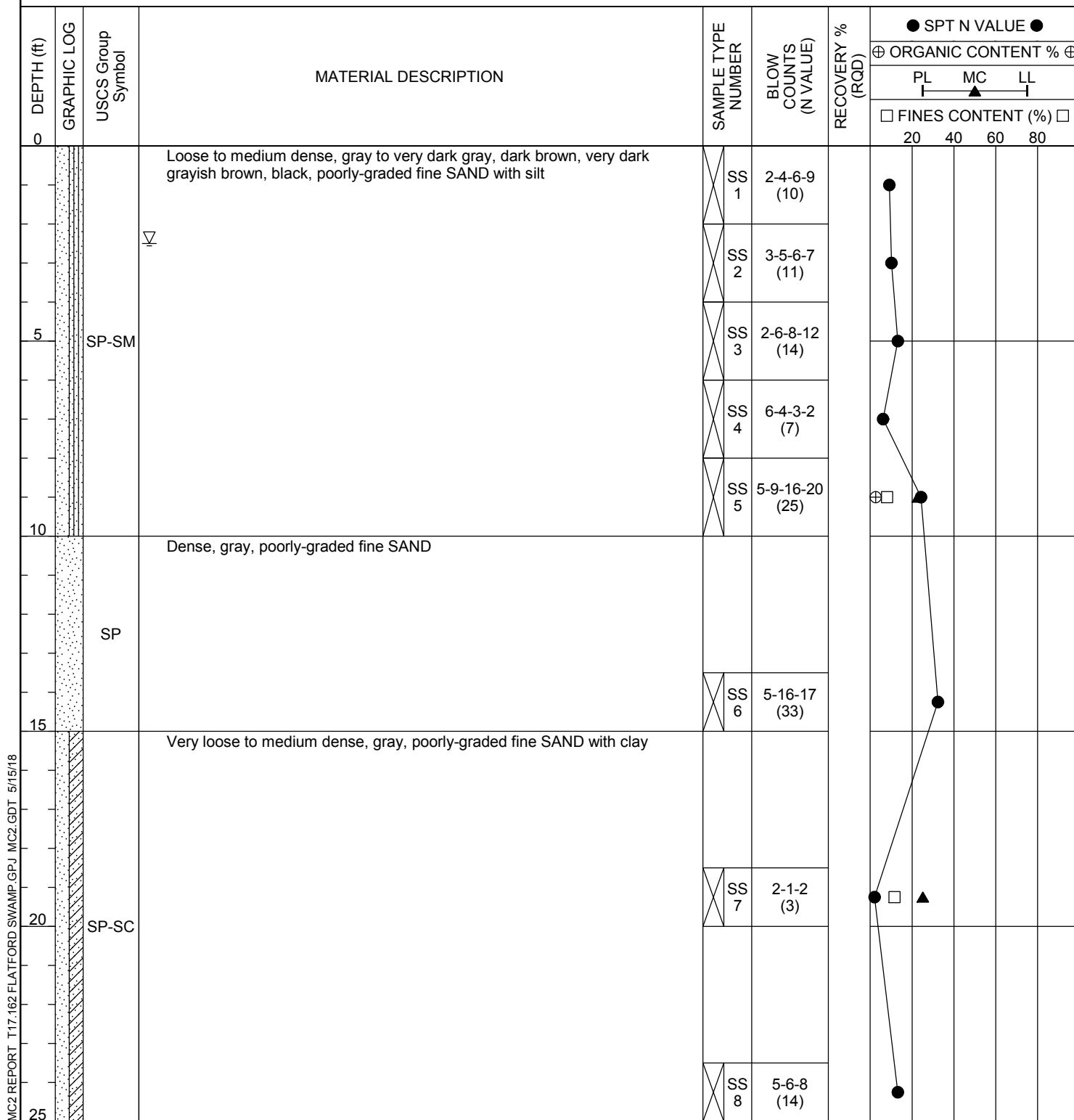
GRANULAR MATERIALS- RELATIVE DENSITY	SPT (BLOWS/FT)
VERY LOOSE	≤ 4
LOOSE	5-10
MEDIUM	11-30
DENSE	31-50
VERY DENSE	GREATER THAN 50
SILTS AND CLAYS CONSISTENCY	SPT (BLOWS/FT)
VERY SOFT	≤ 2
SOFT	3-4
FIRM	5-8
STIFF	9-15
VERY STIFF	16-30
HARD	30-50
VERY HARD	GREATER THAN 50
SPT Spoon Inside Diameter 1 3/8"	ASTM Standard Drop Safety Hammer
SPT Spoon Outside Diameter 2"	Average Hammer Drop Height 30"
	Hammer Weight 140 lbs



