

Technical Specifications for Wastewater Treatment System Upgrade & Expansion (Phase 2)

WPCC-3095-6



Allen Harim Foods, LLC.
Harbeson, Delaware

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QUALITY

VALUE

COMMITMENT

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SECTION 02 20 01
SITE CONDITIONS

PART 1 GENERAL

1.01 SUBSURFACE INFORMATION

- A. A report of subsurface exploration at particular locations in the area of the work has been conducted. The report identifies properties of below grade conditions at the locations and at the time that the borings were conducted.
- B. This report, by its nature, cannot reveal all conditions that exist on the site. Should subsurface conditions be found to vary substantially from this report, changes in the design and construction of foundations may be made.
- C. Geotechnical report data are not considered all conclusive and it is the Contractor's responsibility to further investigate site conditions as he determines necessary and at his own expense.

1.02 SITE INVESTIGATION AND REPRESENTATION

- A. It is the Contractor's responsibility that he completely satisfy himself as to the nature and location of the work; the general and local conditions, particularly those related to the availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; the current and potential conditions of the ground; the type and quantity of equipment and facilities needed prior to and during the execution of the Work and all other matters and conditions which can in any way affect the work or the associated costs required by this Contract.
- B. It is also the responsibility of the Contractor that he completely satisfy himself with regard to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information provided by the Owner in the geotechnical report, as well as from information presented within these Contract Documents. Any failure by the Contractor to acquaint himself with all the available information will not relieve him from his duty to properly estimate the difficulty or cost of successfully performing the work. Neither the Owner nor the Engineer assume responsibility for any conclusion or interpretation made by the Contractor on the basis of the information made available by the Owner or the Engineer.

1.03 RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

- A. Utilities and structures which are known to be adjacent to or in the area of the work are shown on the Drawings. The locations shown are taken from existing records, the best information available from existing plans, and survey information; however, the Contractor shall anticipate deviations and omissions in the actual locations and types and quantities of utilities and structures shown. Those shown are for the convenience of the Contractor only, and no responsibility is assumed by either the Owner or the Engineer for their accuracy or completeness.
- B. The Contractor shall at all times provide unobstructed access to fire hydrants, underground conduit, manholes, and water or gas valve boxes.
- C. The Contractor shall notify all utility offices that are affected by the work at least fifteen (15) days prior to starting construction operations. The Contractor shall not expose any utility without first obtaining permission from the affected agency. Once permission has been granted, locate and, if necessary, expose and provide temporary support for all existing underground utilities in advance of operations.
- D. When existing utility lines or structures are located such that they physically conflict with permanent structures to be constructed under this Contract, the utility line or structure shall be permanently relocated. Such relocations shall be considered as required by this Contract.

- E. The Contractor shall give immediate notice to the Engineer, the Owner and the owner of the utility (where applicable) when a physical conflict is determined to exist. Any delays resulting from the required relocations of the utilities are the responsibility of the Contractor.
- F. Where existing utility lines or structures are so located as to interfere with the Contractor's prosecution of the work, but do not physically conflict with completed manholes or other permanent structures to be constructed under this Contract, any modification, alteration, or relocation of interfering utility, either permanent or temporary, shall be accomplished at the expense of the Contractor.
- G. When notified by the Contractor that an interference or conflict has been determined to exist, the Engineer will determine whether such interference shall be considered as required by construction or as incidental to construction.

1.04 INTERFERING STRUCTURES

- A. The Contractor shall take all necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Plans. While the information has been compiled from the best available sources, the completeness and accuracy of the Plans cannot be guaranteed, and it is given as a guide to avoid known possible difficulties.
- B. The Contractor shall protect existing structures from damage, whether or not they lie within the right-of-way or the limits of the easements obtained by the Owner. Where existing structures must be removed to properly conduct the work, or are damaged during the work, they shall be restored at the Contractor's own expense to at least their original condition and to the satisfaction of the Engineer.
- C. The Contractor may, with the approval of the Engineer and without additional compensation, remove and replace in a condition as good as or better than original, any small interfering structures such as fences and signposts that interfere with the Contractor's operations.

1.05 FIELD RELOCATION

- A. During the progress of the work, minor relocations of the work may be necessary. Such relocations shall be made only by direction of the Engineer. If existing structures are encountered that will prevent construction as shown, notify the Engineer before continuing with the work in order that the Engineer may make such field revisions as necessary to avoid conflict with the existing structures. Failure to notify the Engineer when an existing structure is encountered and the work proceeds in spite of this interference, the Contractor shall be responsible for any damage that may occur.

1.06 DIFFERING SITE CONDITIONS

- A. If the existing site conditions materially differ than what is represented on the Drawings, the contractor shall notify the Owner and Engineer immediately. If the differences will result in the contractor submitting a change order for additional Work, the contractor shall be responsible for obtaining additional topographic and/or utility surveys of the existing conditions to fully substantiate his claim for additional Work. Surveys shall be signed by a licensed land surveyor in the state where the project is located.

1.07 PAYMENT

- A. The work specified in this Section shall be considered incidental and payment will be included as part of the appropriate lump sum specified in the Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals for concrete reinforcement to complete the Work as indicated on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 01300 - Administrative Requirements.
- B. Section 01400 - Quality Requirements.
- C. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
- B. ACI 318 - Building Code Requirements For Structural Concrete and Commentary; American Concrete Institute International; 2005.
- C. ACI SP-66 - ACI Detailing Manual; American Concrete Institute International; 2004.
- D. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2006.
- E. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary; 2006.
- F. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2007.
- G. CRSI (DA4) - Manual of Standard Practice; Concrete Reinforcing Steel Institute; 2001.
- H. CRSI (P1) - Placing Reinforcing Bars; Concrete Reinforcing Steel Institute; Eighth Edition.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Shop drawings for reinforcement for fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (2004), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures. Include locations of construction joints and additional reinforcing for construction joints.
- C. Review of these drawings is mandatory by the Structural Engineer of Record prior to fabrication.
- D. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301.
- B. Provide Engineer with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Steel: ASTM A 615/A 615M Grade 60 (420).
 - 1. Plain billet-steel bars.
 - 2. Unfinished.

- B. Welded Wire Fabric: ASTM A185
 - 1. Plain welded steel wire fabric.
 - 2. Unfinished.
- C. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gage.
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 - a. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 - b. For exposed-to-view concrete surfaces where legs of supports are in contact with forms provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.02 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
- B. Welding of reinforcement is not permitted.
- C. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 - 1. Submit locations of splices to Engineer.

PART 3 EXECUTION

3.01 PLACEMENT

- A. General: Comply with the Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars." for details and methods of reinforcement placement and supports and as specified herein.
- B. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- C. Accurately place, support and secure reinforcement against displacement. Do not deviate from required position.
- D. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that remove or destroy bond with concrete.
- E. Accommodate placement of formed openings.
- F. Place reinforcement to obtain at least minimum coverages for concrete protection and within tolerances permitted by ACI 318 unless noted otherwise on the drawings. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- G. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- H. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.02 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Section 01400 and paid by the Owner, will inspect installed reinforcement for conformance to contract documents before concrete placement.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals for cast-in-place concrete required to complete the Work as indicated on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 03200 - Concrete Reinforcement.

1.03 REFERENCES

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).
- B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
- C. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 1999.
- D. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 1988 (Reapproved 2002).
- E. ACI 308R - Guide to Curing Concrete; American Concrete Institute International; 2001.
- F. ACI 350 - Code Requirements For Environmental Engineering Concrete Structures; American Concrete Institute International.
- G. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2005.
- H. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2006.
- I. ASTM C 33 - Standard Specification for Concrete Aggregates; 2003.
- J. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2005.
- K. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2005.
- L. ASTM C 150 - Standard Specification for Portland Cement; 2005.
- M. ASTM C 171 - Standard Specification for Sheet Materials for Curing Concrete; 2003.
- N. ASTM C 173/C 173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2001.
- O. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete; 2001.
- P. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2003.
- Q. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete; 2005a.
- R. ASTM C 685/C 685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2001.
- S. ASTM C 881/C 881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2002.
- T. COE CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstop; Corps of Engineers; 1974.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.

- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, dry-shake finish materials, and others as requested by the Architect.
- C. Shop drawings for reinforcement, prepared under the supervision of a registered Professional Engineer for fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures. Include locations of construction joints and additional reinforcing for construction joints.
- D. Shop drawings and calculations for formwork, shoring and reshoring, prepared by a registered Professional Engineer, for fabrication erection of forms for specific finished concrete surfaces. Show for construction including jointing, special for joint or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually. Formwork, shoring and reshoring shop drawings, and calculations must bear the seal and signature of an engineer registered in the jurisdiction where the project is being constructed.
 - 1. Engineer's review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor's responsibility.
- E. Laboratory test reports for concrete materials and mix design test.
- F. Minutes of pre-construction conference.
- G. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction for concrete accessories.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
 - 1. Maintain one copy of each document on site.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Form Coatings: Provide commercial formulation form-coating compounds with a maximum VOC (Volatile Organic Compounds) of 350 mg/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface.
 - 1. Provide ties that, when removed, will leave holes not larger than 1 inch diameter in concrete surface.

2.02 REINFORCEMENT

- A. Comply with requirements of Section 03200.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C 150, Type I - Normal Portland type.
 - 1. Use one brand of cement throughout project unless otherwise acceptable to Engineer.

- B. Fine and Coarse Aggregates: ASTM C 33. Provide aggregates from a single source for exposed concrete.
 - 1. Do not use fine or coarse aggregates containing spalling-causing deleterious substances.
 - 2. Local aggregates not complying with ASTM C33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when approved by the Engineer.
- C. Fly Ash: ASTM C 618, Class C or F.
- D. Calcined Pozzolan: ASTM C 618, Class N.
- E. Water: Clean and not detrimental to concrete.

2.04 CHEMICAL ADMIXTURES

- A. General: Do not use chemicals that will result in soluble chloride ions in excess of 0.05 percent by weight of cement.
- B. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Air-Mix" or "AEA 92", Euclid Chemical Co.
 - b. "Darex AEA" or "Daravair," W.R. Grace & Co.
 - c. "MB-VR" or "Micro-Air," Master Builders, Inc.
 - d. "Sika AER," Sika Corp.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Eucon WR-75" or "Eucon WR-91" or "Eucon MR", Euclid Chemical Co.
 - b. "WRDA with Hycol", W.R. Grace & Co.
 - c. "Pozzolith 200N" or "Polyheed 997", Master Builders, Inc.
- D. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F or Type G. The admixture shall not contain more than 0.05 percent Chloride ions.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Eucon 37", "Eucon 1037", or "Plastol 5000", Euclid Chemical Co.
 - b. "WRDA 19" or "Daracem 100", W.R. Grace & Co.
 - c. "Rheobuild 1000" or "Rheobuild 716", Master Builders, Inc.
 - d. "Sikament 300," Sika Corp.
- E. Water Reducing, Non-Corrosive, and Non-Chloride Accelerating Admixture: ASTM C 494, Type C or Type E, and not contain more than 0.05% chloride ions.
 - 1. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least one year duration) using an acceptable accelerated corrosion test method such as electrical potential measures.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Accelguard 80", "Accelguard 90", or "Eucon NCA", Euclid Chemical Co.
 - b. "Daraset," W.R. Grace & Co.
 - c. "Pozzutec 20," Master Builders, Inc.
- F. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Eucon Retarder 75," Euclid Chemical Co.
 - b. "Daratard-17," W.R. Grace & Co.
 - c. "Pozzolith 300-R," Master Builders, Inc.
 - d. "Plastiment," Sika Corporation.
- G. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are not permitted

- H. Certification: Written conformance to the requirements and the chloride ion content of the admixture will be required from the admixture manufacturer prior to the mix design review by the Engineer.

2.05 ACCESSORY MATERIALS

- A. Non-Shrink Grout: ASTM C 1107; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents. In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout, when placed at a fluid consistency, shall achieve 95% bearing under a 48" x 48" base plate.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Euco NS", Euclid Chemical Co.
 - b. "Masterflow 713," Master Builders, Inc.
 - c. "Crystex," L&M Construction Chemicals, Inc.
 2. Where high fluidity and/or increased placing time are required, use high flow grout. In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout, when placed at a fluid consistency, shall achieve 95% bearing under and 18" x 36" base plate.
 - a. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to the following:
 - 1) "High-Flow Grout," Euclid Chemical Co.
 - 2) "Masterflow 928," Master Builders, Inc.
 - 3) Minimum Compressive Strength at 48 Hours: 2,400 psi.
 - 4) Minimum Compressive Strength at 28 Days: 7,000 psi.
- B. Waterstops: Provide centerbulb-type waterstops at construction joints and other joints as indicated. Size to suit joints.
- C. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572.
1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - a. The Burke Co.
 - b. Greenstreak Plastic Products Co.
 - c. W. R. Meadows, Inc.
- D. Vapor Retarder: Provide vapor retarder cover over prepared base material where indicated below slabs on grade. Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154, as follows:
1. Polyethylene sheet not less than 8 mils thick.
- E. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- F. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- G. Curing and Sealing Compound (VOC Compliant, 700 g/l): Liquid type membrane-forming curing compound, clear styrene acrylate type, complying with ASTM C1315, Type I, Class B, 25% solids content minimum. Moisture loss shall be not more than 0.30 Kg/m² when applied at 300 sq. ft./gal. Manufacturer's certification is required.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Super Rez Seal," Euclid Chemical Co.
 - b. "Masterseal 30," Master Builders.
 - c. "Kure N Seal 30," Sonneborn.

- H. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Eucobar," Euclid Chemical Co.
 - b. "E-Con," L&M Construction Chemicals, Inc.
 - c. "Confilm," Master Builders, Inc.

2.06 CONCRETE SURFACE SEALER

- A. Apply silane or siloxane, penetrating sealer to all building interior concrete slab surfaces as specified below:
 - 1. Minimum solids by weight for silane or siloxane based compounds.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Isoflex 618," Harry S. Peterson Companies.
 - b. "Pentane 40," L & M Construction Chemicals, Inc.
 - c. "Euco-Guard VOX," Euclid Chemical Co.
 - d. "Environseal," Hydrozo Co.

2.07 BONDING AND JOINTING PRODUCTS

- A. Joint Filler: Nonextruding, resilient asphalt impregnated fiberboard or felt, complying with ASTM D 1751, 1/4 inch thick and 4 inches deep; tongue and groove profile.
- B. Joint Filler: Compressible asphalt mastic with felt facers, complying with ASTM D 994, 1/4 inch thick and 4 inches deep.
- C. Bonding Compound: Polyvinyl acetate or acrylic base.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyvinyl Acetate (Interior Only):
 - 1) "Euco Weld," Euclid Chemical Co.
 - 2) "Everweld," L&M Construction Chemicals, Inc.
 - b. Acrylic or Styrene Butadiene:
 - 1) "SBR Latex," Euclid Chemical Co.
 - 2) "Daraweld C," W.R. Grace & Co.
 - 3) "Everbond," L&M Construction Chemicals, Inc.
 - 4) "Acryl-Set," Master Builders, Inc.
- D. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Euco Epoxy System #452MV or Eucopoxy LPC," Euclid Chemical Co.
 - b. "Concresive 1001," Master Builders, Inc.
 - c. "Sikadur 32 Hi-Mod," Sika Corp.

2.08 CONCRETE MIX DESIGN

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301, Section 4.2.3. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
- B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.
- C. The exact percentage of supplementary cementitious material used shall be based on a successful test placement on-site.
 - 1. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 2. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
- D. Design mixes to provide normal weight concrete with as indicated on drawings and schedules:

- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.
- F. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows
 - 1. Subjected to freezing and thawing; W/C 0.45.
 - 2. Subjected to deicers/watertight; W/C 0.40.
 - 3. Reinforced concrete subjected to brackish water, salt spray, or deicers; W/C 0.40.
 - 4. Trowel finish interior floors subjected to small hard wheel traffic; W/cm 0.53.
- G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
 - 1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
 - 2. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
 - 3. Concrete containing HRWR admixture (Superplasticizer): 7 to 9 inch range after addition of HRWR to verified 2-inch to 3-inch slump concrete (3" to 4" for concrete receiving a dry shake hardener).
 - 4. Other concrete: Not more than 4 inches.

2.09 ADMIXTURES

- A. Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability.
- B. Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
- C. Use high-range water-reducing admixture (HRWR) in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water/cement ratios below 0.50.
- D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within following limits:
 - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
 - a. 5.0 percent for 1-1/2-inch max aggregate.
 - b. 5.5 percent for 1-inch max aggregate.
 - c. 5.5 percent for 3/4-inch max aggregate.
 - d. 6.0 percent for 1/2-inch max aggregate.
 - 2. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to exposed interior steel troweled finished subjected to vehicular traffic: maximum 3 percent air.
- E. Use admixture for water reduction and set controls in strict compliance with manufacturer's directions.

2.10 MIXING

- A. Job-Site Mixing: Mix materials for concrete in appropriate drum-type batch machine mixer. For mixers of one cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each cu. yd. or fraction thereof.
- B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

- C. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as specified.
 - 1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery to 60 minutes.

2.11 PRE-CONCRETE CONFERENCE

- A. This conference shall be held at least 7-14 days prior to the beginning of the installation of foundations. The Contractor shall hold a meeting to review the detailed requirements for the concrete, including the concrete mix designs, placing techniques, finishing techniques, curing techniques and, the equipment required for these procedures.
- B. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including, but not limiting to, the following:
 - 1. Contractor's superintendent.
 - 2. Laboratory responsible for the contract design mix.
 - 3. Laboratory responsible for field quality control.
 - 4. Concrete subcontractor.
 - 5. Ready-mix concrete producer(s).
 - 6. Admixture manufacturer.
 - 7. Concrete pumping contractor.
 - 8. Engineer
 - 9. Owner project manager
- C. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall also be transmitted to the following for information purposes:
 - 1. Owners representative.
 - 2. Resident engineer.
 - 3. Structural engineer.
- D. The minutes shall include a statement by the concrete contractor indicating that the proposed mix design and placing techniques can produce the concrete quality required by these specifications.
- E. The Structural Engineer will be present at the conference. The Contractor shall notify the Structural Engineer at least 10 days prior to the scheduled date of the conference.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.
- B. Coordinate the installation of joint materials and vapor retarder with placement of forms and reinforcing steel.

3.02 PREPARATION

- A. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

3.03 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, recesses, and the like, for easy removal.
- D. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or other rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- F. Provisions for other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.
- H. Tolerances for formed surfaces shall conform to the following:
 - 1. Variation from plumb:
 - a. In the lines and surfaces of columns, piers, walls, and in arises:
 - 1) In any 10 ft. of length 1/4 in.
 - 2) Maximum for the entire length 1/2 in.
 - b. For exposed corner columns, control-joint grooves and other conspicuous lines:
 - 1) In any 20 ft. length 1/4 in.
 - 2) Maximum for the entire length 1/2 in.
 - 2. Variation from the level or from the grades specified in the contract documents:
 - a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores:
 - 1) Maximum for the entire length 3/8 in.
 - b. In exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:
 - 1) Maximum for the entire length 1/2 in.
 - 2) Refer to section regarding monolithic slab finishes for F(F) and F(L) numbers.
 - 3. Variation of the linear building lines from established position in plan and related position of columns, walls and partitions:
 - a. In any bay 1/4 in.
 - b. In any 20 ft. of length 3/8 in.
 - c. Maximum for the entire length 1/2 in.
 - 4. Variation in the sizes and locations of:
 - a. Sleeves, floor openings and wall openings 1/4 in.
 - 5. Variation in cross sectional dimensions columns and beams and in the thickness of slabs and walls:
 - a. Minus 1/4 in.
 - b. Plus 1/4 in.
 - 6. Footings
 - a. Variations in dimensions in plan:
 - 1) Minus 1/2 in.

- 2) Footings 2 in.
- b. Misplacement or eccentricity:
 - 1) 2 percent of the footing width in the direction of the misplacement, but not more than 2 in.
- c. Thickness:
 - 1) Decrease in specified thickness 5 %
 - 2) Increase in specified thickness No limit
- 7. Variation in steps:
 - a. In a flight of steps:
 - 1) Rise+ 1/8 in.
 - 2) Tread+ 1/4 in.
 - b. In consecutive steps:
 - 1) Rise+ 1/16 in.
 - 2) Tread+ 1/8 in.
- 8. Construct edges of slabs to tolerance that is compatible with the connections of the architectural finishes.

3.04 VAPOR RETARDER INSTALLATION

- A. General: Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.
- B. Lap joint 6 inches and seal vapor retarder joints with manufacturers' recommended mastic and pressure-sensitive tape.

3.05 INSTALLING REINFORCEMENT

- A. A. General: Comply with requirements of Section 03200 Concrete Reinforcement.

3.06 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer. Submit locations of construction joints with shop drawings showing reinforcement.
- B. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated.
- C. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer's printed instructions.
- E. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
 - 1. Joint filler and sealant materials are specified in Division 7 Sections of these specifications.
- F. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-ground to form panels of patterns as shown.
 - 1. If joints are formed by saw cuts, saw cut joints immediately after slab finishing and as may be safely done without dislodging aggregate using a Soff-Cut machine or equal to a depth of 1.25 inches deep or as indicated on the Drawings.
 - 2. If joints are formed by preformed inserts, insert premolded plastic, hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 - 3. Joint sealant material is specified in Division 7 Sections of these specifications.

3.07 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.
- B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.08 PREPARATION OF FORMS SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch, as required, to return forms to acceptable surface condition.
- B. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before reinforcement is placed.
- C. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- D. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.09 PLACING CONCRETE

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.
- B. General: Comply with ACI 304, "Recommend Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.
- C. All water in the concrete mix shall be added at the mix plant. Water shall not be added at the jobsite.
- D. Notify Engineer not less than 24 hours prior to commencement of placement operations.
- E. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.
- F. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while the preceding layer is still plastic to avoid cold joints.
 - 1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have not begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
 - 1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Bring slab surfaces to correct level with straightedge and strike off. Use highway bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

3. Maintain reinforcing in proper position during concrete placement.
- H. Cold-Weather Placing: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - I. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 2. Only the specified non-corrosive non-chloride accelerator shall be used.
 - J. Hot-Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
 1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
 4. Use water-reducing retarding admixture when required by high-temperatures, low humidity, or other adverse placing conditions, when acceptable to the Engineer.
 5. Special hot weather concreting practices for watertight concrete in addition to other items specified:
 - a. When low humidity or windy conditions exist, construct a temporary wind barrier around the concrete pour.
 - b. Fog spray the entire placement during and for 3 hours after, final finishing with approved compressed air or mist foggers. Fog the air above the slab until a sheen appears on the slab surface, but do not allow standing water to build up on the slab surface.
 - c. Immediately after bull floating, apply a monomolecular film-forming compound for evaporation control

3.10 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Related Unformed Surfaces: At top of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

- D. Grout-Cleaned Finish: Provide grout-cleaned finish to scheduled concrete surfaces that have received smooth form finish treatment.
 - 1. Combine one part portland cement to 1-1/2 parts fine sand by volume, and a 50 : 50 mixture of acrylic or styrene butadiene-based bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.
 - 2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

3.11 MONOLITHIC SLAB FINISHES

- A. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
 - 1. After floating, begin first trowel finish operation using a power driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 25 - FL 20. Grind smooth surface defects that would telegraph through applied floor covering system.
 - 2. Note Areas requiring quick-dry concrete.
- B. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply initial a single trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming. Texture shall be as approved by Engineer from sample panel.
 - 1. Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - a. Immediately after float finishing, slightly roughen concrete surface by brooming with a fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Owner project manager before application.
 - b. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose nonslip aggregate.