Soil Profile

BORING ID: SPT-01

CLIENT Jones Edmunds & Associates	PROJECT NAME Flatford Swamp Aquifer Recharge
PROJECT NUMBER T071726.162	PROJECT LOCATION Manatee County, Florida
DATE STARTED 4/17/18 COMPLETED 4/17/18	GROUND ELEVATION HOLE SIZE 4 inches
DRILLING CONTRACTOR Standard Drilling	GROUND WATER LEVELS:
DRILLING METHOD Wet Rotary	▽ AT TIME OF DRILLING 2.5 ft
LOGGED BY S. Nason CHECKED BY J. Hooks	AT END OF DRILLING ---
NOTES	AFTER DRILLING ---



Bottom of hole at 25.0 feet.

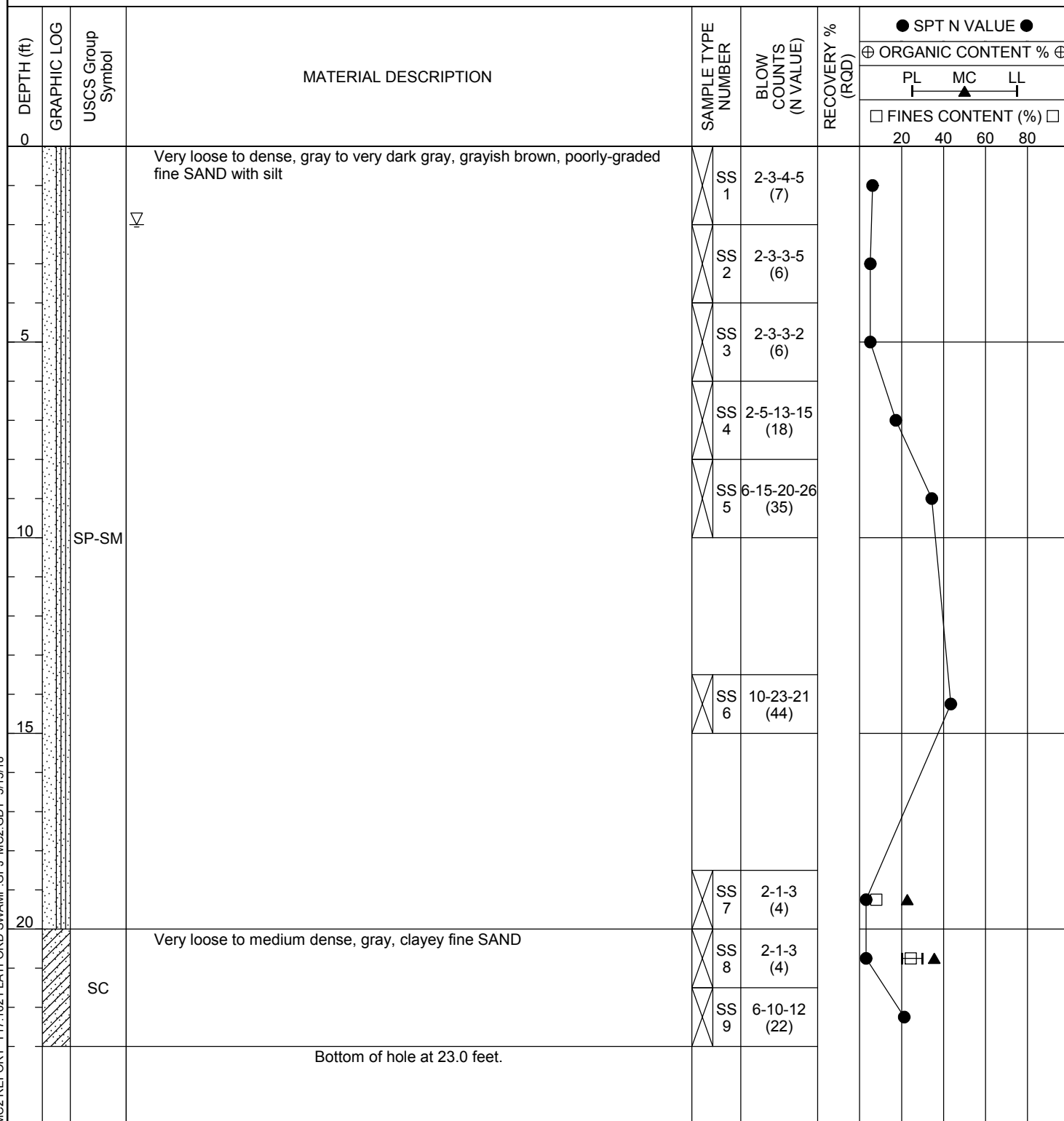
MC2 REPORT T17.162 FLATFORD SWAMP.GPJ MC2.GDT 5/15/18



Soil Profile

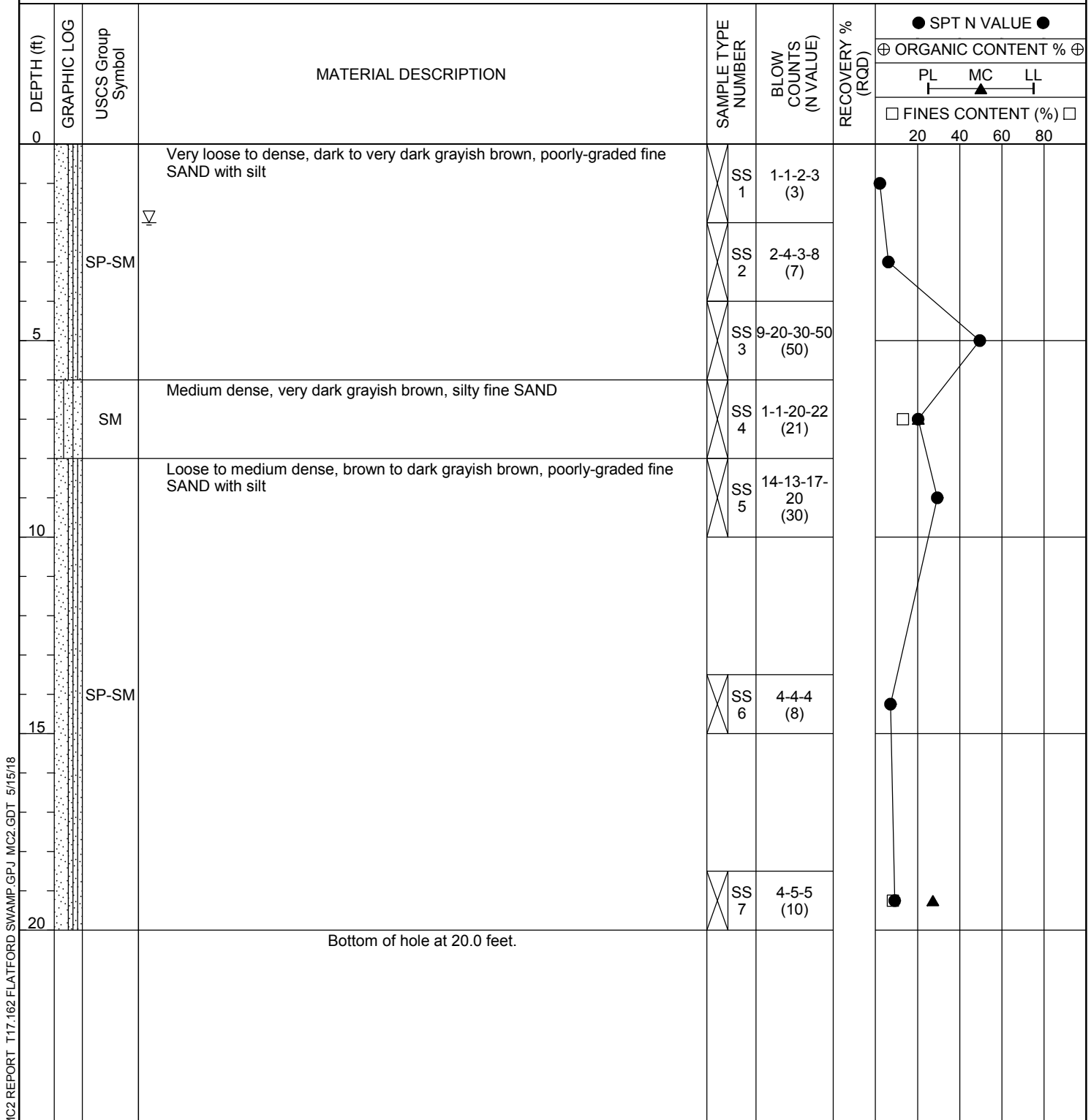
BORING ID: SPT-02

CLIENT Jones Edmunds & Associates	PROJECT NAME Flatford Swamp Aquifer Recharge
PROJECT NUMBER T071726.162	PROJECT LOCATION Manatee County, Florida
DATE STARTED 4/17/18 COMPLETED 4/17/18	GROUND ELEVATION _____ HOLE SIZE 4 inches
DRILLING CONTRACTOR Standard Drilling	GROUND WATER LEVELS:
DRILLING METHOD Wet Rotary	▽ AT TIME OF DRILLING 2.0 ft
LOGGED BY S. Nason CHECKED BY J. Hooks	AT END OF DRILLING ---
NOTES _____	AFTER DRILLING ---





Soil Profile

BORING ID: SPT-03**CLIENT** Jones Edmunds & Associates**PROJECT NAME** Flatford Swamp Aquifer Recharge**PROJECT NUMBER** T071726.162**PROJECT LOCATION** Manatee County, Florida**DATE STARTED** 4/17/18**COMPLETED** 4/17/18**GROUND ELEVATION****HOLE SIZE** 4 inches**DRILLING CONTRACTOR** Standard Drilling**GROUND WATER LEVELS:****DRILLING METHOD** Wet Rotary▽ **AT TIME OF DRILLING** 2.0 ft**LOGGED BY** S. Nason**CHECKED BY** J. Hooks**AT END OF DRILLING** ---**NOTES****AFTER DRILLING** ---

TEST PROCEDURES

The general field procedures employed by MC Squared, Inc. (MC²) 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 boring.

Standard Drilling Techniques

To obtain subsurface samples, boring are drilled using one of several alternate techniques depending upon the subsurface conditions. Some of these techniques are:

In Soils:

- a) Continuous hollow stem augers.
- b) Rotary boring 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 Augering: A hollow stem auger 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.

Mud Rotary: In situations where unconsolidated materials are anticipated, the direct-rotary or "mud" rotary method may be used as a more effective method for obtaining soil samples. The fluid used, which is typically stored in an aluminum tub (also known as a "mudtub"), is a mix of water and bentonite, also known as a bentonite slurry or "mud". This fluid circulates into the borehole and then returns to the mudtub using a pump system. A loss of circulation, partially or otherwise, may signify a void at that sample depth. The key advantage of using this drilling method is that it stabilizes the borehole wall while drilling in unconsolidated formations, due to the buildup of a filter cake on the wall.