3.12 CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and after finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screening and bull floating, but before power floating and troweling.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Cure continuously for not less than 7 days.
- C. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified. Cure watertight concrete by moist curing or moisture cover curing for a minimum of 7 days.
- D. Provide moisture-retaining cover curing by following methods.
 - 1. Keep concrete surface continuously wet by covering with water.
 - 2. Use continuous water-fog spray.
 - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
- E. Provide moisture-cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

- F. Provide curing and sealing compound to all exposed interior slabs, not receiving a liquid densifier, and troweled slabs receiving mastic applied adhesives or "shake on" hardeners. Exterior slabs, sidewalks, curbs, and architectural concrete, not receiving a penetrating sealer, shall be cured with the specified clear, non-yellowing curing and sealing compound. Maximum coverage shall be 400 ft²/gallon on floated or broomed surfaces for the curing/sealing compound.
 - 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- G. The curing process must begin immediately after final finishing.
- H. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue with curing with methods specified above, as applicable.
- I. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

3.13 REMOVAL OF FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed until concrete has attained at least 75% of design minimum 28 day compressive strength but not less than the following time limits:
 - 1. Beams, joists and one-way slabs - 7 days.
 - 2. Two-way slabs - 14 days.
 - 3. Post-tensioned concrete - approval of stressing records.
- C. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- D. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.14 REUSE OF FORMS

- A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces except as acceptable to Engineer.

3.15 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein other miscellaneous concrete filling shown or required to complete work.

- B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
- C. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.
- D. Grout base plates and foundations, as indicated, using specified non-shrink grout. Where high fluidity and/or increased placing time is required use the specified high flow grout. This grout shall be used for all base plates larger than 10 square feet.

3.16 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Engineer.
 - 1. Cut out honeycomb, rock pockets, and voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.
 - 2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at an inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins, and other projections on surface, and stains and other discoloration's that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.
 - 1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete
- C. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.
 - 1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, including crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless for width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
 - 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 - 3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing them with underlayment compound or repair topping. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Owner project manager.
 - 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

- D. Repair isolated random cracks and single holes not over 1 inch in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
- E. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar.
- F. Repair methods not specified above may be used, subject to acceptance of Engineer.
- G. Bonding Compound Usage: The specified bonding compound shall be used in interior uses not subject to moisture. In moist conditions, a bonding grout, including the specified bonding admixture or the specified epoxy adhesive, must be used. The patching mortar or new concrete must then be placed while the bonding grout or epoxy adhesive is still tacky.

3.17 APPLICATION OF SILANE SEALER

- A. Provide a 5 foot by 5 foot test area before starting general application. Obtain Engineer's approval of application rate before general application.

3.18 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as indicated on the Drawings.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- E. Sampling and testing for quality control during placement of concrete may include the following, as directed by Engineer.
 - 1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - 2. Slump: ASTM C 143; one test at one point of discharge for each set of compressive strength test cylinders; additional tests when concrete consistency seems to have changed.
 - 3. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each set of compressive strength test cylinders for each type of air-entrained concrete.
 - 4. Water Content: The water content of freshly mixed concrete will be tested each time cylinders are made and as directed by the Architect in accordance with ASSHTO T318 Measurement of Water Content of Fresh Concrete Using the Microwave Oven.
 - 5. Concrete Temperature: Test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and each time a set of compression test specimens is made.
 - 6. Compression Test Specimen: ASTM C 31. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
 - 7. Compressive Strength Tests: The following number of concrete test cylinders shall be cast for each class of concrete for each day's work (pour), 75 cubic yards, or 5000 square feet or greater:
 - a. For Footings and Other Structural Concrete:
 - 1) 2 @ 7 Days, Lab Cured
 - 2) 2 @ 28 Days, Lab Cured
 - b. For Columns and Walls:
 - 1) 2 @ 7 Days, Lab Cured

- 2) 2 @ 7 Days, Field Cured
 - 3) 2 @ 28 Days, Lab Cured
 - 4) 2 @ 28 Days, Field Cured
8. When additional test specimens shall be performed as directed by the Engineer or Engineer of Record with two (2) specimens required for a test. To establish break data, two (2) cylinders must be broken and averaged.
 9. NOTE: All field cured test cylinders shall be cast and cured in the field in the concrete placement and under environmental conditions similar as possible to the conditions to which the pour is subjected.
 10. When frequency of testing will provide fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
- F. Test results will be reported in writing to Engineer, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

3.19 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the Engineer. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

3.20 SCHEDULE - CONCRETE TYPES AND FINISHES

- A. See structural drawings for minimum 28 day compressive strength.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, and incidentals required and install structural steel including bearing plates, columns, beams, and miscellaneous shapes and plates required to erect the structural framing as indicated on the Drawings and as specified herein. The Contractor shall provide all anchor bolts, nuts, and washers as required to install the structural in a safe and workmanlike manner in accordance with the Drawings and specifications or as required to complete the installation.

1.02 REFERENCE STANDARDS

- A. AISC (MAN) - Steel Construction Manual; American Institute of Steel Construction, Inc.; 2011.
- B. AISC S303 - Code of Standard Practice for Steel Buildings and Bridges; American Institute of Steel Construction, Inc.; 2010.
- C. AISC S348 - Specification for Structural Joints Using ASTM A325 or A490 Bolts; 2004.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- F. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished; 2013.
- G. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.
- H. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- I. ASTM A242/A242M - Standard Specification for High-Strength Low-Alloy Structural Steel; 2004 (Reapproved 2009).
- J. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2012.
- K. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2010.
- L. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength; 2012.
- M. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
- N. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2007.
- O. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2007a (Reapproved 2014).
- P. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts [Metric]; 2007.
- Q. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2011.
- R. ASTM E94 - Standard Guide for Radiographic Examination; 2004 (Reapproved 2010).
- S. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments; 2013.
- T. ASTM E165/E165M - Standard Test Method for Liquid Penetrant Examination for General Industry; 2012.
- U. ASTM E709 - Standard Guide for Magnetic Particle Testing; 2014.
- V. ASTM F436 - Standard Specification for Hardened Steel Washers; 2011.

- W. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.
- X. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010 w/Errata.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - 2. Connections not detailed.
 - 3. Indicate cambers and loads.
 - 4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.04 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC "Steel Construction Manual."
- B. Fabricator: Company specializing in performing the work of this section with minimum five (5) years of documented experience.
- C. Erector: Company specializing in performing the work of this section with minimum five (5) years of documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Steel Angles, Plates, and Channels: ASTM A36/A36M.
- B. Rolled Steel Structural Shapes: ASTM A992/A992M.
- C. Steel Shapes, Plates, and Bars: ASTM A 242/A 242M high-strength, corrosion-resistant structural steel.
- D. Cold-Formed Structural Tubing: ASTM A500/A500M, Grade B.
- E. Hot-Formed Structural Tubing: ASTM A501, seamless or welded.
- F. Pipe: ASTM A53/A53M, Grade B, Finish black.
- G. Stainless Steel: ASTM A276 Standard Specifications for stainless steel bars and shapes.
- H. Structural Bolts and Nuts: Carbon steel, ASTM A307, Grade A galvanized to ASTM A 153/A 153M, Class C.
- I. High-Strength Structural Bolts, Nuts, and Washers: ASTM A325 or A325M, Type 1, medium carbon, galvanized, with matching compatible ASTM A563 or A563M nuts and ASTM F436 washers.
- J. Headed Anchor Rods: ASTM A 307, Grade C.
- K. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- L. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. Shop fabricate to greatest extent possible.
- B. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
- C. Fabricate connections for bolt, nut, and washer connectors.

2.03 FINISH

- A. Galvanize all exterior structural steel members to comply with ASTM A 123/A 123M. Provide minimum 1.7 oz/sq ft galvanized coating.

2.04 SOURCE QUALITY CONTROL

- A. An independent testing agency will perform shop quality control inspection and testing as indicated on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

- A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".
- B. Allow for erection loads, and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Field weld components indicated on shop drawings.
- D. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with AISC "Specification for Structural Joints Using ASTM A325".
- E. Do not field cut or alter structural members without approval of Engineer.
- F. After erection, prime welds, abrasions, and surfaces not galvanized, except surfaces to be in contact with concrete.
- G. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

3.04 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control inspection and testing as indicated on Drawings.

END OF SECTION

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SECTION 08 16 13
FIBERGLASS DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiberglass reinforced plastic (FRP) doors.
- B. Frames for fiberglass reinforced plastic doors.
- C. Hinges and other door hardware.
- D. Glazing.
- E. Accessories.

1.02 REFERENCE STANDARDS

- A. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2011.
- B. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2014.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Obtain hardware templates from hardware manufacturer prior to starting fabrication.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard details, installation instructions, and hardware and anchor recommendations.
- C. Shop Drawings: Show layout and profiles; include assembly methods.
 - 1. Indicate product components, including hardware reinforcement locations and preparations, accessories, finish colors, patterns, and textures.
 - 2. Indicate wall conditions, door and frame elevations, sections, materials, gages, finishes, location of door hardware by dimension, and details of openings; use same reference numbers indicated on Drawings to identify details and openings.
- D. Maintenance Data: Include instructions for repair of minor scratches and damage.
- E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer; include detailed terms of warranty.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of experience.
- B. Installer Qualifications: Company specializing in installing products of the type specified in this section with not less than three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Mark doors with location of installation, door type, color, and weight.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

- C. Store materials in original packaging, under cover, protected from exposure to harmful weather conditions and from direct contact with water.
 - 1. Store at temperature and humidity conditions recommended by manufacturer.
 - 2. Do not use non-vented plastic or canvas shelters.
 - 3. Immediately remove wet wrappers.
- D. Store in position recommended by manufacturer, elevated minimum 4 inches above grade, with minimum 1/4 inches space between doors.

1.07 FIELD CONDITIONS

- A. Do not install doors until structure is enclosed.
- B. Maintain temperature and humidity at manufacturer's recommended levels during and after installation of doors.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide ten (10) year manufacturer warranty covering materials and workmanship .

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Molded Fiberglass Doors:
 - 1. ChemPruf Door Company, Ltd; _____: www.chem-pruf.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOOR AND FRAME ASSEMBLIES

- A. Door and Frame Assemblies: Factory-fabricated, prepared and machined for hardware.
 - 1. Door and frame pre-assembled, complete with hinges; shipped with braces, spreaders, and packaging as required to prevent damage.
 - 2. Mechanical Durability: Tested to ANSI/SDI A250.4 Level A (1,000,000 cycles), minimum; tested with hardware and fasteners intended for use on project.
 - 3. Screw-Holding Capacity: Tested to 900 psi, minimum.
 - 4. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A; when tested in accordance with ASTM E84.
 - 5. Flammability: Self-extinguishing when tested in accordance with ASTM D635.
 - 6. Chemical Resistance: Resist degradation due to exposure to tap water and distilled water.
 - a. Sewage and moisture-laden air in sewage treatment areas.
 - b. Chlorine-treated moisture in air.
 - 7. Sizes: As indicated on drawings.
 - 8. Clearance Between Door and Frame: 1/8 inch, maximum.
 - 9. Clearance Between Meeting Stiles of Pairs of Doors: 1/8 inch, maximum.
 - 10. Clearance Between Bottom of Door and Finished Floor: 3/4 inch, maximum; not less than 1/4 inch clearance to threshold.
 - 11. Provide frame anchors that allow for variation in rough opening size; do not field cut doors or frames to fit.

2.03 COMPONENTS

- A. Doors: Through-color gel coating on fiberglass reinforced polyester resin construction with reinforced core.
 - 1. Thickness: 1-3/4 inches, overall.
 - 2. Door Construction: Molded in one piece including gel coating on all sides; manufacturer's standard subframe, core and faces fused during cure in mold; hardware reinforcements
 - 3. Subframe and Reinforcements: Manufacturer's standard materials.
 - 4. Waterproof Integrity: All edges, cut-outs, and hardware preparations factory fabricated of fiberglass reinforced plastic; provide cut-outs with joints sealed independently of glazing or louver inserts or trim.

5. Hardware Preparations: Factory reinforce, machine, and prepare for all hardware including field installed items; provide solid blocking for each hardware item; make field cutting, drilling or tapping unnecessary; obtain manufacturer's templates for hardware preparations.
 6. Bottom Rail: Provide height necessary to allow up to 1-1/4 inches to be field cut off bottom of door without impairing door strength or durability.
- B. Frames: Profiles and dimensions as indicated on drawings; same type and construction used in mechanical durability test for doors.
1. Construction for Non-Fire-Rated Doors: Use one of the following:
 - a. Molded fiberglass with gel-coating matching doors.
 2. Corner Joints: Mitered with concealed corner blocks or angles of same material as frame; fiberglass and aluminum joined with screws; steel and stainless steel spot welded; sealed watertight with silicone sealant.
 3. At hardware cut-outs provide continuous backing or mortar guards of same material as frame, sealed watertight.
 4. Frame Anchors: Stainless steel, Type 304; provide 3 anchors in each jamb for heights up to 84 inches with one additional anchor for each additional 24 inches in height.
- C. Transom and Other Panels: Same construction as doors.
- D. Hinge and Hardware Fasteners: Stainless steel, Type 304; wood screws.

2.04 ACCESSORIES

- A. Astragals for Inactive Leaves: Pultruded fiberglass angle or tee; same color as gel coat.
- B. Glazing and Louver Stops: Pultruded fiberglass unless otherwise indicated or required by fire rating; provided by door manufacturer to fit factory made openings, color and texture to match door; fasteners not penetrating waterproof integrity.
1. Exterior Doors: Provide non-removable stops on outside and continuous compression gasket weatherseal.
 2. Glazed Openings: Provide removable stops on one side.
 3. Opening Sizes: As indicated on drawings.
- C. Glazing: Laminated safety glass, 1/4 inch thick, with minimum 0.030 inch thick interlayer, clear.
- D. Louvers for Non-Fire-Rated Doors: Same materials, construction, finish, and color as door; fixed vanes, 45 degree sloped vanes.
- E. Hardware: As specified in Section 08 71 00.
- F. Thresholds: Molded fiberglass, with skid resistant surface, full width of door opening, same color as frame.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify actual dimensions of openings by field measurements before door fabrication; show recorded measurements on shop drawings.
- B. Do not begin installation until substrates have been properly prepared.
- C. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Remove existing doors and frames, and dispose of all removed materials in accordance with local authorities having jurisdiction.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean and prepare substrate in accordance with manufacturer's directions.
- D. Protect adjacent work and finish surfaces from damage during installation.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions; do not penetrate frames with anchors.
- B. Set units plumb, level, and true-to-line, without warping or racking doors, and with specified clearances; anchor in place.
- C. Separate aluminum and other metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.
- D. Repair or replace damaged installed products.

3.04 ADJUSTING

- A. Lubricate, test, and adjust doors to operate easily, free from warp, twist or distortion, and to fit watertight for entire perimeter.
- B. Adjust hardware for smooth and quiet operation.
- C. Adjust doors to fit snugly and close without sticking or binding.

3.05 CLEANING

- A. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

3.06 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hardware for wood, aluminum, hollow metal doors.
- B. Electrically operated and controlled hardware.
- C. Thresholds.
- D. Weatherstripping, seals and door gaskets.

1.02 RELATED REQUIREMENTS

- A. Section 08 16 13 - Fiberglass Doors and Frames

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- C. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2009.
- D. BHMA A156.1 - American National Standard for Butts and Hinges; Builders Hardware Manufacturers Association, Inc.; 2013 (ANSI/BHMA A156.1).
- E. BHMA A156.2 - American National Standard for Bored and Preassembled Locks & Latches; Builders Hardware Manufacturers Association; 2011 (ANSI/BHMA A156.2).
- F. BHMA A156.3 - American National Standard for Exit Devices; Builders Hardware Manufacturers Association; 2014 (ANSI/BHMA A156.3).
- G. BHMA A156.4 - American National Standard for Door Controls - Closers; Builders Hardware Manufacturers Association, Inc.; 2013 (ANSI/BHMA A156.4).
- H. BHMA A156.6 - American National Standard for Architectural Door Trim; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.6).
- I. BHMA A156.7 - American National Standard for Template Hinge Dimensions; Builders Hardware Manufacturers Association; 2014 (ANSI/BHMA A156.7).
- J. BHMA A156.8 - American National Standard for Door Controls - Overhead Stops and Holders; Builders Hardware Manufacturers Association, Inc.; 2010 (ANSI/BHMA A156.8).
- K. BHMA A156.13 - American National Standard for Mortise Locks & Latches Series 1000; Builders Hardware Manufacturers Association; 2012 (ANSI/BHMA A156.13).
- L. BHMA A156.18 - American National Standard for Materials and Finishes; Builders Hardware Manufacturers Association, Inc.; 2012 (ANSI/BHMA A156.18).
- M. BHMA A156.21 - American National Standard for Thresholds; Builders Hardware Manufacturers Association; 2014 (ANSI/BHMA A156.21).
- N. BHMA A156.22 - American National Standard for Door Gasketing and Edge Seal Systems, Builders Hardware Manufacturers Association; 2012 (ANSI/BHMA A156.22).
- O. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; Door and Hardware Institute; 2004.
- P. ICC A117.1 - Accessible and Usable Buildings and Facilities; International Code Council; 2009 (ANSI).
- Q. NFPA 101 - Life Safety Code; National Fire Protection Association; 2012.
- R. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware will be installed upon.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- C. Convey Owner's keying requirements to manufacturers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project.
- C. Shop Drawings:
 - 1. Indicate locations and mounting heights of each type of hardware, schedules, catalog cuts, .
- D. Hardware Schedule: Detailed listing of each item of hardware to be installed on each door. Use door numbering scheme as included in the Contract Documents. Identify electrically operated items and include power requirements.
- E. Keying Schedule: Submit for approval of Owner.
- F. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- G. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- H. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.
- I. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year warranty for door closers.

PART 2 PRODUCTS

2.01 DOOR HARDWARE - GENERAL

- A. Provide hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.
- B. Provide items of a single type of the same model by the same manufacturer.
- C. Provide products that comply with the following:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. ANSI/ICC A117.1, American National Standard for Accessible and Usable Buildings and Facilities.
 - 4. Applicable provisions of NFPA 101, Life Safety Code.

5. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.
- D. Electrically Operated and/or Controlled Hardware: Provide all power supplies, power transfer hinges, relays, and interfaces required for proper operation; provide wiring between hardware and control components and to building power connection.
- E. Finishes: Provide door hardware of the same finish unless otherwise indicated.
 1. Primary Finish: Satin chrome plated over nickel on brass or bronze, 626 (approx US26D).
 2. Secondary Finish: Satin chrome plated over nickel on brass or bronze, 626 (approx US26D).
 - a. Use secondary finish in kitchens, bathrooms, and other spaces containing chrome or stainless steel finished appliances, fittings, and equipment; provide primary finish on one side of door and secondary finish on other side if necessary.
 3. Finish Definitions: BHMA A156.18.
 4. Exceptions:
 - a. Where base metal is specified to be different, provide finish that is an appearance equivalent according to BHMA A156.18.

2.02 LOCKS AND LATCHES

- A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
 1. If no hardware set is indicated for a swinging door provide an office lockset.
 2. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
 3. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
- B. Lock Cylinders: Manufacturer's standard tumbler type, six-pin standard core.
 1. Provide cams and/or tailpieces as required for locking devices required.
- C. Keying: Grand master keyed.
- D. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

2.03 HINGES

- A. Hinges: Provide hinges on every swinging door.
 1. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
 2. Provide ball-bearing hinges at all doors having closers.
 3. Provide hinges in the quantities indicated.
 4. Provide non-removable pins on exterior outswinging doors.
- B. Butt Hinges: Comply with BHMA A156.1 and A156.7; standard weight, unless otherwise indicated.
 1. Provide hinge width required to clear surrounding trim.
- C. Quantity of Hinges Per Door:
 1. Doors From 60 inches High up to 90 inches High: Three hinges.
 2. Doors 90 inches High up to 120 inches High: Four hinges.

2.04 PUSH/PULLS

- A. Push/Pulls: Comply with BHMA A156.6.
 1. Provide push and pull on doors not specified to have lockset, latchset, exit device, or auxiliary lock.
 2. On solid doors, provide matching push plate and pull plate on opposite faces.

2.05 LOCKS AND LATCHES

- A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
 1. Hardware Sets indicate locking functions required for each door.
 2. If no hardware set is indicated for a swinging door provide an office lockset.

3. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
 4. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
 5. In door sections, where a lock cylinder referenced to Section 08 71 00 is specified, furnish and install a mortise lock cylinder keyed to the building keying system.
- B. Lock Cylinders: Manufacturer's standard tumbler type, six-pin standard core.
1. Provide cams and/or tailpieces as required for locking devices required.
- C. Keying: Grand master keyed.
1. Key to existing keying system.
- D. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

2.06 CYLINDRICAL LOCKSETS

- A. Locking Functions: As defined in BHMA A156.2, and as follows.
1. Passage: No locking, always free entry and exit.
 2. Privacy: F76, emergency tool unlocks.
 3. Office: F81, key not required to lock, remains locked upon exit.

2.07 MORTISE LOCKSETS

- A. Locking Functions: As defined in BHMA A156.13, and as follows:
1. Passage: F01.
 2. Privacy: F19, or F02 with retraction of deadbolt by use of inside lever/knob.
 3. Office: F04, key not required to lock, remains locked upon exit.
 4. Entry, Deadbolt: F20, may be locked without key, free egress.

2.08 FLUSHBOLTS AND COORDINATORS

- A. Flushbolts: Lever extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
1. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
 2. Floor Bolts: Provide dustproof strike except at metal thresholds.
- B. Manual Flushbolts: Provide lever extensions for top bolt at over-size doors.
- C. Self-Latching Flushbolts: Automatically latch upon closing of door; manually retracted.
- D. Coordinators: Provide on doors having closers and self-latching or automatic flushbolts to ensure that leaves close in proper order.

2.09 EXIT DEVICES

- A. Provide Exit devices for doors as indicated on the Hardware Schedule and for all Electrical room doors.
- B. Locking Functions: Functions as defined in BHMA A156.3, and as follows:
1. Entry/Exit, Always-Unlocked: Outside lever unlocked, no outside key access, no latch holdback.
 2. Entry/Exit, Free Swing: Key outside retracts latch, latch holdback (dogging) for free swing during occupied hours, not fire-rated; outside trim must be specified as lever or pull.