Core Drilling: Soil drilling methods are not normally capable of penetrating through hard cemented soil, weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound, continuous rock. Material which 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 D-2113 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

Several techniques are used to obtain samples and data in soils in the field; however the most common methods in this area are:

- a) Standard Penetrating Testing
- b) Undisturbed Sampling
- c) Dynamic Cone Penetrometer Testing
- d) Water Level Readings

The procedures utilized for this project are presented below.

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 Logs. Split barrel samples are suitable for visual observation and classification tests but are not sufficiently intact for quantitative laboratory testing.

Water Level Readings: Water level readings are normally taken in the boring and are recorded on the Boring Records. In sandy soils, these readings indicate the approximate location of the hydrostatic water level at the time of our field exploration. In clayey soils, the rate of water seepage into the boring is low and it is generally not possible to establish the location of the hydrostatic water level through short-term water level readings. Also, fluctuation in the water level 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 Logs are determined by field crews immediately after the drilling tools are removed, and several hours after the boring are completed, if possible. The time lag is intended to permit stabilization of the groundwater level that may have been disrupted by the drilling operation.

Occasionally the boring will cave-in, preventing water level readings from being obtained or trapping drilling water above the cave-in zone.

BORING LOGS

The subsurface conditions encountered during drilling are reported on a field boring log prepared by the Driller. The log contains information concerning the boring method, samples attempted and recovered, indications of the presence of coarse gravel, cobbles, etc., and observations of groundwater. 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 Logs, which are the basis for our evaluations and recommendations.

SOIL CLASSIFICATION

Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply his 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 Logs.

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary; 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 are presented in this report.

The following table presents criteria that are typically utilized in the classification and description of soil and rock samples for preparation of the Boring Logs.

Relative Density of Cohesionless Soils From Standard Penetration Test		Consistency of Cohesive Soils	
Very Loose	≤ 4 bpf	Very Soft	≤ 2 bpf
Loose	5 - 10 bpf	Soft	3 - 4 bpf
Medium Dense	11 - 30 bpf	Firm	5 - 8 bpf
Dense	31 - 50 bpf	Stiff	9 - 15 bpf
Very Dense	> 50 bpf	Very Stiff	16 - 30 bpf
		Hard	30 – 50 bpf
		Very Hard	> 50 bpf
(bpf = blows per foot, ASTM D 1586)			
Relative Hardness of Rock		Particle Size Identification	
Very Soft	Very soft rock disintegrates or easily compresses to touch; can be hard to very hard soil.	Boulders	Larger than 12"
		Cobbles	3" - 12"
Soft	May be broken with fingers.	Gravel	
		Coarse	3/4" - 3"
Moderately Soft	May be scratched with a nail, corners and edges may be broken with fingers.	Fine	4.76mm - 3/4"
		Sand	
		Coarse	2.0 - 4.76 mm
Moderately Hard	Light blow of hammer required to break samples.	Medium	0.42 - 2.00 mm
		Fine	0.42 - 0.074 mm
Hard	Hard blow of hammer required to break sample.	Fines (Silt or Clay)	Smaller than 0.074 mm
Rock Continuity		Relative Quality of Rocks	
RECOVERY = $\frac{\text{Total Length of Core}}{\text{Length of Core Run}} \times 100 \%$		RQD = $\frac{\text{Total core, counting only pieces > 4" long}}{\text{Length of Core Run}} \times 100 \%$	
<u>Description</u>	<u>Core Recovery %</u>	<u>Description</u>	<u>RQD %</u>
Incompetent	Less than 40	Very Poor	0 - 25 %
Competent	40 - 70	Poor	25 - 50 %
Fairly Continuous	71 - 90	Fair	50 - 75 %
Continuous	91 - 100	Good	75 - 90 %
		Excellent	90 - 100 %