2.10 CLOSERS

- A. Closers: Complying with BHMA A156.4.
1. Provide surface-mounted, door-mounted closers unless otherwise indicated.
 2. Provide a door closer on every exterior door.
 3. Provide a door closer on every fire- and smoke-rated door. Spring hinges are not an acceptable self-closing device unless specifically so indicated.
 4. On pairs of swinging doors, if an overlapping astragal is present, provide coordinator to ensure the leaves close in proper order.

5. At outswinging exterior doors, mount closer in inside of door.

2.11 STOPS AND HOLDERS

- A. Stops: Complying with BHMA A156.8; provide a stop for every swinging door, unless otherwise indicated.
 1. Provide wall stops, unless otherwise indicated.
 2. If wall stops are not practical, due to configuration of room or furnishings, provide overhead stop.
 3. Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop unless specifically so stated.

2.12 GASKETING AND THRESHOLDS

- A. Gaskets: Complying with BHMA A156.22.
 1. On each door in smoke partition, provide smoke gaskets; top, sides, and meeting stile of pairs. If fire/smoke partitions are not indicated on drawings, provide smoke gaskets on each door identified as a "smoke door" and 20-minute rated fire doors.
 2. On each exterior door, provide weatherstripping gaskets, unless otherwise indicated; top, sides, and meeting stiles of pairs.
 - a. Where exterior door is also required to have fire or smoke rating, provide gaskets functioning as both smoke and weather seals.
 3. On each exterior door, provide door bottom sweep, unless otherwise indicated.
 4. On each interior electrical room door, provide gaskets similar to smoke gaskets.
- B. Thresholds: Complying with BHMA A156.21.
 1. At each exterior door, provide a threshold unless otherwise indicated.
- C. Fasteners At Exterior Locations: Non-corroding.

2.13 PROTECTION PLATES AND ARCHITECTURAL TRIM

- A. Protection Plates:
 1. Kickplate: Provide on push side of every door with closer, except aluminum storefront and glass entry doors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available to power operated devices and of the correct characteristics.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Use templates provided by hardware item manufacturer.
- C. Mounting heights for hardware from finished floor to center line of hardware item.
 1. For steel doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Steel Doors and Frames."
- D. Set exterior door thresholds with full-width bead of elastomeric sealant on each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

3.03 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01 40 00.

3.04 ADJUSTING

- A. Adjust work under provisions of Section 01 70 00.

- B. Adjust hardware for smooth operation.
- C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING

- A. Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.06 PROTECTION

- A. Protect finished Work under provisions of Section 01 70 00.
- B. Do not permit adjacent work to damage hardware or finish.

HARDWARE SETS

4.01 HARDWARE SETS - GENERAL

- A. These Hardware Sets indicate requirements for single doors of that type, with conditional requirements for pairs and other situations.
- B. Pairs of Swinging Doors: Provide one of each specified item on each leaf unless specifically stated otherwise. Treat pairs as two active leaves unless otherwise indicated.

4.02 SWING DOORS -- NOT REQUIRING KEY LOCKING

- A. HW-1: Push/Pull, Non-Fire-Rated:
 - 1. Closer.
 - 2. Push/Pull.
- B. HW-2: Latchset, Non-Fire-Rated.
 - 1. Latchset, Passage.
 - 2. Pair: One leaf inactive, with manual flush bolts.
- C. HW-5: Privacy Lockset, Non-Fire-Rated:
 - 1. Lockset, Privacy.
- D. HW-6: Exit Device, Always-Unlocked, Normally-Closed, Fire-Rated or Non-Fire-Rated:
 - 1. Closer.
 - 2. Exit Device, Rim, Entry/Exit, Always-Unlocked.
 - 3. Pair: Removable Mullion, removable only by key.

4.03 SWING DOORS -- LOCKABLE, MAY BE LEFT UNLOCKED, KEY NOT REQUIRED TO LOCK

- A. HW-10: Office, Non-Fire-Rated:
 - 1. Lockset, Office.
 - 2. Pair: One leaf inactive, with manual flush bolts.
- B. HW-13: Public Entrance, Exit Device, Lockable, Non-Fire-Rated:
 - 1. Closer.
 - 2. Exit Device, Rim, Entry/Exit, Free Swing, lever outside trim.
 - 3. Pair: Surface vertical rod type devices.

END OF SECTION

SECTION 09 91 23
PAINTS AND COATINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to prepare surfaces and apply paints and coatings as specified within this Section, unless otherwise indicated on the Drawings.

1.02 REFERENCES

- A. ANSI/NSF 61 - Drinking Water System Components - Health Effects.
- B. ASTM D 16 - Terminology Relating to Paint, Varnish, Lacquer, and Related Products.
- C. ASTM D 4263 - Indicating Moisture in Concrete by the Plastic Sheet Method.
- D. ASTM F 1869 - Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- E. AWWA C 652 - Disinfection of Water-Storage Facilities.
- F. AWWA D 102 - Painting Steel Water Storage Tanks.
- G. International Concrete Repair Institute (ICRI) Guideline No. 03732 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
- H. SSPC-SP 1 - Solvent Cleaning.
- I. SSPC-SP 2 - Hand Tool Cleaning.
- J. SSPC-SP 3 - Power Tool Cleaning.
- K. SSPC-SP 5/NACE 1 - White Metal Blast Cleaning.
- L. SSPC-SP 6/NACE 3 - Commercial Blast Cleaning.
- M. SSPC-SP 10/NACE 2 - Near-White Metal Blast Cleaning.
- N. SSPC-SP 13/NACE 6 - Surface Preparation of Concrete.

1.03 DEFINITIONS

- A. Definitions of Painting Terms: ASTM D 16, unless otherwise specified.
- B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.
- C. Manufacturer's Quality Assurance: Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.
- D. Applicator's Quality Assurance: Submit list of a minimum of 5 completed projects of similar size and complexity to this Work. Include for each project:
 - 1. Project name and location.
 - 2. Name of owner.
 - 3. Name of contractor.
 - 4. Name of engineer.
 - 5. Name of coating manufacturer.
 - 6. Approximate area of coatings applied.
 - 7. Date of completion.
- E. Warranty: Submit manufacturer's standard warranty.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.
 - 2. Able to demonstrate successful performance on comparable projects.
 - 3. Single Source Responsibility: Coatings and coating application accessories shall be products of a single manufacturer.
- B. Applicator's Qualifications:
 - 1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.
 - 2. Applicator's Personnel: Employ persons trained for application of specified coatings.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
 - 1. Coating or material name.
 - 2. Manufacturer.
 - 3. Color name and number.
 - 4. Batch or lot number.
 - 5. Date of manufacture.
 - 6. Mixing and thinning instructions.
- B. Storage:
 - 1. Store materials in a clean dry area and within temperature range in accordance with manufacturer's instructions.
 - 2. Keep containers sealed until ready for use.
 - 3. Do not use materials beyond manufacturer's shelf life limits.
- C. Handling: Protect materials during handling and application to prevent damage or contamination.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Weather:
 - 1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer's instructions.
 - 2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
 - 3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer's instructions.
 - 4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
 - 5. Wind: Do not spray coatings if wind velocity is above manufacturer's limit.
- B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.
- C. Dust and Contaminants:
 - 1. Schedule coating work to avoid excessive dust and airborne contaminants.
 - 2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Tnemec Company Incorporated
- B. Benjamin Moore
- C. Sherwin Williams
- D. Substitutions: See Section 01600 - Product Requirements.

2.02 COATING SYSTEMS FOR STEEL - STRUCTURAL, TANKS, PIPE, AND EQUIPMENT

- A. Exterior Exposed:
 - 1. System Type: Epoxy/urethane.
 - 2. Surface Preparation: SSPC-SP 6.
 - 3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
 - 4. Intermediate Coat: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
 - 5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 5.0 mils.
 - 6. Total DFT: 7.0 to 13.0 mils.
 - 7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
- B. Interior Exposed:
 - 1. System Type: Epoxy.
 - 2. Surface Preparation: SSPC-SP 6.
 - 3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils
 - 4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
 - 5. Total DFT: 7.0 to 11.0 mils.
 - 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
- C. Immersion:
 - 1. System Type: Coal tar epoxy.
 - 2. Surface Preparation: SSPC-SP 10.
 - 3. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar: DFT 14.0 to 20.0 mils.
 - 4. Total DFT: 14.0 to 20.0 mils.
 - 5. Finish Color: Black.
- D. Below Grade:
 - 1. System Type: Coal tar epoxy.
 - 2. Surface Preparation: SSPC-SP 10.
 - 3. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar: DFT 14.0 to 20.0 mils.
 - 4. Total DFT: 14.0 to 20.0 mils.
 - 5. Finish Color: Black.
- E. Marginally Prepared Surfaces (Maintenance, Non-Immersion):
 - 1. System Type: Epoxy.
 - 2. Surface Preparation: In accordance with manufacturer's instructions.
 - 3. Primer: Series 135 Chembuild: DFT 4.0 to 6.0 mils.
 - 4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
 - 5. Total DFT: 8.0 to 12.0 mils.
 - 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.03 COATING SYSTEMS FOR FACTORY PRIMED STEEL - DOORS, FRAMES, AND MISCELLANEOUS EQUIPMENT

- A. Exterior Exposed:
 - 1. System Type: Epoxy/urethane.
 - 2. Surface Preparation: Clean and dry.
 - 3. Primer: Factory primed.
 - 4. Intermediate Coat: Series 27 Typoxy: DFT 2.0 to 3.0 mils.
 - 5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
 - 6. Total DFT: 4.0 to 6.0 mils.
 - 7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
- B. Interior Exposed:
 - 1. System Type: Epoxy.

2. Surface Preparation: Clean and dry.
3. Primer: Factory primed.
4. Intermediate Coat: Series 27 Typoxy: DFT 2.0 to 3.0 mils.
5. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
6. Total DFT: 4.0 to 6.0 mils.
7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.04 COATING SYSTEMS FOR NONFERROUS METAL - PIPE AND MISCELLANEOUS FABRICATIONS

- A. Exterior Exposed:
1. System Type: Epoxy/urethane.
 2. Surface Preparation: In accordance with manufacturer's instructions.
 3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
 4. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
 5. Total DFT: 4.0 to 6.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
- B. Interior Exposed:
1. System Type: Epoxy.
 2. Surface Preparation: In accordance with manufacturer's instructions.
 3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
 4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
 5. Total DFT: 4.0 to 6.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
- C. Immersion:
1. System Type: Epoxy.
 2. Surface Preparation: SSPC-SP 1 followed by abrasive blast.
 3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
 4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
 5. Total DFT: 7.0 to 11.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.05 COATING SYSTEMS FOR DUCTILE OR CAST IRON - PIPE, PUMPS AND VALVES

- A. Exterior Exposed:
1. System Type: Epoxy.
 2. Surface Preparation: In accordance with manufacturer's instructions.
 3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
 4. Intermediate Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
 5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
 6. Total DFT: 9.0 to 14.0 mils.
 7. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
 8. Note: Factory Coated Pumps and Valves shall not be coated by Contractor.
- B. Below Ground:
1. System Type: Coal tar epoxy.
 2. Surface Preparation: In accordance with manufacturer's instructions.
 3. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar: DFT 14.0 to 20.0 mils.
 4. Total DFT: 14.0 to 20.0 mils.
 5. Finish Color: Black.
 6. Note: Factory Coated items shall not be coated.

- C. Interior Exposed:
1. System Type: Epoxy.
 2. Surface Preparation: In accordance with manufacturer's instructions.
 3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
 4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
 5. Total DFT: 7.0 to 11.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

- D. Immersion:
1. System Type: Coal tar epoxy.
 2. Surface Preparation: In accordance with manufacturer's instructions.
 3. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar: DFT 14.0 to 20.0 mils.
 4. Total DFT: 14.0 to 20.0 mils.
 5. Finish Color: Black.

2.06 COATING SYSTEMS FOR PVC

- A. Exterior Exposed:
1. System Type: Epoxy/urethane.
 2. Surface Preparation: Scarify.
 3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
 4. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.
 5. Total DFT: 4.0 to 6.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
- B. Interior Exposed:
1. System Type: Epoxy.
 2. Surface Preparation: Scarify.
 3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
 4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
 5. Total DFT: 4.0 to 6.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.07 COATING SYSTEMS FOR INSULATED PIPE

- A. Interior/Exterior Exposed:
1. System Type: Acrylic.
 2. Surface Preparation: Clean and dry.
 3. Primer: Series 6 Tneme-Cryl: DFT 2.0 to 3.0 mils.
 4. Finish Coat: Series 6 Tneme-Cryl: DFT 2.0 to 3.0 mils.
 5. Total DFT: 4.0 to 6.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.08 COATING SYSTEMS FOR PRECAST CONCRETE AND CONCRETE MASONRY UNITS

- A. Exterior Exposed:
1. System Type: Acrylate.
 2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
 3. Primer: Series 156 Enviro-Crete: DFT 4.0 to 8.0 mils.
 4. Finish Coat: Series 156 Enviro-Crete: DFT 4.0 to 8.0 mils.
 5. Total DFT: 8.0 to 16.0 mils.
 6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.
- B. Interior Exposed:
1. System Type: Epoxy.

2. Surface Preparation: SSPC-SP 13/NACE 6. Brush-off blast.
3. Primer: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.
5. Total DFT: 8.0 to 12.0 mils.
6. Finish Color: See Schedule of Colors. If not specified, as selected by Owner from manufacturer's standard colors.

2.09 COATING SYSTEMS FOR CONCRETE FLOORS

- A. See Section 03300 - "Cast-In-Place Concrete".

2.10 COATING SYSTEMS FOR CONCRETE MASONRY UNITS

- A. Exterior
1. Primer: Two-Component, heavy-duty cementitious acrylic block filler
 - a. Cement-Plex 875 B62W200/B42V201, @ 13.0 - 25.0 mils DFT, as manufactured by The Sherwin Williams Co.
 2. Finish: One Component, Pigmented Acrylic
 - a. DTM Acrylic Coating, Gloss or Semi Gloss, B66 Series, @ 2.5 - 4.0 mils DFT per coat (two coats), as manufactured by The Sherwin Williams Co.
- B. Interior
1. Primer: Two-Component
 - a. 1.PrepRite Masonry Primer, B28W300, @ 1.0 - 1.5 mils DFT, as manufactured by The Sherwin-Williams Company
 2. Finish: One-Component, Pigmented Alkyd Coating, Gloss
 - a. Industrial Enamel VOC, B54Z Series, @ 2.0 - 3.0 mils DFT per coat (two coats), as manufactured by The Sherwin-Williams Co.

2.11 ACCESSORIES

- A. Coating Application Accessories:
1. Accessories required for application of specified coatings in accordance with manufacturer's instructions, including thinners.
 2. Products of coating manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

3.02 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

- A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.
- B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.03 SURFACE PREPARATION OF STEEL

- A. Prepare steel surfaces in accordance with manufacturer's instructions.
- B. Fabrication Defects:
1. Correct steel and fabrication defects revealed by surface preparation.
 2. Remove weld spatter and slag.
 3. Round sharp edges and corners of welds to a smooth contour.
 4. Smooth weld undercuts and recesses.
 5. Grind down porous welds to pinhole-free metal.
 6. Remove weld flux from surface.
- C. Ensure surfaces are dry.

- D. Immersion or Below Grade Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2.
- E. Exterior Exposed or Interior Exposed Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3.
- F. Interior or Immersion Surfaces, Severe Exposure: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 5/NACE 1.
- G. Marginally Prepared Surfaces (Maintenance): Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with manufacturer's instructions.
- H. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.
- I. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions.

3.04 SURFACE PREPARATION OF NONFERROUS METAL

- A. Prepare galvanized steel and nonferrous metal surfaces in accordance with manufacturer's instructions.
- B. Surface preparation recommendations will vary depending on substrate and exposure conditions.
- C. Ensure surfaces are dry.
- D. Immersion Service: Clean surfaces by abrasive blasting.
- E. Remove Rust From Galvanized Steel:
 - 1. Remove white rust from galvanized steel by hand or power brushing.
 - 2. Remove rust from old galvanized steel in accordance with SSPC-SP 2 or SP 3.
 - 3. Do not damage or remove galvanizing.
- F. Increase mechanical adhesion under moderate to severe conditions, such as exterior exposure or chemical environments, by abrasive blast and/or chemical cleaning.

3.05 SURFACE PREPARATION OF DUCTILE OR CAST IRON

- A. Prepare ductile or cast iron surfaces in accordance with manufacturer's instructions.
- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.06 SURFACE PREPARATION OF PVC

- A. Prepare PVC surfaces in accordance with manufacturer's instructions.
- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- C. Scarify PVC surfaces.

3.07 SURFACE PREPARATION OF INSULATED PIPE

- A. Prepare insulated pipe surfaces in accordance with manufacturer's instructions.
- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.08 SURFACE PREPARATION OF CONCRETE

- A. Interior, Wet Substrate:
 - 1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
 - 2. Allow concrete to cure for a minimum of 28 days.
 - 3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

4. Abrasive blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.
 5. Fill holes, pits, voids, and cracks with Tnemec 63-1500 Filler and Surfacer.
 6. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.
- B. Exterior:
1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
 2. Allow concrete to cure for a minimum of 7 days.
 3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
 4. Level concrete protrusions and mortar spatter.
 5. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.
- C. Exterior, Previously Painted:
1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
 2. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
 3. Remove chalk and old paint not tightly bonded to surface.
 4. Patch cracks in accordance with manufacturer's instructions.
 5. Level concrete protrusions and mortar spatter.
 6. Determine compatibility of primer over unknown previously-applied coatings by preparing a test patch.
 7. Ensure surfaces are clean, dry, and free of oil, grease, and other contaminants.

3.09 SURFACE PREPARATION OF CONCRETE FLOORS

- A. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- C. Allow concrete to cure for a minimum of 28 days before coating.
- D. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

3.10 SURFACE PREPARATION OF POROUS CONCRETE MASONRY UNITS

- A. Prepare porous concrete masonry unit surfaces in accordance with manufacturer's instructions and SSPC-SP 13/NACE 6.
- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- C. Allow mortar to cure for a minimum of 28 days before coating.
- D. Level protrusions and mortar spatter.

3.11 APPLICATION

- A. Apply coatings in accordance with manufacturer's instructions.
- B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.
- C. Keep containers closed when not in use to avoid contamination.
- D. Do not use mixed coatings beyond pot life limits.
- E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.
- F. Uniformly apply coatings at spreading rate required to achieve specified DFT.
- G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

- H. Stripe paint with brush critical locations on steel such as welds, corners, and edges using specified primer.

3.12 DISINFECTION

- A. Disinfection of Water Contact Surfaces and Filling of Water Storage Tanks:
 - 1. Do not disinfect water contact surfaces or fill water storage tanks until application of coating systems is complete, coatings have fully cured, and field quality control inspection is complete.
 - 2. Allow number of days in accordance with manufacturer's instructions and as directed by Engineer for full cure of coating systems on water contact surfaces before flushing, disinfecting, or filling with water.
 - 3. Disinfection: AWWA C 652 or as directed by Engineer.

3.13 REPAIR

- A. Materials and Surfaces Not Scheduled To Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.
- B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.
- C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.14 CLEANING

- A. Remove temporary coverings and protection of surrounding areas and surfaces.

3.15 PROTECTION OF COATING SYSTEMS

- A. Protect surfaces of coating systems from damage during construction.

3.16 ONE-YEAR INSPECTION

- A. Owner will set date for one-year inspection of coating systems.
- B. Inspection shall be attended by Owner and Contractor.
- C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer's instructions.

3.17 SCHEDULES

- A. Schedule of Colors:
 - 1. Raw Water: Olive Green
 - 2. Anaerobic Lagoon Effluent: Olive Green
 - 3. Clarified Water :Aqua
 - 4. Potable Water: Dark Blue
 - 5. Backwash Waste: Light Brown
 - 6. Activated Sludge: Light Gray
 - 7. Return Sludge: Dark Brown
 - 8. Waste Sludge: Dark Brown
 - 9. Primary Coagulant: Orange
 - 10. Ammonia: White
 - 11. Carbon Source: Black
 - 12. Caustic: Yellow with Green Band
 - 13. Chlorine: Yellow
 - 14. Lime Slurry: Light Green
 - 15. Polymers: Orange with Green Band
 - 16. Sulfuric Acid: Yellow with Red Band
 - 17. Compressed Air: Dark Green
 - 18. Fire Protection: Red

Allen Harim Foods, LLC.
Harbeson, DE
Wastewater Treatment System Upgrade and Expansion - Phase Two

- B. Coating Systems in this section do not apply to Precast Concrete Tanks. Refer to section 03481-Precast Post Tension Concrete Tanks.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.
- D. Section 31 22 00 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Site Plan: Showing:
 - 1. Vegetation removal limits.
 - 2. Areas for temporary construction and field offices.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Fill Material: As specified in Section 31 22 00 - Grading

PART 3 EXECUTION

3.01 SITE CLEARING

- A. Comply with other requirements specified in Section 01 70 00.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
- B. Do not begin clearing until vegetation to be relocated has been removed.
- C. Do not remove or damage vegetation beyond the limits indicated on drawings.
 - 1. 40 feet outside the building perimeter.
 - 2. 10 feet each side of surface walkways, patios, surface parking, and utility lines less than 12 inches in diameter.
 - 3. 15 feet each side of roadway curbs and main utility trenches.
 - 4. 25 feet outside perimeter of pervious paving areas that must not be compacted by construction traffic.

5. Exception: Specific trees and vegetation indicated on drawings to be removed.
- D. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
 1. At vegetation removal limits.
 2. Around other vegetation to remain within vegetation removal limits.
- E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.
- F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
 3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
 4. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
 5. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.
- G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.
- H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 DEBRIS

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 31 22 00
GRADING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required for the removal of topsoil, rough grading, finish grading, and removal and disposal of topsoil and sub-soil which is within the limits of the work necessary for construction in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Drawings or established by the Engineer.

1.02 RELATED REQUIREMENTS

- A. Section 31 10 00 - Site Clearing.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 23 - Fill: Filling and compaction.
- D. Section 31 23 16.13 - Trenching: Trenching and backfilling for utilities.

1.03 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: See Section 31 23 23.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect from damage above- and below-grade utilities to remain.
- D. Notify utility company to remove and relocate utilities.
- E. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.
- F. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
- G. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
- D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform work by hand and cut roots with sharp axe.
- F. See Section 31 23 23 for filling procedures.

- G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.
- H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL

- A. Stockpile topsoil to be re-used on site; remove remainder from site.
- B. Stockpile excavated subsoil on site.
- C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.
- C. Where topsoil is to be placed, scarify surface to depth of 3 inches.
- D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.
- E. Place topsoil in areas where seeding are indicated.
- F. Place topsoil where required to level finish grade.
- G. Place topsoil to the following compacted thicknesses:
 - 1. Areas to be Seeded with Grass: 6 inches.
 - 2. Shrub Beds: 18 inches.
 - 3. Flower Beds: 12 inches.
- H. Place topsoil during dry weather.
- I. Remove roots, weeds, rocks, and foreign material while spreading.
- J. Near plants spread topsoil manually to prevent damage.
- K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- L. Lightly compact placed topsoil.

3.06 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).
- C. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.
- D. Top Surface of Finish Grade: Plus or minus 1/2 inch.

3.07 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Engineer as to remedy.
- C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.08 FIELD QUALITY CONTROL

- A. See Section 31 23 23 for compaction density testing.

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3.09 CLEANING

- A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

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SECTION 31 23 16.13

TRENCHING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required for the trenching for site utilities as shown on the Drawings and as specified herein.

1.02 SECTION INCLUDES

- A. Backfilling and compacting for utilities outside the building to utility main connections.

1.03 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Site grading.
- B. Section 31 23 16 - Excavation: Building and foundation excavating.
- C. Section 31 23 23 - Fill: Backfilling at building and foundations.

1.04 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: Indicated on drawings.

1.05 REFERENCES

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
- B. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.
- C. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.
- D. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- C. Compaction Density Test Reports.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where indicated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. See Section 02316 Fill and Backfill.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.

- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 22 00 for additional requirements.

3.03 TRENCHING

- A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
- G. Remove excavated material that is unsuitable for re-use from site.
- H. Remove excess excavated material from site.

3.04 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.05 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Thrust bearing surfaces: Fill with concrete.
 - 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. At other locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.

3.06 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Utility Piping :
 - 1. Bedding: Use granular fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.
- C. At Pipe Culverts:
 - 1. Bedding: Use granular fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.07 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.08 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D3017, or ASTM D6938.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: one (1) test per 2,500 SF per lift.

3.09 CLEANING

- A. Leave unused materials in a neat, compact stockpile.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

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SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required for all excavation required to complete the Work as shown on the Drawings and as specified herein.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Soil removal from surface of site.
- B. Section 31 22 00 - Grading: Grading.
- C. Section 31 23 23 - Fill: Fill materials, filling, and compacting.
- D. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

1.03 PROJECT CONDITIONS

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the work are as indicated.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 22 00 for additional requirements.

3.03 EXCAVATING

- A. Excavation shall include the loosening, loading, removing, and transporting and disposing of all materials, wet or dry, necessary to be removed for the purpose of construction; all dewatering, bailing, sheeting and bracing necessary to maintain trenches and pits in a safe and workable condition and sufficiently dry to enable proper execution of the work. Shoring construction to be designed by professional engineer licensed in the state in which the Work is to be located.
- B. Underpin adjacent structures that could be damaged by excavating work.
- C. Excavate to accommodate new structures and construction operations.
- D. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- E. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- F. Do not interfere with 45 degree bearing splay of foundations.
- G. Cut utility trenches wide enough to allow inspection of installed utilities.
- H. Hand trim excavations. Remove loose matter.
- I. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume.
- J. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.
- K. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; any such excavation under or adjacent to the 45 degree bearing splay of new or existing structures which may cause a weakening of the structure shall be filled with concrete, as directed by the Engineer, at the expense of the Contractor.

- L. Where the bottom of the excavation at subgrade is found to be unstable, frozen, excessively soft or loose or to include deleterious materials such as ashes, cinders, all types of refuse, vegetable or other organic material, or large pieces or fragments of inorganic material which, in the judgement of the Engineer should be removed, such unsuitable material shall be removed to expose firm native soils to the width and depth directed by the Engineer and at no cost to the Owner.
- M. Where the bottom of the excavation at subgrade is found to consist of material which is unstable to such a degree that, in the opinion of the Engineer, it cannot be removed and replaced with an approved material compacted as required in place to support the pipe properly, a foundation for the structure consisting of piling, timbers or other materials, shall be constructed in accordance with Drawings prepared by the Engineer. The Contractor shall be reimbursed for this Extra Work in accordance with Section 01 20 00 - Price and Payment Procedures.
- N. Provide suitable means to promptly and effectively remove water from all excavations and keep such excavations dry until the work or structures to be built therein have been satisfactorily completed.
- O. Provide for all dewatering necessary in order that the construction may proceed in a safe workmanlike manner.
- P. Provide for the disposal of the water removed from the excavation in such a manner as shall not create a nuisance, cause water pollution, cause injury to public health, private property, any portion of the work completed or in progress, the surface of the streets, or any impediment to the use of the site.
- Q. In no case shall water be permitted to run over the excavated subgrade or foundation or through the conduits.
- R. Provide well points, pumps or other approved means to keep the ground water sufficiently low, in the opinion of the Engineer, to permit the placing of concrete, masonry, or pipe in first class condition; and sufficiently long thereafter to protect the concrete, masonry, or joints against washing or damage.
- S. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- T. Remove excavated material that is unsuitable for re-use from site.
- U. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00.
- V. Remove excess excavated material from site.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
- B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

3.05 PROTECTION

- A. All excavation work is to be conducted in accordance with OSHA Safety and Health Regulations for Construction (29 CFR 1926; Subpart P - Excavations).
- B. For pipe and utility trenches, excavations shall be dug such that the pipe can be laid to the alignment and depth required.
- C. Excavations shall be braced and drained that the workmen may work therein safely and efficiently.
- D. For pipe and utility trenches, the width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed and compacted in accordance with Section 02316.

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- E. Excavations shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting and bracing, and handling of fittings.
- F. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- G. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION

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SECTION 31 23 23

FILL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to complete all fill and backfill required to complete the Work as shown on the Drawings and as specified herein.

1.02 RELATED REQUIREMENTS

- A. Section 01 57 13 - Temporary Erosion and Sedimentation Control: Slope protection and erosion control.
- B. Section 31 22 00 - Grading: Site grading.
- C. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.
- D. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

1.03 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: Indicated on drawings.

1.04 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
- C. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.
- E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
- G. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.
- H. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.
- I. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.

- B. When fill materials need to be stored on site, locate stockpiles where designated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 3. Conforming to ASTM D2487 Group Symbol CL.
- B. Structural Fill - Granular Soil Fill Type conforming to ASTM D 2487 Group Symbol GW, GP, GM, SM, SW, and SP classified in accordance with the Unified Soil Classification System (USCS). Furthermore, the material to be utilized as structural fill should have a Plasticity Index (PI) less than 20. Free of lumps larger than 3 inches, rocks larger than 2 inches, organic matter, and debris.
- C. Drainage Fill - ASTM C 33 Size AASHTO 57 stone: Crushed stone or gravel; washed, free of clay, shale, organic matter.
- D. Dense Graded Aggregate Fill - Well graded aggregate crushed stone. Conforming to the State of the State in which the Project is located Department of Transportation standards.
- E. Concrete for Fill: Lean concrete.
- F. Granular Fill - Gravel : Angular crushed washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM D2487 Group Symbol GW.
- G. Granular Fill - Pea Gravel : Natural stone; washed, free of clay, shale, organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol GM.
- H. Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
 - 1. Grade in accordance with ASTM D2487 Group Symbol SW.
- I. Topsoil: Topsoil excavated on-site.
 - 1. Unclassified.
 - 2. Graded.
 - 3. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.
 - 4. Acidity range (pH) of 5.5 to 7.5.
 - 5. Containing a minimum of 4 percent and a maximum of 25 percent inorganic matter.
 - 6. Conforming to ASTM D2487 Group Symbol OH.

2.02 ACCESSORIES

- A. Vapor Retarder: 10 mil thick, polyethylene.

2.03 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the Work are as indicated.

- B. Identify required lines, levels, contours, and datum locations.
- C. See Section 31 22 00 for additional requirements.
- D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.
- E. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.02 PREPARATION

- A. Prior to the construction of foundations, ground slabs or roads/parking lots, or the placement of fill in structural areas, all existing organic bearing materials, frozen or wet, excessively soft or loose soils, and other deleterious materials should be removed and wasted.
- B. After the stripping operations have been completed, the exposed subgrade soils should be inspected by the Geotechnical Engineer. The exposed subgrade materials should be sealed with a smooth-drum roller and proofrolled utilizing a heavily-loaded dump truck or other pneumatic tired vehicle of similar size and weight, if conducted during dry weather. If the site is wet at the time of stripping and filling, then the Contractor should first install surface drainage features (swales, drains, sloping surface, etc.). The inspecting engineer should determine the means to evaluate the stripped subgrade if the operation is scheduled when the site is wet. The purpose of subgrade sealing and proofrolling is to provide surficial densification and to locate any isolated areas of soft or loose soils requiring undercutting. Proofrolling is not advised in wet areas which may destabilize under repeated vehicular loading. Precipitation may result in standing water (perched water) at low areas. If the water is allowed to pond, the natural soils may deteriorate and overexcavation or subgrade improvement may be necessary at those areas. The Geotechnical Engineer should be consulted to evaluate subgrade conditions during construction. The Geotechnical Engineer may require the use of lightly loaded equipment to proofroll in an effort to not destabilize the subgrade.
- C. For the proofrolling and fill compaction operations, fill limits should be extended at least five feet beyond the wastewater treatment facility boundaries including new road/parking lot and ancillary structures.
- D. Scarify subgrade surface to a depth of 6 inches to identify soft spots.
- E. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- F. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- G. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. For the proofrolling and fill compaction operations, fill limits should be extended at least five feet beyond the wastewater treatment facility boundaries including new road/parking lot and ancillary structures. Fill to contours and elevations indicated using unfrozen approved materials.
- B. Fill to contours and elevations indicated using unfrozen materials.
- C. Fill up to subgrade elevations unless otherwise indicated.
- D. Employ a placement method that does not disturb or damage other work.
- E. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- F. Maintain optimum moisture content of fill materials to attain required compaction density.
- G. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
- H. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- I. Slope grade away from building minimum 2 inches in 10 ft . Make gradual grade changes. Blend slope into level areas.

- J. Correct areas that are over-excavated.
 - 1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 100 percent of maximum dry density.
 - 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- K. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. At other locations: 95 percent of maximum dry density.
- L. Reshape and re-compact fills subjected to vehicular traffic.

3.04 FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Under Interior Slabs-On-Grade:
 - 1. Use granular fill.
 - 2. Depth: 4 inches deep.
 - 3. Compact to 95 percent of maximum dry density.
- C. At Foundation Walls and Footings:
 - 1. Use general fill.
 - 2. Fill up to subgrade elevation.
 - 3. Compact each lift to 90 percent of maximum dry density.
 - 4. Do not backfill against unsupported foundation walls.
 - 5. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- D. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:
 - 1. Drainage fill : Section 33 46 00.
 - 2. Cover drainage fill with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact to 95 percent of maximum dry density.
- E. Over Buried Utility Piping, Conduits, and Duct Bank in Trenches :
 - 1. Bedding: Use dense graded aggregate fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.
- F. Under Interior Tank Slabs-On-Grade:
 - 1. Use dense graded aggregate fill.
 - 2. Depth: 6 inch thick layer. Unless otherwise indicated on the plans or as required by geotechnical engineer.
 - 3. Compact 97 percent of maximum dry density.
- G. At Lawn Areas:
 - 1. Use general fill.
 - 2. Fill up to 6 inches below finish grade elevations.
 - 3. Compact to 95 percent of maximum dry density.
 - 4. See Section 31 22 00 for topsoil placement.

3.05 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D3017, or ASTM D6938.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: one (1) test per 2,500 SF per lift.
- F. Proof roll compacted fill at surfaces that will be under slabs-on-grade, paving, and tanks.

3.07 CLEANING

- A. Leave unused materials in a neat, compact stockpile.
- B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

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SECTION 40 23 36
PROCESS PIPING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and all pipe and appurtenances as shown on the Drawings and specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 31 23 23 - Fill.
- B. Section 09 91 23 - Paints and Coatings.

1.03 REFERENCES

- A. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings; The American Society of Mechanical Engineers; 1998.
- B. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 1996 (ANSI/ASME B31.9).
- C. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2001.
- D. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2002.
- E. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2003.
- F. ASTM A 105 - Standard Specification for Steel Pipe Flanges.
- G. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- H. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2003.
- I. ASTM D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 1999.
- J. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2000.
- K. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2002a.
- L. ASTM D 2846/D 2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 1999.
- M. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).
- N. ASTM F 493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 1997.
- O. AWWA C104/A21.4 - ANSI Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water (1995).
- P. AWWA C110 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm Through 1200 mm), for Water and Other Liquids; American Water Works Association; 1998.

- Q. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2000 (ANSI/AWWA C111/A21.11).
- R. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002 (ANSI/AWWA C151/A21.51).
- S. AWWA C153 - American National Standard for Ductile-Iron and Gray-Iron Compact Fittings for Water and Other Liquids; American Water Works Association.
- T. AWWA C200 - Steel Water Pipe - 6 inches and Larger (1997).
- U. AWWA C206 - Field Welding of Steel Water Pipe (1997).
- V. AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 inches Through 144 inches (2001).
- W. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings (2001).
- X. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances (2005)
- Y. AWWA C604 - Installation of Steel Water Pipe - 4 In. and Larger (2006)
- Z. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water (2005)
- AA. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 1999 (ANSI/AWWA C651).
- AB. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution; American Water Works Association; 1997 (ANSI/AWWA C900).
- AC. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. for Water Transmission and Distribution (1997).
- AD. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2001.
- AE. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 1997.
- AF. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1993.
- AG. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2002.
- AH. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1998.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Project Record Documents: Record actual locations of valves, bends, tees, connections and other pipe/utility crossings.

1.05 QUALITY ASSURANCE

- A. All non-metallic below grade piping shall be installed with a 12 gauge coated copper wire attached to the crown of the pipe with duct tape in not less than 2 places per length of pipe to provide detectors a means of locating buried lines. All tracer wire shall be tested and deemed usable by the Owner prior to final completion of the project.
- B. Upon completion of backfilling for trenches, the Contractor shall be responsible for matching the existing surface conditions.
- C. Identify and label all visible pipe with markings indicating the direction of flow.

1.06 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with State of Delaware plumbing code.
- B. Conform to applicable code for installation of backflow prevention devices.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED

- A. Ductile Iron Pipe: AWWA C151/A21.51, minimum pressure class 350 psi
 - 1. Fittings:
 - a. 90 Bends: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).
 - b. All other Bends/Fittings: Ductile or gray iron, conforming to AWWA C153 (ANSI 21.53).
 - 2. Joints: AWWA C111/A21.11, rubber gasket with 3/4 inch diameter rods and concrete thrust blocks as indicated on the Drawings.
 - 3. Flanges: ASME B16.1 - 125 pound template.
 - 4. Lining: AWWA C104 (ANSI 21.4).
- B. PVC Pipe: ASTM D 3034 SDR 35.
 - 1. Fittings: PVC.
 - 2. Joints: Push-on, using ASTM F 477 elastomeric gaskets.

2.02 PROCESS AND WATER PIPING, BURIED

- A. Ductile Iron Pipe: AWWA C151/A21.51, minimum pressure class 350 psi
 - 1. Fittings:
 - a. 90 Bends: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).
 - b. All other Bends/Fittings: Ductile or gray iron, conforming to AWWA C153 (ANSI 21.53).
 - 2. Joints: AWWA C111/A21.11, rubber gasket with 3/4 inch diameter rods and concrete thrust blocks as indicated on the Drawings. Under slabs and foundations, restrained joint fittings shall be provided.
 - 3. Flanges: ASME B16.1 - 125 pound template.
 - 4. Lining: AWWA C104 (ANSI 21.4).
 - 5. Fittings: Ductile or gray iron, standard thickness.
- B. PVC Pipe: AWWA C900 and AWWA C905, minimum pressure class 150 psi
 - 1. Provisions must be made for expansion and contraction at each joint with an elastomeric gasket.
 - 2. Fittings:
 - a. 90 Bends: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).
 - b. All other Bends/Fittings: Ductile or gray iron, conforming to AWWA C153 (ANSI 21.53).
 - 3. Joints: Under slabs and foundations, restrained joint fittings shall be provided.

4. Random lengths shall not be less than 10 feet long.

2.03 PROCESS AND WATER PIPING, ABOVE GRADE

- A. Steel Pipe 8 Inches and Smaller: ASTM A 53/A 53M, Schedule 40, Black Steel; unless otherwise noted to be galvanized.
 1. Fittings and unions: AWWA C206 and AWWA C208 with a minimum working pressure of 150 psi.
 2. Screw Joints: Perfectly tight with a still mixture of graphite and mineral oil, or an approved, non-toxic, non-hardening pipe joint compound applied to the male threads only.
 3. Flanges: AWWA C207.
 4. The interior of the pipe shall not be coated
 5. The exterior of the pipe shall be coated in accordance with Section 09900.
- B. Steel Pipe 10 Inches and Larger: ASTM A 53/A 53M and AWWA C200, Schedule 20, Black Steel; unless otherwise noted to be galvanized.
 1. Fittings and unions: AWWA C206 and AWWA C208 with a minimum working pressure of 150 psi.
 2. Flanges: Flanges shall be steel slip on or welding neck type, raised face, Class 150, conforming to ASTM A 105 and ANSI B16.5.
 3. Pipe shall have beveled ends for welding.
 4. Pipe ends shall be provided to suit the field joints indicated on the Drawings.
 5. Field welded joints shall be single (outside) lap or butt type conforming to AWWA C206.
 6. The interior of the pipe shall not be coated.
 7. The exterior of the pipe shall be coated in accordance with Section 09900.
- C. Ductile Iron Pipe: AWWA C151/A21.51, minimum pressure class 350 psi
 1. Fittings: Ductile or gray iron, standard thickness, conforming to AWWA C110 (ANSI 21.10).
 2. Joints: AWWA C111/A21.11, rubber gasket with 3/4 inch diameter rods and concrete thrust blocks as indicated on the Drawings.
 3. Flanges: ASME B16.1 - 125 pound template.
 4. Lining: AWWA C104 (ANSI 21.4).
- D. Stainless steel pipe, fittings and flanges and shall meet the following requirements:
 1. Stainless Steel Pipe, 4" through 36"
 - a. Material for Stainless Steel Pipe, 4" through 36": AISI 304L Stainless steel.
 - b. Pipe Standards for Stainless Steel Pipe, 4" through 36": ASTM A312 or ASTM A778.
 - c. Dimension Standard for Stainless Steel Pipe, 4" through 36": ANSI/ASME B36.19M, 12 gage thickness.
 2. Stainless Steel Pipe, 3" or smaller
 - a. Material for Stainless Steel Pipe, 3" and smaller: AISI 316L stainless steel.
 - b. Pipe Standard for Stainless Steel Pipe, 3" and smaller: ASTM A312.
 - c. Dimension Standard for Stainless Steel Pipe, 3" and smaller: ANSI/ASME B36.19M, Schedule 40S.
 3. Stainless Steel Fittings 4" through 36"
 - a. Material for Stainless Steel Fittings, 4" through 36": AISI 304L stainless steel.
 - b. Material Standard for Steel Fittings, 4" through 36"
 - 1) Fittings for ASTM A312 Pipe: ASTM A403
 - 2) Fittings for ASTM A778 Pipe: ASTM A774
 - c. Dimension Standards for Stainless Steel Fittings, 4" through 36"
 - 1) Fitting Wall Thickness: ANSI/ASME B36.19M, 5 gage.
 - 2) Fitting Dimensions: ANSI B16.9
 4. Stainless Steel Fittings, 3" and smaller
 - a. Material for Stainless Steel Fittings, 3" and smaller: ASTM 316L stainless steel.
 - b. Fitting Standard for Stainless Steel Fittings, 3" and smaller
 - 1) Forged/Wrought Stainless Steel Fittings: ASTM A182, Grade 316L

- 2) Cast Stainless Steel Fittings: ASTM A351, Grade CF 8M.
- c. Dimension Standard for Stainless Steel Fittings, 3" and smaller: ANSI B316.3, Class 150
- d. Stainless Steel Pipe and Fitting Joints
- e. Stainless Steel Pipe and Fittings, 4" through 36": Flange, welded, or clamp type coupling.
- f. Stainless Steel Pipe and Fittings, 3" and smaller: Threaded or Flange.
5. Flanges for Stainless Steel Pipe and Fittings
 - a. Stainless Steel Flange Material
 - 1) Flanges for 4" through 36" Stainless Steel Pipe and fittings: AISI 304L stainless steel.
 - 2) Flanges for 3" and smaller Stainless Steel Pipe and Fittings: AISI 316L stainless steel.
 - b. Stainless Steel Flange Standard: ASTM A182.
 - c. Stainless Steel Flange Dimension Standard: ANSI B16.5, Class 150.
 - d. Stainless Steel Flange Type
 - 1) Flanges for Stainless Steel Pipe, 4" through 36": Welding neck, lap joint, or slip-on.
 - 2) Flanges for Stainless Steel Fittings, 4" through 36": Welding Neck.
 - 3) Flanges for Stainless Steel Pipe and fittings, 3" and smaller: Threaded.
 - e. Flange Face Type: 1/16" raised face.
6. Stainless Steel Flange Joint Accessories
 - a. Stainless Steel Flange Joint Gaskets
 - 1) Gasket Type: ring.
 - 2) Gasket Thickness: 1/8"
 - 3) Gasket Material: Ethylene-Propylene diene terpolymer (EPDM) rubber.
 - b. Bolts, Studs, and Nuts for Stainless Steel Flange Joints
 - 1) Bolt, Stud, and Nut Material: AISI Type 316 or Type 316N stainless steel.
 - 2) Bolt and Stud Standard: ASTM A193, Grade B8M, B8MN, or B8MLN.
 - 3) Nut Standard: ASTM A194, Grade 8M, B8MN, or M8MLN.
 - 4) Bolt, Stud and Nut Threads: UNC threads.
 - 5) Stud Length: Studs shall extend through nuts a minimum of 1/4".

2.04 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 1. Ferrous pipe: Class 150 malleable iron threaded unions.
- B. Flanges for Pipe Size Over 1 Inch:
 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
- C. Grooved and Shouldered Pipe End Couplings:
 1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
 2. Sealing gasket: "C" shape composition sealing gasket.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.05 PIPE HANGERS AND SUPPORTS

- A. Process Piping:
 1. Conform to ASME B31.9.
 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 7. Vertical Support: Steel riser clamp.
 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- B. Plumbing Piping - Water:
1. Conform to ASME B31.9.
 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
 8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 10. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
 11. Vertical Support: Steel riser clamp.
 12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
 14. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
 15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.06 PIPE PENETRATION SEALS

- A. Wall/floor penetration seals shall be used to continuously fill the annular space between pipe and wall/floor. Wall/floor penetration seals, once expanded, shall provide a seal between the pipe and wall/floor opening.
- B. Where walls or floors have pipe penetrations that are continuously wet on one or both sides, the use of wall sleeves with water stops shall be employed along with the wall/floor penetration seal to achieve a watertight seal between pipe and wall/floor opening.
- C. The wall/floor opening size and/or type shall be selected according to recommendations found in seal penetration manufacturer's representative catalog. The wall/floor opening refers to a steel or plastic sleeve, coredrilled hole or cast-formed hole.
- D. Penetration Seal Rubber Links
 1. The wall/floor penetration seal shall be made of mechanically interlocked, solid synthetic rubber links. There shall be a sufficient quantity of links about the pipe that once expanded, shall achieve a 20-PSI hydrostatic seal between pipe and wall/floor opening.
 2. The elastomer element shall be EPDM elastomer.
 3. Penetration seal pressure plates shall be molded of glass reinforced nylon.
 4. Hardware Fasteners shall consist of stainless steel bolts and hex nuts.

- E. Wall Sleeves
 - 1. Cast in place concrete wall sleeves are to be fabricated from galvanized heavy wall welded or seamless carbon steel pipe. All sleeves are to have a 2" wide, full perimeter water stop, welded on both sides.

2.07 TRACER WIRE AND ACCESS BOXES

- A. All new non-metallic buried piping shall be installed with tracer wire. Metallic pipes do not require a tracer wire. Metallic pipe systems require access points along the route for direct connection. The tracer wire shall be installed continuously along the new pipe route with access points at 300 feet maximum. The tracer wire shall be brought to the ground surface at the access points. Access points may include valve boxes, handholes, manholes, vaults, or other covered access devices. Access point covers shall be clearly marked with a pipe description. Splices in the tracer wire shall be connected by means of a split bolt or compression type connector to ensure continuity. Wire nuts shall not be used. A waterproof or corrosion-proof connector for direct bury applications shall be used. After installation, the tracer wire shall be tested to verify continuity of the tracer wire system.
- B. For locations where valve boxes are not present, the tracer wire access point shall be composed of one SnakePit Tracer Wire Access Box, or approved equal, installed at each proposed access point.
- C. At each valve location, a loop of wire is to be brought up the outside of the valve box and looped inside the box through a hole drilled two (2) inches below the bottom of the lid.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install to the required lines and grades with fittings, valves, and accessories at the required locations; spigots centered in the bells; and all valves and appurtenances properly aligned. The laying of pipe shall conform to the applicable portions of AWWA C600, AWWA C604, or AWWA C605.
- C. Pressure test all piping in accordance with AWWA C600, AWWA C604, or AWWA C605 to a minimum test pressure of 150 psi, unless otherwise indicated.
- D. All piping and fittings shall be rigidly supported.
- E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls, except as indicated otherwise on the Drawings.
- G. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- H. Group piping whenever practical at common elevations.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- J. Deflections from a straight line or grade made necessary by vertical or horizontal curves or offsets shall not exceed the manufacturer's recommendations. If the required alignment requires deflections in excess of those recommended, the Contractor shall either provide special bends, as approved by the Engineer, of a sufficient number of shorter lengths of pipe to provide angular deflections within the required limit.

- K. Laying of pipe shall be commenced immediately after the excavation is started, and every means must be used to keep pipe laying closely behind the trenching. The Engineer may stop the trenching when, in the opinion of the Engineer, the trench is open too far in advance of the pipe laying operation. Pipe may be laid in the best manner adapted to securing speed and good results.
- L. Inspect pipe and fittings for defects and all lumps, blisters, excess coal-tar coating and other foreign material shall be removed from the bell and spigot end of each cast iron or PVC pipe, or inside of PVC couplings and fittings. All pipe, couplings, adapters, and other pipe connections shall be wiped clean and dry before the pipe is laid.
- M. After placing a length of pipe in the trench, center the spigot end in the bell and force the spigot end into the bell end.
- N. Secure the pipe in place with approved backfill material tamped under it except at the bells. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to insure each uniform space.
- O. Prevent dirt from entering the joint space.
- P. The cutting of cast iron pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe.
- Q. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- R. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.
- S. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- T. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- U. Provide restrained joint fittings under all slabs.
- V. Provide support for utility meters in accordance with requirements of utility companies.
- W. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 23.
- X. Excavate in accordance with Section 31 23 16 for work of this Section.
- Y. Backfill in accordance with Section 31 23 23 [] for work of this Section.
- Z. Install bell and spigot pipe with bell end upstream.
- AA. Install valves with stems upright or horizontal, not inverted; unless indicated otherwise on the Drawings.
- AB. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
- AC. Sleeve pipes passing through partitions, walls and floors.
- AD. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- AE. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
8. Support cast iron drainage piping at every joint.

3.04 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- E. Provide spring loaded check valves or as otherwise indicated on the drawings on the discharge of all water and wastewater pumps.

3.05 ERECTION TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 SCHEDULES

- A. Pipe Hanger Spacing:
 1. Metal Piping:
 - a. Pipe size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum hanger spacing: 6.5 ft.
 - 2) Hanger rod diameter: 3/8 inches.
 - b. Pipe size: 1-1/2 inches to 2 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 3/8 inch.
 - c. Pipe size: 2-1/2 inches to 3 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 1/2 inch.
 - d. Pipe size: 4 inches to 6 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 5/8 inch.
 - e. Pipe size: 8 inches to 12 inches:
 - 1) Maximum hanger spacing: 14 ft.
 - 2) Hanger rod diameter: 7/8 inch.
 - f. Pipe size: 14 inches and Over:
 - 1) Maximum hanger spacing: 20 ft.
 - 2) Hanger rod diameter: 1 inch.
 2. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum hanger spacing: 5 ft.
 - 2) Hanger rod diameter: 3/8 inch.

END OF SECTION

Allen Harim Foods, LLC.
Harbeson, DE
Wastewater Treatment System Upgrade and Expansion - Phase Two

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SECTION 40 23 37
VALVES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all tools, supplies, materials, equipment, and labor necessary for furnishing, epoxy coating, installing, adjusting, and testing of all valves and appurtenant work, complete and operable as shown on the Drawings and specified herein. Where buried valves are shown, furnish and install valve boxes to grade, with covers, extensions, and tee handles.
- B. Furnish all labor, materials, equipment, and incidentals required and all valves and appurtenances as shown on the Drawings and specified herein.
- C. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 REFERENCES

- A. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
- C. ANSI/ASME B1.20.1 General Purpose Pipe Threads (inch).
- D. ANSI/ASME B31.1 Power Piping.
- E. ASTM A 36 Specification for Structural Steel.
- F. ASTM A 48 Specification for Gray Iron Castings.
- G. ASTM A 126 Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- H. ASTM A 536 Specification for Ductile Iron Castings
- I. ASTM B 61 Specification for Steam or Valve Bronze Castings.
- J. ASTM B 62 Specification for Composition Bronze or Ounce Metal Castings.
- K. ASTM B 148 Specification for Aluminum-Bronze Castings.
- L. ASTM B 584 Specification for Copper Alloy Sand Castings or General Applications.
- M. ANSI/AWWA C500 Gate Valves for Water and Sewerage Systems.
- N. ANSI/AWWA C504 Rubber-Seated Butterfly Valves.
- O. ANSI/AWWA C506 Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valves Types.
- P. ANSI/AWWA C507 Ball Valves 6 inches through 48 inches.
- Q. AWWA C508 Swing-Check Valves for Waterworks Service, 2 inches Through 24 inches NPS.
- R. AWWA C550 Protective Interior Coatings for Valves and Hydrants.
- S. SSPC-SP-5 White Metal Blast Cleaning.
- T. MSS-SP-70 Manufacturers Standardization Society of the Valve and Fitting Industry; Cast Iron Gate Valves. Flanged and Threaded Ends.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Shop drawings of all valves and operators including associated wiring diagrams and electrical data (if required).
- C. Valve Schedule: Submit a complete valve schedule of all valves being supplied including each valve location, size, type, end connections, and operator type.

- D. Valve Labeling: Submit a schedule of valves to be labeled indicating in each case the valve location and the proposed wording for the label.

1.04 QUALITY ASSURANCE

- A. The Contractor shall demonstrate that each valve installed as a part of a piping system will operate under field conditions in a manner consistent with the design of the system.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves shall be suitable for use in raw wastewater and sewage applications.
- B. The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- C. Valves and appurtenances shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.
- D. Valves and appurtenances shall have the name of the manufacturer, nominal size, flow directional arrows, working pressure for which they are designed, cast in raised letters or indelibly marked upon some appropriate part of the body.
- E. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they are connecting to, whichever is higher and suitable for the pressures noted where they are installed.
- F. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to.
- G. Provide all special adaptors as required to ensure compatibility between valves, appurtenances and adjacent pipe.
- H. Valves and operators located outdoors but not within a building; within maximum 2 feet above liquid; in vaults; or where otherwise noted shall be especially designed for submerged service where water may completely submerge the valve and operator. All other units shall be as a minimum weather tight.
- I. The Contractor shall furnish all valves, operators, actuators, valve-operating units, stem extensions, and other accessories as shown, specified, or required to install a fully functional valve. All valves shall have the name of the manufacturer and the site of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters. All valves and gates shall be new and of current manufacture. All shut-off valves, 6-inch and larger, shall have operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing position indicators, and valve extensions. Shut-off valves mounted higher than 6 feet above working level shall be provided with chain operators.
- J. Gate Valve Stems: Manually operated valves shall have silicon-bronze stems conforming to ASTM B 584-875, having minimum tensile strength of 60,000 psi, a minimum yield point of 24,000 psi, and elongation of 16% in 2 inches.
- K. Protective Coating: Except where otherwise specified, ferrous surfaces, exclusive of stainless steel surfaces, in the water passages of all valves 4-inch and larger, as well as the exterior surfaces of all submerged valves, shall be coated as specified in Section 099000 - Paints and Coatings. Flange faces of valves shall not be coated.

- L. Valve Operators: Where shown, certain valves and gates shall be furnished with electric operators, provided by the valve or gate manufacturer. All operators of a given type shall be furnished by the same manufacturer. Where these operators are supplied by different manufacturers, the Contractor shall coordinate their selection to provide uniformity of each type of electric operator. All valve operators, regardless of type, shall be installed, adjusted, and tested by the valve manufacturer at the manufacturing plant.
- M. Nuts and Bolts: All nuts and bolts on valve flanges and supports shall be Type 316 stainless steel.

2.02 VALVE OPERATORS

- A. The valve manufacturer shall supply and integrally, rigidly mount all operators, including any type of manual or powered operators, on valves at the factory. The valves and their individual operators shall be shipped as a unit.
- B. Unless otherwise noted, valves shall be manually operated; nonburied valves shall have an operating wheel, handle or lever mounted on the operator; buried valves and those with operating nuts shall have a non-rising stem with an AWWA 2 inch nut. At least four tee handles shall be provided. Tee handles shown on the Drawings shall be permanently installed and rigidly supported.
- C. Except as otherwise shown on the Drawings or specified herein, all valves 3 inch diameter or larger, with the valve center line located 6 feet or more above the operating floor, shall be provided with chain wheel operators complete with chain guides and hot dipped galvanized steel chain, which loop within 4 foot of the operating floor.
- D. All operators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.
- E. Gear Operators:
 - 1. Unless otherwise noted on the Drawings, gear operators shall be provided for all valves larger than 12 inch diameter and all buried valves with the operating shaft mounted horizontally (butterfly, plug, etc.).
 - 2. Gear operators shall be of the worm or helical gear type with output shaft perpendicular to the valve shaft, having a removable hand wheel mounted on the output shaft. Unless noted they shall conform to AWWA C504.
 - 3. Operators shall be capable of being removed from the valve without dismantling the valve or removing the valve from the line.
 - 4. Gearing shall be machine-cut steel designed for smooth operation. Bearings shall be permanently lubricated, with bronze bearing bushings provided to take all thrusts and seals and to contain lubricants. Housings shall be sealed to exclude moisture and dirt, allow the reduction mechanisms to operate in lubricant and be of the same material as the valve body.
 - 5. Maximum handwheel size shall be 24 inch diameter.
- F. Each operating device shall have cast on it the word "OPEN" and an arrow indicating the direction of operation.
- G. Additional valve operators are included with the individual valve types and as noted on the Drawings.

2.03 GATE VALVES

- A. Manufacturers:
 - 1. Clow
 - 2. American R/D
 - 3. Mueller
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. General:
 - 1. Gate valves shall meet or exceed the requirements of AWWA standard C500 covering solid wedge gate valves.

2. Buried and submerged valves shall be furnished with mechanical joints and stainless steel hardware.
 3. Exposed valves shall be furnished with Class 125 flanged ends; provide valves.
 4. Valves shall be non-rising stem, opening by turning stem left or right and provided with 2" square operating nut or handwheel with the word 'open' and an arrow cast in the metal to indicate direction to open.
 5. The wedge shall be of cast iron completely encapsulated with rubber.
 6. The sealing rubber shall be permanently bonded to the cast iron wedge to meet ASTM tests for rubber metal bond ASTM D429.
 7. Valves shall be supplied with o-ring seals at all joints. No flat gaskets allowed.
 8. Stems for non-rising stem assemblies shall be cast bronze with integral collars in full compliance with AWWA. The non-rising stem stuffing box shall be the o-ring seal type with two o-rings located above thrust collar and one o-ring below. The two o-rings above the thrust collar shall be replaceable with valve fully open and subjected to full rated working pressure.
 9. There shall be two low torque thrust bearings located above and below the thrust collar. The stem nut shall be independent of the wedge and shall be made of solid bronze. There shall be a smooth, unobstructed waterway free of all pockets, cavities and depressions in the seat area.
 10. The body and bonnet shall be coated with fusion bonded epoxy both interior and exterior, complying with AWWA C-550 and be NSF 61 approved. Each valve shall have maker's name, pressure rating and year in which manufactured cast on the body.
 11. Prior to shipment from the factory, each valve shall be tested by hydrostatic pressure equal to AWWA (twice the specified working pressure) requirements.
 12. Non-rising stem valves shall use a double O-Ring stem seal, except that packing shall be used where geared operators are required.
 13. Flanged valves to have face-to-face dimensions per ANSI B16.1 and flanges per ANSI B16.10.
 14. Provide geared operator and chainwheel, chain and chain guides for valves with handwheel centerline more than 6 foot above operating level.
 15. Unless otherwise indicated, valves 12 inch and smaller shall be capable of installation in the vertical or horizontal position, and sealing in both directions at the rated pressure.
 16. Valves shall be installed with the stem within the upright vertical position to the 90 degrees horizontal position. Valves shall not be installed with the stem projected downward.
- C. Buried Valves:
1. Conform to the requirements above, except mechanical joint bell ends per AWWA standard C111.
 2. All exposed valve hardware (nuts, bolts, washers, etc.) including bonnet, bonnet cover, stuffing box, gear adaptor and joints shall be Type 304 stainless steel.
 3. Non-rising stem design, double O-Ring seals for non-geared valves and shall incorporate packing for geared valves.
 4. Provide valve box, 2 inch operating nut and extension stem and stem cover.
- D. Tapping Valves and Sleeves:
1. Tapping valves shall comply with the above specifications except they shall have the flanged end and port opening modified for tapping service. Valve shall be capable of passing a full nominal sized cutter without damage to the valve. The tapping sleeve shall be gray cast iron or ductile iron mechanical joint type.

2.04 KNIFE GATE VALVES

- A. Manufacturers:
1. Orbinox
 2. DeZurik
 3. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Valves shall be flanged type, unless otherwise indicated on the drawings rated for a working pressure of 150 psi.
- C. Face-to-face dimensions per MSS SP-81 with BI-DIRECTIONAL shut-off.
- D. Valve shall have a maximum leakage rate of no more than 20 CC per inch of diameter per minute at 40 psi in both directions without the use of O-rings, guides or wedges obstructing the port.
- E. The seating material shall be metal-to-metal or made from a resilient EPDM or Viton material and completely field replaceable.
- F. To prevent atmospheric leakage, the valve features an adjustable packing assembly consisting of multiple layers of braided packing around gate, evenly compressed by a one-piece packing gland.
- G. The valve is to have 100% full port flow with no guides or wedges obstructing the port.
- H. The gate shall be finished ground on both sides, and made from stainless steel.
- I. The body material shall be 304 stainless steel.
- J. Valve is equipped with a manual handwheel operator assembly featuring a cast ductile iron handwheel, a heavy duty foot mounted yoke with an acid resistant bronze stem nut, including a 304 stainless steel rising stem.
- K. The gate shall be a beveled knife edge.
- L. All wetted surfaces shall be Type 316 stainless steel.
- M. Packing gland bolts shall be Type 316 stainless steel with plated, self-locking nuts.
- N. The valves shall have full port straight through opening.
- O. Flanges shall be drilled to match connecting pipe.

2.05 PLUG VALVES

- A. Manufacturers:
 - 1. Val Matic
 - 2. Milliken
 - 3. Clow American R/D; www.american-rd.com
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Plug valves shall be of the offset disc type, 1/4 turn, non-lubricated, serviceable (able to be repacked) under full line pressure and capable of sealing in both directions at the rated pressure.
- C. The valves shall be designed, manufactured and tested in accordance with American Water Works Association Standards ANSI/AWWA C517.
- D. Flanged valves shall have flanges with drilling to ANSI B16.1, Class 125.
- E. Mechanical Joint valves shall fully comply with ANSI/AWWA C111/A21.11.
- F. The plug shall be of one-piece construction and made of ASTM A126 Class B cast iron with a resilient facing per ASTM D2000-BG and ANSI/AWWA C504 requirements
- G. Radial shaft bearings shall be constructed of self-lubricating type 316 stainless steel. The top thrust bearing shall be Teflon. The bottom thrust bearing shall be Type 316 stainless steel. Cover bolts shall be corrosion resistant with zinc plating.
- H. The disc shall be completely out of the flow path when open.
- I. Valve bodies shall be of cast iron, ASTM A 126, Grade B, or of ductile iron, ASTM A 536 and of the top entry, bolted bonnet design, cast with integral flanges conforming to the connecting piping. All exposed bolts, nuts and washers shall be zinc or cadmium-plated, except for buried or submerged plug valves, which shall have Type 316 stainless steel hardware.

- J. Shaft bearings shall be permanently lubricated, rigidly backed TFE, stainless steel or bronze at both upper and lower stem journals. The operator shaft shall have easily replaceable seals, which shall be externally adjustable and repackable without removing the bonnet from the valve, or shall have self-adjusting packing.
- K. The valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on the disc mating with welded-in 99% high nickel content overlay seating surface in the body.
 - 1. The seating design shall be resilient and of the continuous interface type having consistent opening and closing torques and shall be non-jamming in the closed position. Screw-in seats shall not be acceptable.
 - 2. Discs shall have a full resilient facing of neoprene or EPDM.
- L. Actuators: The methods of mounting the actuator to the valve shall provide an air gap between the two. Actuator shall clearly indicate valve position and an adjustable stop shall be provided. Construction of actuator housing shall be semi-steel. Hardware on actuators shall be of the same materials as the valve.
 - 1. 8 inch and smaller valves shall be equipped with a 2 inch square nut for direct quarter turn operation. The packing gland shall include a friction collar and an open position memory stop. The friction collar shall include a nylon sleeve to produce friction without exerting pressure on the valve packing.
 - 2. When specified, 4 inch and larger valves shall include a totally enclosed and sealed worm gear actuator with position indicator (above ground service only) and externally adjustable open and closed stops. The worm segment gear shall be ASTM A536 Grade 65-45-12 ductile iron with a precision bore and keyway for connection to the valve shaft. Bronze radial bearings shall be provided for the segment gear and worm shaft. Alloy steel roller thrust bearings shall be provided for the hardened worm.
 - 3. All gear actuators shall be designed to withstand, without damage, a rim pull of 200 lb. on the handwheel and an input torque of 300 ft-lbs for nuts.
 - 4. Buried service actuators shall be packed with grease and sealed for temporary submergence to 20 feet of water.
 - 5. Exposed worm shafts shall be stainless steel.
- M. Each plug valve shall be provided with its own securely attached lever. Provide adjustable limit stops for both opening and closing and a clearly marked position indicator.
- N. Plug valves shall be installed so that the direction of flow through the valve and the shaft orientation is in accordance with the manufacturer's recommendations. Unless otherwise noted, shaft shall be horizontal, with plug opening up.

2.06 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Val Matic
 - 2. Milliken
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Swing check valves shall meet the requirements of AWWA C508.
- C. Valves shall be provided with flanges in accordance with ANSI B16.1, Class 125.
- D. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 inch valve shall be capable of passing a 3 inch sphere. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator, without special tools or removing the valve from the line.

- E. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.
- F. The disc shall be of one-piece construction, precision molded with an integral o-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a memory disc return action.
- G. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified.
- H. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B for 30 inches and larger. Optional body materials include ASTM A-351 Grade CF8M, stainless steel (sizes 3" through 8").
- I. The exterior and interior of the valve shall be coated with an ANSI/NSF 61 approved fusion bonded epoxy coating.
- J. The valves shall be iron body, bronze mounted, single disc with a 150 psi working water pressure.
 - 1. When there is no flow through the line, the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.
 - 2. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.
 - 3. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: All valves, gates, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as shown and specified. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.
- B. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.
- C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.
- D. All valves shall be field tested following installation to demonstrate that the valve operates under field conditions in a manner consistent with the design of the system.
- E. When joining PVC pressure pipe to fittings and accessories, pipe ends shall be cut square, deburred, beveled and cleaned in accordance with pipe manufacturer's recommendations. Bevel requirements for PVC pipe bell and PVC push-on fitting joints are the same as a factory bevel. If push on or mechanical joint butterfly valves are used, PVC pipe ends shall be beveled in accordance with the valve manufacturer's installation instructions.

END OF SECTION

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SECTION 40 91 10
PROCESS AND INSTRUMENTATION EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, two (2) dissolved oxygen meters, one (1) pH meter, and one (1) ORP meter, as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 SYSTEM DESCRIPTION

- A. The Dissolved Oxygen Meters shall be provided for continuous on-line measurement of dissolved oxygen in wastewater within a range of 0-15 mg/L in the activated sludge reactor tanks.
- B. The pH/ORP Meters shall be provided for continuous on-line measurement of the pH and ORP in wastewater in the activated sludge reactor tanks.

1.03 DESIGN REQUIREMENTS

- A. Controllers (Signal Process Controllers):
 - 1. Quantity: Three (3)
 - a. Nitrification Reactor #2B
 - b. Anoxic Reactor #3
 - c. Aerobic Reactor #4
 - 2. Current Output: 4-20 mA (per sensor)
 - 3. Enclosure: NEMA 4X Pipe Mount with Sun screen
 - 4. Power Supply: 120 Vac
 - 5. Light Emitting Diode (LED) Readout: 4 digits
 - 6. Capable of connecting a minimum of 2 sensors
- B. Dissolved Oxygen Sensors:
 - 1. Quantity: Two (2)
 - 2. Locations:
 - a. Nitrification Reactor #2B
 - b. Aerobic Reactor #4
 - 3. Measuring Electrode: Gold
 - 4. Isolated Reference Electrode: Silver
 - 5. Auxiliary Electrode: Silver
 - 6. Test Electrode: Gold
 - 7. Automatic Temperature Compensation
 - 8. Cable Length: 30 Feet (min.)
 - 9. Material: 316 Stainless Steel Body
 - 10. Mounting Type: Ball Float
 - 11. Performance Requirements
 - a. Measurement range: 0.01 to 20.00 mg/L
 - b. Resolution: 0.01 mg/L
 - c. Accuracy
 - 1) Less than 5 ppm: ± 0.1 ppm
 - 2) Greater than 5 ppm: ± 0.2 ppm
 - d. Repeatability: ± 0.1 ppm
 - e. Response Time:
 - 1) Less than 40 seconds to 90% at 20 °C

- 2) Less than 60 seconds to 95% at 20 °C
- f. Temperature sensor: PT100 integrated, external sensor
- g. Temperature range: 0 to 50 °C
- h. Temperature accuracy: ± 0.2°C
- C. ORP Sensors:
 - 1. Quantity: One (1)
 - 2. Locations:
 - a. Anoxic Reactor #3
 - 3. ORP Electrode Type: Platinum
 - 4. ORP Range: +/- 2000mv
 - 5. Temperature Range: 20 to 175 degrees Fahrenheit
 - 6. Maximum Pressure: 100 psi
 - 7. Cable Length: 30 Feet (min.)
 - 8. Integral preamplifier
 - 9. Automatic Temperature Compensation (ATC).
 - 10. Mounting Type: Ball Float
- D. pH Sensors:
 - 1. Quantity: One (1)
 - 2. Locations:
 - a. Nitrification Reactor #2B
 - 3. pH Electrode Type: Spherical Glass
 - 4. pH Range: 2 to 12
 - 5. Temperature Range: 20 to 175 degrees Fahrenheit
 - 6. Maximum Pressure: 100 psi
 - 7. Cable Length: 30 Feet (min.)
 - 8. Integral preamplifier
 - 9. Automatic Temperature Compensation (ATC).
 - 10. Mounting Type: Ball Float

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data and installation instructions.
- C. Shop Drawings: Indicate mounting and wiring details.
- D. Certificates: Certify that products of this section meet or exceed specified requirements.
- E. Operation and Maintenance Data: calibration requirements and procedures, routine cleaning and maintenance requirements for proper operation.
- F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with manufacturer's instructions and Section 01 60 00 - Product Requirements for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hach
- B. Cerlic
- C. Endress-Hauser
- D. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DO SENSOR

- A. Sensor housing shall be 316 stainless steel.
- B. Sensor shall plug into the controller. The sensor shall have built-in self-identity logic so controller acknowledges sensors identity and calibration points which are stored in the sensors memory.
- C. Sensor to air calibrate over bucket of water to match saturated air solubility chart.
- D. Sensor shall have three (3) flushing nozzles which can be used with flushing solenoid valve assembly. Flushing media can be 60 psig air or water.
- E. Electrode shall be designed to operate at least 12 months at 3-5 mg/L operation between replacement and should not require recalibration more than once every 6 months.

2.03 CONTROLLERS

- A. Microprocessor-based sensor controller.
- B. Change digital sensors connected to the controller by unplugging and plugging sensors as necessary.
- C. Change analog sensors modules connected to the controller by unplugging and plugging analog sensor modules as necessary.
- D. The controller uses a menu-driven operation system.
- E. The controller display is graphic dot matrix LCD with LED backlighting.
- F. The controller is equipped with a real-time clock.
- G. The controller is equipped with two security levels.
- H. The controller is equipped with a data logger with RS-232 capability.
- I. The controller is equipped with an SD card reader for data download and controller software upload.
- J. Four electromechanical, UL rated, SPDT relays (Form C) are provided for user-configurable contacts rated 100 to 230 Vac, 5 Amp at 30 Vdc resistive maximum.
 - 1. The following can be programmed:
 - a. Alarm
 - b. Warning
 - c. Timer/scheduled cleaning
 - d. Feeder control
 - e. Event control
 - f. Pulse width modulation
 - g. Frequency modulation
 - 2. The following can be assigned:
 - a. Primary value measurement I
 - b. Secondary value measurement I
 - c. 3rd value measurement I
 - d. 4th value measurement I
 - e. Primary value Measurement II
 - f. Secondary value measurement II
 - g. 3rd value measurement II
 - h. 4th value measurement II
 - i. Real time clock
 - j. Calculated values
- K. Two analog 0/4-20 mA outputs are provided with a maximum impedance of 500 ohms.
 - 1. The following can be programmed:
 - a. Alarms:
 - 1) Low alarm point

- 2) Low alarm point deadband
- 3) High alarm point
- 4) High alarm point deadband
- 5) Off delay
- 6) On delay
- b. Controls:
 - 1) Linear
 - 2) Bi-linear
 - 3) Logarithmic
 - 4) PID
2. The following can be assigned:
 - a. Primary value measurement I
 - b. Secondary value measurement I
 - c. 3rd value measurement I
 - d. 4th value measurement I
 - e. Primary value measurement II
 - f. Secondary value measurement II
 - g. 3rd value measurement II
 - h. 4th value measurement II
 - i. Calculated values
- L. The controller can be equipped with four additional 4-20 mA outputs with a maximum impedance of 500 ohms.
- M. The controller can be equipped with the following forms of communication:
 1. MODBUS RS-232
 2. MODBUS RS-485
 3. Profibus DP
- N. All user settings of the controller are retained for 10 years in flash memory.
- O. The controller is equipped with a system check for:
 1. Power up test (monitoring and shutdown)
 2. Total power draw
 3. Memory devices
 4. Temperature mother board

2.04 ACCESSORIES

- A. Provide a AC Power / Signal protection device between all transmitters and PLC Control Panels for lightning and surge suppression for AC power and low voltage signal lines.
 1. Enclosure shall be a NEMA 4X polycarbonate case
 2. Input Voltage: 120VAC / 60 Hz
 3. Power "ON" indicator
 4. 15 Amp replaceable fuse
 5. UL Rated

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.02 INTERFACE WITH OTHER WORK

- A. Signal converter shall send 4-20 mA signal to PLC.

3.03 STARTING EQUIPMENT

- A. Provide manufacturer's field representative to prepare and start equipment.

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- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION

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SECTION 40 91 20
MAGNETIC FLOW METERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, four (4) magnetic flow meters as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION

- A. The process fluid to be measured will be raw wastewater from the processing plant.
- B. Fluid temperature will range from 5 degrees C to 45 degrees C

1.04 DESIGN REQUIREMENTS

- A. Nitrate Recycle Flow Meter(s):
 - 1. Quantity: Two (2)
 - 2. Size: 20 inch
 - 3. Liner Material: Neoprene
 - 4. Process Connection: Flange ANSI Class 150
 - 5. Flange Material: Carbon Steel
 - 6. Electrode Material: AISI 316 Ti (316 SS)
 - 7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
 - 8. Transmitter Electronics: Remote mounted with cable to sensor
 - 9. Flow range: 1,000 - 6,500 gpm
 - 10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
 - 11. Flow Meter to be located outside.
- B. DAF Effluent Pump Station Flow Meter(s):
 - 1. Quantity: Two (2)
 - 2. Size: 12 inch
 - 3. Liner Material: Neoprene
 - 4. Process Connection: Flange ANSI Class 150
 - 5. Flange Material: Carbon Steel
 - 6. Electrode Material: AISI 316 Ti (316 SS)
 - 7. Enclosure: NEMA 6 (10 feet of water for 72 hours)
 - 8. Transmitter Electronics: Remote mounted with cable to sensor
 - 9. Flow range: 200 - 3,000 gpm
 - 10. Flow Indicators: Digital flow indicator (gpm) and totalizer (gallons).
 - 11. Flow Meter to be located outside

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit product data, including Manufacturer's data, for specified products. Include the following:
 - 1. Manufacturer's outline and mounting dimensions for all flow meters.
 - 2. Manufacturer's wiring diagrams, including field connections.
 - 3. Mounting Details.

4. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.

1.06 QUALITY ASSURANCE

- A. The flow meters covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such flow meters. The flow meters furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
- B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Rosemont
- B. ABB
- C. Sparling Instrument Co., Inc.
- D. Or Approved Equal
 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL

- A. The magnetic flowmeter shall utilize characterized electromagnetic induction to produce a voltage linearly proportional to the average flow rate. The metering system shall consist of a sensor with field coils, transmitter and interconnecting cables to make a complete operating flow metering system. The meter shall be of the bi-polar pulsed dc type with continuous automatic zeroing.

2.03 CONSTRUCTION

- A. The sensor shall be a flanged tube with non-conductive liner. The tube shall be constructed of Type 304 stainless steel with carbon steel flanges AWWA Class D if the coils are external to the tube. If the coils are encapsulated inside the tube, the tube and flanges may be of carbon steel. Sensor rating shall be NEMA-4 and capable of withstanding accidental submergence in water. The power supply shall be 120-volt AC, 60 HZ. Power consumption shall not exceed 42 watts regardless of size. Accuracy of the flowmeter system shall be 0.5 percent of rate from 10 to 100 percent of scale. Below 1 full percentage scale [fps] it shall be 0.1 percent of full scale. Repeatability shall be 0.1 percent of rate. Liner material shall be neoprene or teflon. External surfaces shall be factory-finished with a corrosion resistant coating. The specific conductivity of the liquid shall not preclude meter operation.

2.04 COMPONENTS

- A. Output: 4-20 mA DC into 800 ohms, isolated, standard
- B. Adjustments: Calibration, Sensitivity, Damping, mA zero and span.
- C. Linearity: plus or minus 0.5% full span
- D. Repeatability: plus or minus 0.1% full span
- E. Accuracy: Within plus or minus 2.0% full span

- F. Signal Strength Meter: Analog type standard
- G. Transducer: Single twin-crystal transducer with 20 feet armored flexible cable.
- H. Standard Transducer Temperature Range: -300 degrees F to 320 degrees F.
- I. Transmitter Temperature Range: -10 degrees F to 140 degrees F.
- J. Power Requirements: 120 Volts, 60 Hz.
- K. Transmitter Housing: NEMA 4X thermoplastic standard.
- L. Flow Rate Indicator: Mounted integrally in transmitter housing. Graduations linear in gpm. Shatterproof window.
- M. Internal Frequency Standard: Calibration assured by on-board frequency reference.
- N. Grounding: Grounding rings or electrodes of the same material as the sensing electrodes shall be furnished mounted in each end of all meters one inch and larger in size. Provide grounding strap between adjacent pipe, grounding rings and flow tube, unless adjacent pipe is either non-conductive or lined with non-conductive materials, in which case provide grounding string between the rings and tube only. If grounding electrodes are provided, grounding rings shall also be provided for liner protection.
- O. Transmitter: The transmitter shall be either meter and/or remote mounted as indicated on the Drawings and as specified in paragraph 1.04 Design Requirements. If the transmitter is remote mounted, the interconnecting cable shall be furnished by the manufacturer of the metering system. Remote transmitters shall be housed in NEMA-4X enclosures suitable for wall mounting. The transmitter shall produce a 4-20 mA dc output signal into a minimum load of 800 ohms linear to flow, and a scaled pulse when called for above for totalization.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings and as specified herein.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Each flow meter shall be tested prior to shipment and the documentation of the test shall be submitted with O & M Manual for the flow meters.
- C. The services of a factory trained representative shall be provided for a total of two (2) days of testing and calibration of the flow meters.

END OF SECTION

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SECTION 40 91 30
ULTRASONIC LEVEL SENSOR

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, four (4) Ultrasonic level sensors and transmitters as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION

- A. The process fluid to be measured will be treated sanitary wastewater treatment system effluent.
- B. Fluid temperature will range from 5 degrees C to 35 degrees C
- C. The percent solids by weight of the fluid will range from 0.2 percent to 1.5 percent.

1.04 DESIGN REQUIREMENTS

- A. Nitrification Reactor No. 2B:
 - 1. Quantity: One (1)
 - 2. Designed for measuring the liquid level in the Nitrification Reactor No. 2B as shown on the drawings.
 - 3. Level range:
 - a. Top of Tank Wall: 28.0 feet Above Bottom
 - b. Emergency High Water Level: 27.5 feet Above Bottom
 - c. High Water Level 26.0 feet Above Bottom
 - d. Equipment Supplier shall verify that there is sufficient distance from the mounting position of the Ultra Sonic Level Sensor to the Emergency High Water Level
 - 4. Indicators: Digital level indicator (feet).
- B. Anoxic Reactor No. 3:
 - 1. Quantity: One (1)
 - 2. Designed for measuring the liquid level in the Anoxic Reactor No. 3 as shown on the drawings.
 - 3. Level range:
 - a. Top of Tank Wall: 28.0 feet Above Bottom
 - b. Emergency High Water Level: 27.5 feet Above Bottom
 - c. High Water Level 24.0 feet Above Bottom
 - d. Equipment Supplier shall verify that there is sufficient distance from the mounting position of the Ultra Sonic Level Sensor to the Emergency High Water Level
 - 4. Indicators: Digital level indicator (feet).
- C. Aerobic Reactor No. 4:
 - 1. Quantity: One (1)
 - 2. Designed for measuring the liquid level in the Aerobic Reactor No. 4 as shown on the drawings.
 - 3. Level range:
 - a. Top of Tank Wall: 25.0 feet Above Bottom
 - b. Emergency High Water Level: 24.5 feet Above Bottom
 - c. High Water Level 23.0 feet Above Bottom

- d. Equipment Supplier shall verify that there is sufficient distance from the mounting position of the Ultra Sonic Level Sensor to the Emergency High Water Level
- 4. Indicators: Digital level indicator (feet).
- D. Filter Flow Splitter Tank:
 - 1. Quantity: One (1)
 - 2. Designed for measuring the liquid level in the Aerobic Reactor No. 4 as shown on the drawings.
 - 3. Level range:
 - a. Top of Tank Wall: 15.5 feet Above Bottom
 - b. Emergency High Water Level: 15.0 feet Above Bottom
 - c. High Water Level 10.5 feet Above Bottom
 - d. Equipment Supplier shall verify that there is sufficient distance from the mounting position of the Ultra Sonic Level Sensor to the Emergency High Water Level
 - 4. Indicators: Digital level indicator (feet).

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit product data, including Manufacturer's data, for specified products. Include the following:
 - 1. Manufacturer's outline and mounting dimensions for all flow meters.
 - 2. Manufacturer's wiring diagrams, including field connections.
 - 3. Mounting Details.
 - 4. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.

1.06 QUALITY ASSURANCE

- A. The flow meters covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such flow meters. The flow meters furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
- B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Siemens
- B. Endress-Hauser
- C. Rosemount
- D. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

- A. Sensor:
 - 1. Type:
 - a. The transducer shall generate an ultrasonic signal and receive an echo from the liquid surface.
 - 2. Operation/Function:
 - a. The sensor shall be potted/encapsulated in a chemical and corrosion resistant PVC or CPVC housing. Sensors shall be capable of being completely submerged without damage.
 - b. Temperature Limits: - 5 degrees F to + 120 degrees F.
 - c. Relative Humidity: 0 to 100%.
 - d. The sensor shall be provided with automatic air temperature and density compensation.
 - 3. Physical:
 - a. Sensors located in areas where freezing condensation may occur shall be provided with special heaters or other type of transducer protection designed to prevent sensor icing.
 - b. Sensors shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings.
 - c. The supplier shall be responsible for coordinating all sensor mounting requirements and shall furnish dimensional and elevational drawings to ensure proper and satisfactory installation.
- B. Transmitter:
 - 1. Type:
 - a. Microprocessor based device which converts the sensor output signal to a flow output in gallons per minute, as well as, totalize flow in gallons for flow meters and liquid level in feet for level indication.
 - 2. Function/Performance:
 - a. Temperature Limits: -5 degrees F to +120 degrees F.
 - b. Accuracy: Shall be plus or minus 0.25 percent for the transducer and converter.
 - c. Transmitter shall ignore momentary loss-of-echo signals.
 - d. Output: Isolated 4-20 mA linear to gallons per minute.
 - e. Power Requirements: 120 Volt/60 Hz
 - f. Display: 4 digit 18 mm LCD, scaled to read in gallons per minute and total flow in gallons.
 - g. All required device programming interface equipment is to be provided.
 - 3. Physical:
 - a. Provide NEMA 4X enclosure.
 - b. Provide sensor interconnecting cable between sensor and transmitter.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings and as specified herein.

3.02 FIELD QUALITY CONTROL

- A. Each flow meter shall be tested prior to shipment and the documentation of the test shall be submitted with O & M Manual for the flow meters.
- B. The services of a factory trained representative shall be provided for a total of one (1) day of testing and calibration of the flow meters.

END OF SECTION

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SECTION 43 11 33
ROTARY LOBE POSITIVE DISPLACEMENT BLOWERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, five (5) positive displacement blowers with sound enclosures as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 01 10 00 - Summary
- B. Section 01 60 00 - Product Requirements
- C. Division 26 - Electrical
- D. Section 26 29 23 - Variable Frequency Drives

1.03 SYSTEM DESCRIPTION

- A. The positive displacement blowers described in this section shall be supplied by a single manufacturer.
- B. The blowers shall be positive displacement, rotary lobe type, designed for air service, suitable for variable frequency drive operation, and belt driven via electric motor.
- C. Each blower package unit shall be complete with rotary lobe positive displacement blower, drive unit, V-Belt drive, Flexible expansion joints, drive guard, common steel base discharge silencer, inlet filter silencer, pressure relief valve, check valve, discharge isolation valve, pressure gauge (inlet and discharge), temperature Gauge (inlet and discharge), temperature switch (discharge), pressure switch (discharge), vibration isolation pads, and appurtenances. One manufacturer shall furnish all components.

1.04 DESIGN REQUIREMENTS

- A. The manufacturer shall supply identical positive displacement blowers as follows for Nitrification Reactor No. 2B:
 - 1. Quantity: Three (3)
 - 2. Site Elevation: 35 ft. Above Sea Level
 - 3. Ambient Pressure: 14.7 psia
 - 4. Ambient Temperature: 95 degrees F
 - 5. Relative Humidity: 90%
 - 6. Inlet Volume: 1100 scfm
 - 7. Inlet Pressure: 14.7 psia
 - 8. Inlet Temperature: 95 degrees F
 - 9. Discharge Pressure: 27.7 psia
 - 10. Differential Pressure: 13 psig
 - 11. Relief Valve Set Pressure: 14 psig
 - 12. Supply Voltage: 480 Volts, three (3) phase, 60 Hz
 - 13. Gas: Air
 - 14. Motor Horsepower: 100 HP
 - 15. Rotors: Tri-Lobe Design
 - 16. Air Inlet Type: Piped to Outside
 - 17. Blowers shall be capable of being operated on a variable frequency drive for automatic speed control to maintain a constant dissolved oxygen concentration in Nitrification Reactor No. 2B.

- B. The manufacturer shall supply identical positive displacement blowers as follows for Aerobic Reactor No. 4:
1. Quantity: Two (2)
 2. Site Elevation: 35 ft. Above Sea Level
 3. Ambient Pressure: 14.7 psia
 4. Ambient Temperature: 95 degrees F
 5. Relative Humidity: 90%
 6. Inlet Volume: 400 scfm
 7. Inlet Pressure: 14.7 psia
 8. Inlet Temperature: 95 degrees F
 9. Discharge Pressure: 26.2 psia
 10. Differential Pressure: 11.5 psig
 11. Relief Valve Set Pressure: 12.5 psig
 12. Supply Voltage: 480 Volts, three (3) phase, 60 Hz
 13. Gas: Air
 14. Motor Horsepower: 40 HP
 15. Rotors: Tri-Lobe Design
 16. Air Inlet Type: Piped to Outside
 17. Blowers shall be capable of being operated on a variable frequency drive for automatic speed control to maintain a constant dissolved oxygen concentration in Aerobic Reactor No. 4.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit product data, including Manufacturer's data, for specified products.
- C. Product Description: Include product description including the following:
 1. Manufacturer's data, order sheet, or equivalent for the blowers being supplied.
 2. Manufacturer's outline and mounting dimensions for all field mounted devices, including, but not limited to, drives, motors, and enclosures.
 3. Manufacturer's wiring diagrams for control system, including necessary field connections (if required).
 4. Manufacturer's dimensions and field fabrication details for all mechanical equipment.
 5. The manufacturer shall clearly identify any exception to the specification or drawings. Failure to do this shall be grounds for rejection of the submittal.
 6. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.
- D. Shop Drawings: Show layout of all equipment; including layout and erection details for all blowers; include mounting details.
- E. Certification: Show characteristics curves for blowers; including pressure and brake horsepower plotted against CFM capacity for full blower range. Clearly identify the design point specified.
- F. Operating and Maintenance Manuals (O&M Manuals): Submit two (2) sets and one (1) electronic copy in pdf format of operating and equipment maintenance instructions and detailed drawings.
- G. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

- H. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.
 2. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommendations for any appropriate appurtenances, not already shown or specified, that should be installed to the Rotary Lobe Positive Displacement Blower(s) and associated air piping to prevent damage to the supplied equipment as a result of thermal expansion or vibration.

1.06 QUALITY ASSURANCE

- A. The blowers and equipment covered by this specification are intended to be standard blower equipment, of proven ability, as manufactured by a reputable CE certified manufacturer having at least ten (10) years' experience in the production of such blowers; and, at least 25 successful systems of the type specified in operation of such blowers.
- B. The blowers furnished shall be designed, constructed, and installed in accordance with the best practice and methods and shall operate satisfactorily when installed.
- C. The positive displacement blowers furnished under this specification shall be new, unused, and shall be the standard product of a single manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of two (2) years.

1.07 FACTORY TESTING

- A. All critical dimensions of the blower components actually provided by the manufacturer shall be verified and documented prior to assembly.
- B. The rotating parts of each blower actually provided by the Manufacturer shall be statically and dynamically balanced before final assembly. The blower alone shall operate without excessive vibration.
- C. Each blower actually provided by the Manufacturer shall be slip tested. The Slip RPM shall be documented. A document certifying that the supplied blowers conform to the design specifications shall be provided.
- D. On completion of final assembly of the packaged blower and prior to shipment, each packaged blower shall be mechanically run for a minimum of fifteen (15) minutes.

1.08 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01600.
- B. The blower packages shall be factory assembled and tested before shipment.
- C. The blower packages shall be stored on-site with a protective covering and elevated off the ground.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. The Manufacturer and Contractor shall warrant the blowers, motors and all other package components being supplied to the Owner against all defects in workmanship and materials for a period of twenty-four (24) months from date of Substantial Completion.

- C. The Manufacturer's warranty shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed. The Contractor shall be responsible for proper storage of the equipment so as to remain in "as shipped" condition. If the equipment remains in storage at the job site for longer than six (6) months before installation, the Contractor shall provide factory service personnel for a complete inspection of the equipment. Any work necessary to restore the equipment to "as shipped" condition shall be the responsibility of the Contractor.
- D. Provide five year manufacturer warranty for _____.

1.10 EXTRA MATERIALS

- A. See Section 01600 - Product Requirements, for additional provisions.
- B. Supply one (1) set of belts for each blower supplied.
- C. Supply enough oil for two (2) oil changes for each blower supplied.
- D. Supply two (2) intake filter elements for each blower supplied.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Robuschi USA Inc.
- B. Kaeser Compressors, Inc.
- C. Aerzen
- D. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DESIGN CRITERIA

- A. Blower shall be positive displacement rotary type with top inlet and bottom outlet.
- B. Blower shall be V-belt driven by an electric motor.
- C. All bearings shall be anti-friction type rated by AFBMA standards to have a minimum B10 life of 100,000 hours at design speed and maximum radial and thrust load conditions.
- D. All piping shall be so installed that no weight or strain will be imposed on the blower.
- E. Design point noise levels for each blower furnished shall not exceed the dbA limits specified herein. The required room level dbA limits are expressed as measurements taken at a distance of three feet in any direction from the blower system or from the acoustical enclosure if it is provided. With its submittals, the contractor shall provide the engineer with the manufacturer's certification of the design point dbA level for each blower system furnished.

2.03 BLOWER COMPONENTS

- A. Casing:
 - 1. The casing shall be made of high strength, close grained, cast iron, and shall be adequately ribbed to resist deflection and facilitate cooling.
 - 2. The casing shall be precision machined to allow for minimum clearances.
 - 3. The casing design shall incorporate two cast in machined ports to minimize pulsation.
 - 4. Casing has flanged inlet and discharge connections. Screwed connections will not be acceptable.
- B. Rotor Assemblies:
 - 1. The rotor assemblies shall be one piece and precision machined from high strength, close grain, spheroidal graphite ductile iron allowing smooth, efficient operation at all rated speeds and pressures.
 - 2. The rotors shall be of the straight, three-lobe involute type and shall operate without rubbing, liquid seals or lubrication. Two lobe rotors will not be acceptable.
 - 3. The integral shafts shall be designed to carry higher loads than calculated for the maximum design load and shall incorporate replaceable seal ring wear sleeves.

4. The rotor assemblies shall be statically and dynamically balanced. Rotor cavities shall be plugged to prevent imbalance due to contaminants.
 5. The rotors shall be a tri-lobe design in order to minimize pulsation and noise.
- C. End Plates:
1. The gear-end plate shall be cast iron.
 2. The drive-end plate shall be integral to the blower casing ensuring heavy-duty construction, long life, and maximum machine noise attenuation in all applications.
 3. Bearing fits shall be precision machined to ensure accurate positioning of the rotors in the casing.
 4. Replaceable seal wear inserts shall be provided on the drive-end and gear-end plates.
 5. The end plates shall be heavy-duty cast iron with a precision machined sealing face.
- D. Timing Gears:
1. Both rotors shall be positively timed by a pair of accurately machined, heat treated ground alloy steel, helical tooth timing gears. To increase gear life and reduce noise, the use of spur gears is not acceptable. The timing gears shall be mounted on tapered shafts to provide positive locking of gears and shaft.
 2. Connections shall be provided for a hydraulic pump for expansion to adjust and/or remove gears.
 3. The rotor timing gears shall be precision machined from case hardened and ground alloy steel.
 4. Each timing gear shall be straight cut and beveled to eliminate axial bearing loads and ensure long life as well as quiet operation.
 5. Gears shall be finish ground on a precision grinder to ensure concentricity.
 6. The timing gear set shall be taper-mounted on the rotors for improved rebuild ability and accurate timing.
- E. Bearings:
1. All four shaft support locations shall incorporate large, heavy-duty cylindrical roller or ball bearings designed to handle extreme radial loads without sacrificing product integrity and reliability.
 2. The minimum acceptable B10 design life at the blower's maximum rated speed and maximum rated differential pressure shall be no less than 100,000 hours.
 3. Drive shaft bearing is sized for an overhung V-belt drive maximum continuous operating load.
 4. The bearing housing shall have a retainer providing positive containment of the bearings. Ground gear spacers shall maintain permanent rotor clearances within the blower casing.
- F. Lubrication:
1. The blower shall incorporate two (2) separate oil chambers each with adequately sized sight glasses, and ample reservoir capacity.
 2. Both the gear-end and the drive-end of the blowers shall be oil splash lubricated for minimal maintenance and long service life.
 3. Grease lubricated bearings are not acceptable.
 4. The lubrication design shall ensure adequate lubrication of the timing gears and bearings.
- G. Seals:
1. There shall be four (4) piston ring type labyrinth seals at each end of each rotor to minimize leakage and maintenance costs.
 2. The cavity between the air-side and oil-side seals shall be vented through threaded ports to allow external purging or containment of any lubricating oil or process gas that may have migrated past the seals.
 3. Enough ports shall be incorporated in the design to ensure that the cavity is vented from the bottom no matter what blower drive-to-driven shaft orientation is utilized.
 4. A vent cavity shall be provided on all four (4) sets of piston ring type labyrinth seals. The two (2) vent holes located on the bottom side of the blower shall be left open. The vent holes at the other locations shall be closed off with threaded metal plugs.

5. The input drive shaft seal shall be a high temperature radial lip type seal with Viton elastomers. The seal design shall incorporate a replaceable wear sleeve on the input drive shaft.

2.04 DRIVE MOTORS:

- A. Drive motors shall be designed, manufactured, and tested in accordance with the latest revised editions of NEMA MG-1, IEC, IEEE, ANSI, and AFBMMA standards as applicable and shall be capable of continuous operation.
- B. The motor nameplate horsepower rating shall not be exceeded at the design speed.
- C. The motor shall be sized to accept load at pressure relief valve pop pressure without exceeding rated FLA.
- D. The temperature rise of the motor windings shall not exceed IEC and NEMA standards when the motor is operated continuously at the rated horsepower, rated voltage, and rated frequency in ambient conditions of 40 degrees C.
- E. The motors shall conform to the following:
 1. Mounting: Horizontal.
 2. Type: Squirrel Cage Induction.
 3. Enclosure: Totally Enclosed - Fan Cooled.
 4. Service Factor: 1.15.
 5. Duty Cycle: Continuous.
 6. Ambient Temperature Rating: 40 degrees C
 7. Starting Current: Six (6) times full load current maximum.
 8. Winding Insulation: Class F.
 9. Temperature Rise: Class B.
 10. Voltage/Frequency/Phase: 460/60/3
 11. Bearing Life: 60,000 hours rating life as defined by AFBMA standards
 12. Bearing Lubrication: Oil, Oil Mist, or Grease (with grease addition fittings and grease relief fittings).
 13. Maximum Speed: 3,600 rpm.
 14. Speeds: Capable of being operating with a variable frequency drive
 15. Accessories: Winding Temperature Detector

2.05 BLOWER PACKAGES:

- A. The packaged blowers are to be standard engineered designs of a CE certified manufacturer regularly engaged in the production of packaged blowers to ensure single source accountability and shall include the following listed standard features:
 1. The packages shall be driven through V-belts and sheaves. The drive assembly shall be of the high capacity type, oil and heat resistant, with a minimum service factor of 1.4.
 2. Automatic tensioning of the V-belts by use of a pivoting, swing frame motor base with adjustable spring assistance and visual indication of V-belt tension shall be provided to ensure the V-belts remain properly tensioned with minimal maintenance and to extend V-belt, sheave, and bearing life. Adjustment of the tensioning device shall be accomplished without removal of the guard or loosening of the motor mounting bolts.
 3. The drive guard shall be the manufacturer's standard sheet metal with provision for ventilation. The installed guard shall be fully enclosed, easily removable, and designed to meet current OSHA recommendations and CE standards.
 4. The base shall be an elevated, rigid, fabricated steel design with a solid sub-base. The absorptive type discharge silencer shall be integral to the frame in order to minimize space requirements. The blower shall be mounted horizontally for a compact frame.
 5. To prevent transmission of vibration and noise, as well as secure the package to the foundation, the base shall include vibration isolators made of rubber in a steel footing equipped with mounting holes for anchoring purposes.

6. Oil drains from the blower drive-end and gear-end lubricating oil sumps shall be piped to the front of the base for ease of maintenance. The drain valves shall be a ball valve with a fully retained and gasketed threaded cap.
7. The inlet filter shall be integral to the inlet silencer and shall include a washable and reusable polyester element for minimal pressure drop.
8. The inlet silencer shall be of the absorptive type, directly connected to the inlet port of the blower, and shall be mounted horizontally.
9. The discharge silencer shall be of the absorptive type with an integral pulsation dampener and directly connected to the outlet port of the blower. The discharge silencer shall be mounted horizontally and shall be integral to the base frame.
10. The relief valve shall be spring loaded and factory installed after the discharge silencer in a location to protect the blower from excessive differential pressures. The relief valve exhaust shall be piped out of the enclosure.
11. A discharge check valve shall be provided constructed of a cast iron body, double disc-type check valve for mounting on the blower discharge piping. Valve shall have aluminum bronze internals and EPDM seat material.
12. An elastomeric compensator/flex connector shall be provided for connection of the packaged blower to the system piping to reduce transmission of structure borne noise as well as prevent unacceptable loading of the silencer connection and blower casing.
13. A sound enclosure shall be provided. The sound enclosure shall be sheet steel construction with powder coat finish. It shall have acoustic foam insulation and shall provide sound attenuation of up to 20 dba. The enclosure shall also provide sound attenuation such that the maximum average noise level is 75 dbA measured at six locations at a distance of 3 feet from the enclosure. Noise level shall be measured in a "free-field". The enclosure shall have a hinged panel on top and a removable panel on the front of the package to allow maintenance access. Panels shall incorporate locking closures.
14. An installed, integral ventilation fan, sized to provide adequate cooling of the package, shall be provided. The fan shall be provided with a dedicated motor. Powering the fan from the blower drive motor is not acceptable.
15. A discharge pressure gauge shall be provided, pre-piped and panel mounted, on the sound enclosure.
16. A discharge temperature gauge, with adjustable switching point and contact, shall be provided pre-piped and panel mounted on the sound enclosure.
17. An inlet filter differential pressure gauge shall be provided pre-piped and panel mounted on the sound enclosure.
18. A discharge pressure high temperature switch shall be provided. The high temperature switch shall be Ashcroft or equal with an operating range of 150° to 260°F. The maximum temperature capability shall be 400°F. Sensor is to be capillary type with remote 3-3/4" brass bulb. Contractor to provide 1/2" FPT in discharge piping near blower for thermostat well. Piping under 4 inches will require a tee with bushings to mount the well. Piping 4 inches and over may be drilled and tapped.
19. A high pressure shut-down switch shall be provided. The high pressure switch be Ashcroft type 400, B4 series or equal with an operating range of 1 psig to 15 psig. Actuator seal must be Viton.
20. The blower package shall be designed to allow all preventive maintenance to be performed from the front of the package. All utility connections and process connections shall be at the rear of the package.
21. The blower packages must fit in the space provided as indicated on the Drawings. The Manufacturer is responsible for assuring that the equipment provided is serviceable and that all clearances for maintenance are provided as necessary to ensure safe and trouble-free maintenance for the blower packages.

2.06 BLOWER CONTROLS

- A. When in Auto mode all blowers will be controlled by the PLC Panel as indicated on the Drawings. Refer to Electrical Drawings for additional information.
- B. Pump controls shall be located in the motor control center (MCC) as indicated on the Drawings and specified herein.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions to provide a complete installation.
- B. All piping shall be supported to prevent exerting undue forces and moments on the blower flanges. Single arch expansion joints shall be furnished to isolate the blower package from the piping system.
- C. Each blower unit will be installed on a flat and level concrete pad, suitable for supporting the dead weight of the unit. Vibration isolation pads must always be placed between concrete pad and common base legs.
- D. All piping and fittings to mount the specified instruments must be provided by the blower system manufacturer.
- E. If required all blower oil drains must be piped away from the blower to easily drain oil.
- F. The blower manufacturer will furnish the services of a factory-based technician to check the installation of the blower system and make any field adjustments necessary to insure proper mechanical operation. The blower system manufacturer will submit, to the contractor, a written report certifying that the equipment has been satisfactorily installed and lubricated.

3.02 FIELD QUALITY CONTROL

- A. Provide manufacturer's field representative for one (1) day of eight (8) hours to prepare and start equipment.

END OF SECTION

SECTION 43 21 39
SUBMERSIBLE PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, two (2) submersible pumps as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 01 10 00 - Summary
- B. Section 01 60 00 - Product Requirements
- C. Division 26 - Electrical

1.03 REFERENCES

- A. Hydraulic Institute Standards (Latest Edition).
- B. AGBMA Standard 11-78 - Load and Fatigue Life for Roller Bearings.
- C. ASTM A48 - Gray Iron Castings

1.04 SYSTEM DESCRIPTION

- A. The submersible pumps specified herein are intended to be standard for submersible use in industrial wastewater handling.
- B. The pumps shall be located as indicated on the Drawings.
- C. Each pump shall be wet pit type submersible pumps with all materials in contact with the pumped fluid. Pumps shall be non-clog sewage pumps.
- D. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences.
- E. Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.
- F. Pumps shall be capable of operating continuously without being fully submerged.
- G. Pump motors shall be non-overloading across the entire pump curve or as indicated by pump head ranges shown and minimum pump operating head indicated.

1.05 DESIGN REQUIREMENTS

- A. Raw Wastewater Pump Station:
 - 1. Number of Pumps: Two (2)
 - 2. Configuration: Parallel
 - 3. Pumped Liquid: 1% solids waste activated sludge
 - 4. Design Flow Capacity: 200 gpm
 - 5. Total Dynamic Head at Design Flow: 35 feet
 - 6. Maximum Solids Size: 3 inches
 - 7. Motor Horsepower: 10 HP
 - 8. Minimum Discharge Nozzle Size: 3-inch
 - 9. Motor Voltage: 480 Volt/3 Phase/60 Hz
 - 10. Motor Type: Submersible
 - 11. The pump(s) shall be capable of operating with a variable speed drive for manual control of pump speed and flow rate.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data shall include at least the following:
 - 1. Certified shop and erection drawings showing all important details of construction and dimensions.
 - 2. Descriptive literature, bulletins, and/or catalogs of the equipment.
 - 3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
 - 4. The total weight of the equipment including weight of the single largest item.
 - 5. A complete total bill of materials for all equipment.
 - 6. A list of manufacturer's recommended spare parts.
 - 7. Complete data on motors.
 - 8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).
- C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.
- D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
 - 1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

1.07 QUALITY ASSURANCE

- A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
- B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.
- C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.08 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.

1.09 EXTRA MATERIALS

- A. One set of all special tools required for normal operation and maintenance shall be provided.
- B. The following spare parts shall be provided:
 - 1. One extra set of mechanical seals for each pump.
 - 2. Two complete set of gaskets, O-rings, etc. for each pump.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Flygt Pumps
- B. KSB
- C. Gorman Rupp Company
- D. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A. Volute, Impeller and Motor Casing shall be Cast Iron, ASTM A48, Class 35B.
- B. The impeller Wear Ring for non-clog impellers shall be a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.
- C. The Volute Wearing Ring for non-clog impellers shall be a Nitrile rubber coated steel ring insert or shall be a stainless steel ring with a 450 brinnell hardness insert that is drive-fitted to the volute inlet.
- D. Discharge elbow shall be Cast iron, ASTM, Class 35B.
- E. Guide Rails shall be stainless steel, Type 304.

2.03 GENERAL CONSTRUCTION

- A. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. Single guide rail or cabling systems shall not be acceptable. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.
- B. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming in contact with the pumpage, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
 - 1. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirements of a specific torque limit. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.
- C. Bearings: The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single roller bearing. The lower bearing shall be a two row angular contact bearing. Excessive shaft overhang and single row lower bearings are not acceptable. The minimum L10 bearing life shall be 50,000 hours along the usable portion of the pump curve at maximum product speed.
- D. Pump Shaft: Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel C-1035 and shall be completely isolated from the pumped liquid. If the pump shaft is not isolated from the pumped liquid, the shaft shall be stainless steel, ANSI 431 with a shaft sleeve. The shaft deflection ratio, L^3/d^4 , shall have a maximum ratio of 50 to insure minimal deflection and low vibration levels. The length (L) of the shaft overhang shall be measured from the center of the inboard radial bearing to the end of the shaft. The diameter (d) represents the diameter of the shaft.

- E. Cooling System: Each unit shall be provided with an adequately designed cooling system. A water jacket shall be provided for motors greater than 18 Hp. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B or Type 316 stainless steel. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. The water jacket shall encircle the stator housing; thus, providing heat dissipation for the motor regardless of the type of installation. Impeller back vanes shall provide the necessary circulation of the cooling liquid through the water jacket. The cooling media channels and ports shall be non-clogging by virtue of their dimensions. The cooling system shall provide for continuous pump operation in liquid temperature up to 104 DEGREES F. Restrictions below this temperature are not acceptable. Carbon steel cooling jackets are not acceptable.
- F. Sealing System: Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. The tungsten-carbide seals shall use nickel binder for corrosion resistance. Seals containing silicon carbide, ceramic, or carbon or tool steel elements will not be considered equal to tungsten carbide. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing.
1. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, or seals using external exposed springs. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.
 2. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. Seal lubricant shall be FDA Approved, nontoxic. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication.
 3. The motor shall be able to operate dry without damage while pumping under load.
- G. The seal chamber shall incorporate a spiral track in the seal chamber wall. This spiral track or "spin-out" creates a "flushing" action, forcing abrasive particles away, to reduce wear and extend seal life. In lieu of a spiral-track, provide an additional lower mechanical seal for each pump in addition to the spare parts indicated.
- H. Seal Failure and Thermal Sensors: A leakage sensor shall be available to detect water and oil in the stator chamber. The Float Leakage Sensor is a small float switch used to detect the presence of water or oil in the stator chamber. When activated, the sensor will stop the motor and send an alarm the control panel in both local and remote modes. A capacitance sensor in the oil chamber shall be acceptable. **USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.**
1. The motor stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125°C (260°F) the thermal switches shall open, stop the motor and activate an alarm.
 2. The thermal switches and leakage sensor shall be connected to a control and status monitoring unit that is mounted in any control panel.
- I. The pump manufacturer shall provide a Submeg, an automatic meggering device with a minimum testing voltage of 500 V at a current of less than 0.25 mA. A device with testing voltage less than 500 V is unacceptable. This device shall be a 12-pin plug-in module and have sunlight visible LED indicators: "Power On", "500VDC On" and "Low Meg". A "Motor Reset" push-button and "Emergency Bypass" switch shall be mounted on the Submeg module so that

- the pump may be run in emergency situations. The monitoring device shall have a manual "Meg Test" button, which tests the internal circuitry of the module. The device shall test the motor insulation for 10 seconds prior to starting. The device shall prevent the motor from starting if it detects a resistance of 1 Megohm or less. The device will test motor before starting after power failure and provide an early warning system to prevent motor burn-outs due to moisture. The function of this device shall allow repairs to be scheduled, monitors repaired submersible motors, and monitors cable entry leakage.
- J. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type. The motor shall be inverter duty/VFD rated in accordance with NEMA MG1 standards. The stator windings and stator leads shall be insulated with moisture resistant Class H insulation rated for 180°C. The stator shall have Class H insulation and shall be heat-shrink fitted into the stator housing and shall be applied by the trickle impregnation process monomer-free polyester resin resulting in a winding fill factor of at least 95% of the winding voids. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer O-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be assembled by the same manufacturer and provide a written guaranty for parts replacement and availability for 15 years.
- K. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting current and torque.
- L. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
- M. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through operating flows and head ranges shown for each station.
- N. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Cable entry seals shall be standard design of manufacturer. If epoxy or silicone sealing systems are used, a ground conductor, relay and pilot cable shall be provided. The pump's ground conductor(s) and associated ground terminals shall be continuously monitored for open circuits, corrosion and loose connections. This monitoring of ground check and shall take place in the pump control panel and shall not require the addition of any electrical/ electronic circuitry within the pump. The standard pump cable shall be provided with a yellow ground check conductor in addition to the green ground conductor(s), to

provide a continuous ground loop for monitoring. A solid state plug-in relay shall be provided to monitor the continuity of the ground loop and to measure the ground connections for a resistance of less than 500 ohms. LED pilot lights shall provide an indication of a faulty ground condition and in the event of an alarm, the relay shall shut down the motor. A manual reset shall be provided to reset the alarm condition. A test push-button shall simulate an open ground wire and shall check the relay for proper operation.

- O. Volute: Single-piece minimum ASTM A48, Class 35B gray cast iron, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. An impeller Volute must be equipped with a centerline discharge.
- P. The impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, double shrouded non-clogging design or a semi-open design as described herein. The impeller shall have a long throughlet without acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. Impeller(s) shall be keyed to the shaft, retained with an expansion ring and shall be capable of passing a minimum 3 inch diameter solid. All impellers shall be coated with an acrylic dispersion zinc phosphate primer.

2.04 PROTECTIVE COATING

- A. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
- B. Provide field touch-up kit.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

3.02 FIELD QUALITY CONTROL

- A. Controls shall be factory tested and documentation of the test shall be submitted to the Engineer and shall be included in the O&M manual.
- B. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water or wastewater and auxiliary equipment required to complete the field tests.
- C. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified.
- D. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

3.03 MANUFACTURER'S FIELD SERVICES

- A. A factory-authorized service representative shall perform the following:
 - 1. Eight (8) labor hours, on-site time for installation assistance and inspection.
 - 2. Eight (8) labor hours, on-site time for functional and performance testing and training.
- B. Site Test: Conduct a functional test on each pump prior to substantial completion of the project:
 - 1. Start-up - Start-Up of pumps, operation of control system, and demonstration of guide rail lift out operation.

2. Alignment - Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
3. Operating Temperatures - Monitor bearing areas on pump and motor for abnormally high temperatures.
4. Verify that under actual operating conditions that the motor stator temperature windings analog readouts do not exceed a 176 degree F (80 degree C) temperature rise over ambient conditions.
5. Inspect the field assembly of components and installation of equipment including electrical connections. Prepare a written report on findings and any recommended corrective actions.

END OF SECTION

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SECTION 43 41 23
BOLTED STAINLESS STEEL STORAGE TANK

PART 1 GENERAL

1.01 NOTE: BOLTED STAINLESS STEEL STORAGE TANKS MAY BE OFFERED IN LIEU OF THE PRECAST POST TENSIONED CONCRETE TANKS, SECTION 43 41 64. ANY REVISIONS REQUIRED TO THE TO THE DESIGN AND/OR THE DESIGN DRAWINGS SHALL BE PERFORMED AT THE EXPENSE

1.02 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals to erect the bolted stainless steel tanks, including foundation, drilled concrete piers (if required), tank structure, and tank appurtenances as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.03 RELATED SECTIONS

- A. Section 00 30 00 - Information Available to Bidders
- B. Section 02 31 50 - Excavation
- C. Section 02 31 60 - Fill
- D. Section 03 30 00 - Cast-in-Place Concrete: Concrete for concrete components.

1.04 ALTERNATIVES

- A. See Section 01 23 00 - Alternatives, for product alternatives affecting this section.
- B. This section describes the base bid product; refer to Section 03 48 10 for the alternative product.

1.05 REFERENCES

- A. 29 CFR 1910 - Occupational Safety and Health Standards; current edition.
- B. ASTM A36 - Standard Specification for Structural Steel.
- C. ASTM A325 - Specification for High Strength Bolts.
- D. AWWA D103-09 - Factory-Coated Bolted Steel Tanks for Water Storage; 1997 - As adapted for bolted stainless steel tanks.
- E. NFPA 22 - Standard for Water Tanks for Private Fire Protection; 1998.

1.06 DESIGN CRITERIA

- A. Tank - Nitrification Reactor No. 2B: Cylindrical tank with flat bottom to be backfilled as indicated on the final grading plan; including appurtenances.
 - 1. Nominal Diameter: 60 feet.
 - 2. Stored Material: Screened wastewater from a poultry processing facility
 - a. pH range: 5 - 9
 - b. TSS: < 6,000 mg/L
 - 3. Required Capacity: 500,000 gallons at the High Water Level.
 - 4. High Water Level: 26 feet from top of floor.
 - 5. Sidewall Height: 28 feet from top of concrete floor.
 - 6. Structurally designed to comply with applicable building codes including but not limited to:
 - a. Live and dead loads.
 - b. Wind and Seismic Loads
 - c. Thermal movements resulting from temperature change range of 120 degrees F ambient and 180 degrees F on material surfaces.

7. Design to prevent uplift from ground water and/or flood waters. Provide pressure relief valves in the side walls of the tank to prevent uplift.
 8. Tank base slab shall allow for aeration manifold supports being embedded a minimum of 6 inches into the slab.
 - a. Base slab thickening, if required, shall occur below the slab. Slab thickening within the tank shall not be allowed.
 - b. Contractor shall coordinate/confirm actual minimum embedment required for aeration system manifold supports.
- B. Tank - Anoxic Reactor No. 3: Cylindrical tank with flat bottom to be backfilled as indicated on the final grading plan; including appurtenances.
1. Nominal Diameter: 66 feet.
 2. Stored Material: Screened wastewater from a poultry processing facility
 - a. pH range: 5 - 9
 - b. TSS: < 6,000 mg/L
 3. Required Capacity: 600,000 gallons at the High Water Level.
 4. High Water Level: 24 feet from top of floor.
 5. Sidewall Height: 28 feet from top of concrete floor.
 6. Structurally designed to comply with applicable building codes including but not limited to:
 - a. Live and dead loads.
 - b. Wind and Seismic Loads
 - c. Thermal movements resulting from temperature change range of 120 degrees F ambient and 180 degrees F on material surfaces.
 7. Design to prevent uplift from ground water and/or flood waters. Provide pressure relief valves in the side walls of the tank to prevent uplift.
 8. Tank base slab shall allow for aeration manifold supports being embedded a minimum of 6 inches into the slab.
 - a. Base slab thickening, if required, shall occur below the slab. Slab thickening within the tank shall not be allowed.
 - b. Contractor shall coordinate/confirm actual minimum embedment required for aeration system manifold supports.

1.07 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's published literature describing capacity, fittings, equipment, and paint.
- C. Shop Drawings: Fabrication and installation details for tanks, foundations, supports, fittings, and equipment.
 1. Structural analysis data signed and sealed by design engineer licensed to practice in the State of the State in which the Project is located.
- D. All necessary documentation required to verify compliance with the American Iron and Steel provisions of the Clean Water Act.

1.08 QUALITY ASSURANCE

- A. The tanks covered by this Section are intended to be the standard design of a tank supplier having long experience in the manufacture and erection of such tanks. The tanks supplied shall be designed, constructed, and installed in accordance with the best practices and methods and shall perform satisfactorily when installed as shown on the Drawings and as specified herein.
- B. The tanks covered by this Section shall be designed, manufactured, installed and erected by a single tank manufacturer. This shall include all concrete foundations, slabs, and weirs and baffles (as required).
- C. Tank Installer's Qualifications: Contractor licensed in the State of the State in which the Project is located to perform the work covered by this and related sections.

- D. Design Engineer's Qualifications: Professional engineer licensed to practice in the State of the State in which the Project is located and capable of assuming responsibility for structural design of tank, fittings, and supports, including foundations; engineering design conducted for a different project not more than 5 years earlier will be acceptable provided design conditions are the same.

1.09 WARRANTY

- A. The tank manufacturer shall warrant the tank system against any defects in workmanship and materials for a period of one (1) year from the date of final acceptance. In the event any defect should appear, it shall be reported in writing to the manufacturer during warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Water Storage Tanks:
1. Liquid Tech Tank Systems, Inc.
 2. USA Tank Storage Systems
 3. Or Approved Equal
 - a. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FOUNDATION / FLOOR DESIGN

- A. Design floor and foundation for the following loading criteria:
1. Dead Loads
 2. Water Loads
 3. Uplift to ground water and/or flood water.
 4. Radial forces from base to tank wall.
- B. Tank base slab shall be designed by drilled concrete piers. Refer to geotechnical for additional information on design requirements for concrete piers.
- C. Loads are assumed to be transmitted to the sub base directly through the membrane. Minimum thickness of the membrane slab shall be 6 inches. Floors shall be placed continuously in sections as large as practicable to decrease the length of construction joints and their related problems. Precautions shall be taken with large floor sections to limit long-term shrinkage by using low-slump concrete, adequate reinforcement, and proper curing conditions. Hydrostatic uplift when the tank is empty, or when the tank water level is lowered rapidly, shall be precluded by adequate surface drainage and underdrainage, as necessary.
- D. Where joints are provided, suitable methods and/or devices will be employed to prevent leakage. For crack control in the floor, the minimum reinforcement in each of the two perpendicular directions in the horizontal plan shall be 0.0015 times the cross sectional area of the concrete area for prestressed floors or 0.005 times the cross sectional area for non-prestressed floors. Where the wall base shear is transferred into radial tension in the slab, additional reinforcement shall be as required. A minimum of 2 in. of concrete protection shall be provided for all reinforcing steel on the sides of the walls in contact with the liquid contents of the tanks.

2.03 STAINLESS STEEL TANKS

- A. The tanks shall be designed in such a manner that the primary vertical seams shall be staggered from top to bottom of tank. This design shall incorporate a bolt at the corner of each plate intersection to eliminate the "potential leak path".
- B. Stainless Steel
1. Sheet. Stainless steel sheets shall conform to or shall be at least equal to cold-rolled quality per ASTM A240 Type 304 with a minimum yield strength of 35,000 psi. Minimum thickness shall be 12 gauge (0.0984" minimum).
 2. Plate. Stainless steel plates shall conform to or shall be at least equal to cold-rolled quality per ASTM A240 Type 304 with a minimum yield strength of 35,000 psi.

3. Rolled Structural Shapes and Bars. Rolled structural shapes and bars shall conform to ASTM A276 Type 304 with a minimum yield strength of 35,000 psi.
- C. Bolts
 1. Poly-capped bolt heads shall be used for additional corrosion protection.
 2. Stainless Steel bolts, nuts, and washers used in tank joints shall be minimum ½ inch bolt diameter and shall meet the minimum requirements of ASTM A193/A320.
 3. Nuts and Washers: 18-8 stainless steel.
 - D. Structural Shapes & Web Trusses: Structural Steel, complying with ASTM A36 - Structural Steel with a hot dipped galvanized coating.
 - E. Sealant: Sikaflex-1A, premium grade, high performance, moisture-cured, one component, polyurethane base, non-sag elastomeric coating.
 - F. Lap joint bolts shall be installed such that the head portion is located inside the tank and the washer and nut are on the exterior. Lap joint bolts shall be properly selected such that threaded portions will not be exposed in the "shear plane" between tank sheets. Bolt lengths shall be selected to achieve a neat and uniform appearance. Excessive threads extending beyond the nut after tightening is not acceptable. Lap joint bolts shall include a minimum of two splines on the underside of the bolt head at the shank in order to resist rotation during tightening.
 - G. Reinforced concrete ring wall foundation with leveling plate, anchor bolt and seal assembly.
 - H. Reinforced concrete floor slab: Perform in accordance with Section 03 20 00 - Concrete Reinforcement and Section 03 30 00 - Cast-In-Place Concrete.
 - I. Bolted steel foundation sheet assembly with leveling plates and anchors.
 - J. Bolted steel shell assembly, with required hardware and joint sealant.
 - K. Required galvanized web trussing and hardware for wind girders.
 - L. 24" diameter minimum round shell manway will be provided of 304 stainless steel with a hinged support for cover removal.
 - M. Gaskets: All bolted connections of roof sheet seams shall incorporate an EPDM prefabricated gasket with a minimum width 1 ¾".

2.04 TANK APPURTENANCES

- A. Flanges: Provide painted steel flanges as follows:
 1. Flange Locations:
 - a. Refer to Drawings for all pipe penetration quantities, locations and sizes.
- B. Pipe Supports: Provide pipe supports attached to the tank wall to support pipes as shown on the Drawings. Pipe supports shown on the Drawings are only to indicate which pipe shall be supported from the tank wall and do not reflect the type, quantity or attachment details required. The tank Manufacturer shall be responsible for determining the type, quantity and attachment location of all pipe supports.
- C. Access Manway: A bolted 18" x 24" elliptical access manway shall be provided in the side wall of each above ground tank. The manhole frame shall have a waterstop flange attached with a continuous weld. The manway door shall be hinged to the tank wall and shall include a 40 durometer, full faced neoprene rubber gasket to provide a water tight seal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Field erection of stainless steel bolted tanks shall be factory certified in accordance with the tank manufacturer's recommendations. Particular care shall be exercised in handling and bolting of the tank plates, supports, and members to avoid abrasion or scratching of the sheeting.
- B. Contractor shall be responsible for leveling tank site to sub-grade and obtaining a minimum 2,500 psf soil compaction or the minimum compaction required by the tank manufacturer as determined by the structural engineer for the tank manufacturer.

- C. Contractor shall be responsible for all below grade piping to the tank and any piping within the tank as indicated on the Drawings.
- D. Tank Manufacturer shall be responsible for the erection of the tank and any associated appurtenances.
- E. The concrete foundation and floor slab shall be designed by the tank manufacturer's structural engineer.
- F. The starter ring shall be leveled and rounded prior to encasement in concrete. A leveling plate assembly shall be used to secure the starter ring. Prior to placement of concrete, butyl rubber and bentonite water stop seals shall be placed on the inside surface of the starter ring below the concrete floor line.
- G. All vertical, horizontal, shell to roof, and shell to bottom plates or sheets shall be field bolted. Sealant shall be used on all joints to ensure liquid tightness. Fillet sealant at all lapped joints to provide a neat and pleasing appearance.
- H. Contractor to supply protective barrier between tank and any backfill around the tank. The protective barrier shall be approved in writing by the tank manufacturer as an acceptable barrier that will protect the tank and bolts without affecting the tank manufacturer's warranty.
- I. The foundations shall be level with differential not exceeding +/- 1/8 inch in any 30-foot circumference under the shell. The levelness on the circumference shall not vary more than +/- 1/4 inch from an established plane.

3.02 FIELD QUALITY CONTROL

- A. Comply with requirements of Section 01 40 00.
- B. All tanks shall be hydrostatically tested to ensure liquid tightness by filling each tank to its overflow elevation. Owner will furnish the water for the test.
- C. A representative of the Tank Manufacturer shall be made available upon a 24-hour notice to correct any leaks which may occur upon hydrostatic testing of the tank.

3.03 CLEANING

- A. Clean interior of tank prior to filling. Tank shall be free of any debris, trash or any other foreign materials that may be present as a result of construction activities.

END OF SECTION

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SECTION 43 41 43

HIGH DENSITY CROSS-LINKED POLYETHYLENE STORAGE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install, field test, complete and make ready for service one (1) vertical, flat bottom, seamless, high density crosslinked polyethylene storage tanks with double wall containment (as required) as indicated on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 REFERENCES

- A. ANSI B16.5 - Pipe Flanges and Flanged Fittings.
- B. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
- C. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
- D. ASTM D746 - Brittleness Temperature of Plastics and Elastomers by Impact.
- E. ASTM D790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- F. ASTM D883 - Standard Definitions of Terms Relating to Plastics
- G. ASTM D1505 - Density of Plastics by the Density-Gradient Technique.
- H. ASTM D1525 - Vicat Softening Temperature of Plastics.
- I. ASTM D1693 - ESCR Spec. Thickness .125" F50 - 10% legal.
- J. ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tank: Section 11.3: Low Temperature Impact Test and Section 11.4: Oxylene-Insoluble Fraction (Gel Test).

1.03 SYSTEM DESCRIPTION

- A. General:
 1. It is the intent of this Specification and Drawings to afford the fabricator as much design latitude as possible insomuch as the design is consistent with the basic requirements. Therefore, it is intended that the fabricator will have ample opportunity to utilize his particular "know how" in the design and details of tank fabrication in order to produce equipment which will be adequate for the intended purpose.
 2. The fabricator shall submit a design based on the information given which will meet the requirements of the job regarding strength, corrosion resistance, and work ability.
 3. Double Wall Tanks:
 - a. The tank shall be a double wall tank consisting of two bottoms and two shells with a single dish top.
 - b. The interior and exterior tank shall be designed to be self-sustaining.
 - c. The exterior tank shall be designed to 100% of the interior tank capacity.
- B. Carbon Source Bulk Storage Tank:
 1. Fluid: Non-flammable carbon source
 2. Nominal Volume: 6,650 gallons
 3. Tank Design: Double Wall Tank
 4. Outside Diameter: 10 feet 2 inches
 5. Height: 14 feet 3 inches
 6. Tank dimensions are for reference only. Manufacturers standard tank dimensions will be satisfactory so long as the supplied tank will fit in the area and location provided as well as through the access doorways..

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit product data, including Manufacturer's data for specified equipment. Include the following:
 - 1. Manufacturer's data, order sheet, or equivalent for each major item being supplied.
 - 2. Dimensions of tank, fittings, and attachments, with bolt and gasket material.
 - 3. Wall thickness calculations per ASTM D 1998-97 using 600-psi design hoop stress at 100 degrees F.
 - 4. Locations of fittings and attachments and size of manway openings.
 - 5. Resin used and a complete manufacturer specification of the resin used.
 - 6. Weight of tanks.
 - 7. Statement that fabrication is in accordance with these Specifications.
 - 8. Certificate of Compliance from the tank manufacturer stating:
 - a. All fittings, heat tracing, insulation, etc. have been installed by the tank manufacturer.
 - b. Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.
 - 9. Details on packaging.
 - 10. Instructions for handling, storage and installation of tanks.
 - 11. Statement that materials and resin used are suitable for intended service.
 - 12. The manufacturer shall clearly identify any exception to the specification or Drawings. Failure to do this shall be grounds for rejection of the submittal.
- C. Shop drawings shall be approved by the Engineer prior to any manufacturing of tanks, fittings, etc. Approval of drawings by the Engineer shall not release the Contractor of responsibility of compliance with these specifications.
- D. Submit a list of previous five similar use site installations in the past 36 months or provide a list of three or more customers using tanks for the same chemical applications and similar weather conditions for at least ten years.
- E. Submit supporting information of UL tank manufacturing capabilities.
- F. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
 - 1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

1.05 QUALITY ASSURANCE

- A. The tanks covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as supplied by a single manufacturer, having long experience in the fabrication of such tanks. The tanks furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and as specified herein.
- B. In the event that a tank which differs from this Section be offered and determined to be equal to that specified, such tanks shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, et. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.
- B. Tanks which are shipped in the horizontal position shall be mounted on padded cradles. All tank end blocking used to prevent shifting of tanks must be padded and bare only upon the knuckle radius of the tank bottom.

- C. Tanks shall be secured to the cradles or skids to prevent rotation or other movement. In turn, the cradles or skids shall be fastened securely to the truck bed.
- D. All tie-down straps shall give provision for thermal expansion and shall be padded where in contact with the equipment.
- E. Flange faces shall be protected from damage by covering with suitable plywood or hardboard and securely fastened.
- F. Tanks shall be positively vented at all times.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Poly Processing Company
- B. Or Approved Equal
 - 1. Substitutions - In accordance with Section 01 60 00 - Product Requirements

2.02 MATERIALS

- A. Plastic
 - 1. The tanks shall be molded from high density crosslinked polyethylene. The resin used shall be Marlex CL-200 YJN as manufactured by Phillips Petroleum Company, Plastics Division or Paxon 7004 as manufactured by Paxon, Inc. or of resins of equal physical and chemical properties.
- B. Fillers and Pigments
 - 1. The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent U.V. stabilizer and maximum of 0.60 percent. Pigments may be added as desired by the OWNER or as designated by the manufacturer, not to exceed 0.5 percent of dry blended or 2 percent if melt compound of the total weight of the tank.

2.03 HIGH DENSITY CROSSLINKED POLYETHYLENE TANKS

- A. The high density crosslinked polyethylene tanks shall be constructed by the rotational molding process.
- B. The high density crosslinked polyethylene tanks shall be capable of storing the above specified chemicals at temperatures up to 130 degrees F.
- C. The nominal properties of the material are as follows based on molded parts:
 - 1. Density (ASTM D1505): 0.940 to 0.945 g/cc
 - 2. ESCR Spec. Thickness 0.125" F50 10% Igepal (ASTM D1693):>1,000 hours
 - 3. Tensile Strength Ultimate 2 in/min (ASTM D638 Type IV Spec):2,600 psi
 - 4. Elongation at Break 2 in/min (ASTM D638):400 percent
 - 5. Vicat Softening Temperature (ASTM D1525):240 degrees F
 - 6. Brittleness Temperature (ASTM D746):-130 degrees F
 - 7. Flexural Modulus (ASTM D790):100,000 to 110,000 psi

2.04 SAFE TANKS/CONTAINMENT SYSTEMS

- A. Tanks shall consist of a crosslinked polyethylene primary tank with a secondary containment tank. The primary tank shall be vertical, cylindrical, flat bottom, dome top, and seamless construction. The secondary containment tank, outer tank, shall be a crosslinked polyethylene, open top, vertical, cylindrical, flat bottom, and seamless in construction.
- B. The tank diameter shall be measured externally. Tolerance on the outside diameter including out of roundness shall be plus or minus two percent. Measurement shall be taken in a horizontal position. The knuckle radius at bottom to wall shall be a minimum of one inch.
- C. The minimum wall thickness shall be 1/4 inch in all places.
- D. All edges cut out, such as entrance manway, shall be trimmed to have smooth edges.

2.05 ACCESSORIES

- A. Manways
 - 1. The manway openings for the double wall containment tanks shall be a minimum of 24" diameter. The manway cover shall be a bolt on type or screw on type lid manufactured from crosslink polyethylene. Bolts used on the bolt on type lid shall be polyethylene, nylon or a compatible plastic material.
- B. Integrally Molded Flanged Outlets
 - 1. The integrally molded flanged outlets shall be located at the bottom of the sidewall and allow the tank to be fully drained. The integrally molded flanged outlets shall be integrally molded into the tank during the rotational molding process. The integrally molded flanged outlets shall be seamless, flanged, and manufactured from the same material as the tank. Inserts are not acceptable. A PVC companion flange assembly with a split backing ring, stainless steel bolts and EPDM gasket shall be provided.
- C. The Polymer Mix Tank shall be provided with the following:
 - 1. One 4-inch integrally molded flange outlet shall be located at bottom of tank.
 - 2. Center mounted mixer designed to mix 2,000 gallons of 2% polymer solution.
 - 3. The mixer shall have a minimum horsepower of 2 HP.
 - 4. The mixing shaft shall be equipped with a minimum of two impellers and shall extend to a minimum of 2 feet off the floor.
- D. The Double Wall Storage Tanks shall be provided with the following:
 - 1. Vent - one per tank.
 - 2. One 3-inch integrally molded flange outlet filling port shall be provided at the top of the tank.
 - 3. One 3-inch integrally molded flange outlet discharge port shall be provided at the bottom of the tank.
 - 4. One 3-inch integrally molded flange outlet overflow port shall be provided 6 inches below top of shell.
 - 5. Necessary corrosion resistant hardware for installation of tank accessories.
- E. Tie Down Systems
 - 1. A tie down system shall be provided for each Double Wall Storage Tank. 316 Stainless Steel clips, bolts, and accessories shall be provided to securely anchor the tank to the cylindrical tank concrete pad. Anchor bolts shall be supplied by the Contractor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with the Drawings and manufacturer's instructions.
- B. Tanks shall be installed on five layers of 30-lb roofing felt, or other resilient support as recommended by the manufacturer to provide for an even bearing on the concrete pad.
- C. Make all pipe connections to tanks as shown on the Drawings.
- D. Tanks and support members shall be anchored in their final position according to the manufacturer's recommendations.
- E. Once installation is complete and approved for use by the Engineer, provide and fill each tank with appropriate chemical.

END OF SECTION

SECTION 43 41 64
PRECAST POST TENSIONED CONCRETE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals to design and erect the precast post tensioned concrete tanks, including foundation, drilled concrete piers, tank structure, and tank appurtenances as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 00 30 00 - Information Available to Bidders
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 23 - Fill

1.03 REFERENCES

- A. General: The work shall comply with the most recent standards or tentative standards as published at the date of the contract and as listed in this specification using the abbreviation shown.
- B. American Concrete Institute (ACI):
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 302 - Recommended Practice for Concrete Floor and Slab Construction
 - 3. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
 - 4. ACI 305R - Hot Weather Concreting
 - 5. ACI 306R - Cold Weather Concreting
 - 6. ACI 308 - Recommended Practice for Curing Concrete (Reaffirmed 1978)
 - 7. ACI 309 - Recommended Practice for Consolidation of Concrete (Reaffirmed 1978)
 - 8. ACI 311 - Recommended Practice for Concrete Inspection
 - 9. ACI 318 - Building Code Requirements for Reinforced Concrete
 - 10. ACI 318-77 - Appendix B Alternate Design Method
 - 11. ACI 344R - Design and Construction of Circular Prestressed Concrete Structures (Reported by ACI Committee 344)
 - 12. ACI 347 - Recommended Practice for Concrete Formwork
 - 13. ACI 350R - Concrete Sanitary Engineering Structures
 - 14. ACI SP-2 - ACI Manual of Concrete Inspection
 - 15. ACI 533-3R - Fabrication, Handling and Erection of Precast Concrete Wall Panels
- C. American Waterworks Association (AWWA) Publications
 - 1. AWWA D115 - AWWA Standard for Circular Prestressed Concrete Water Tanks With Circumferential Tendons
 - 2. AWWA C652-92 - AWWA Standard for Disinfection of Water Storage Facilities
- D. American Society of Civil Engineers:
 - 1. ASCE - 7 - Loads for Buildings and Structures
- E. American Society for Testing and Materials (ASTM):
 - 1. ASTM A416 - Steel Strand, Uncoated Seven-Wire Stress Relieved for Prestressed Concrete
 - 2. ASTM A615 - Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
 - 3. ASTM C150 - Specification for Portland Cement

4. ASTM D395 - Standard Test Methods for Rubber Property Compression Set
5. ASTM D412 - Standard Test Methods for Rubber Properties in Tension
6. ASTM D566 - Standard Test Method for Dropping Point of Lubricating Grease
7. ASTM D1743 - Corrosion Inhibitor
8. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications
9. ASTM D2240 - Standard Test Method for Rubber Property Durometer Hardness
10. ASTM D30331 - Specification for Standard Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
11. ASTM D3350 - Specification for Polyethylene Plastics Pipe and Fittings Materials

1.04 SYSTEM DESCRIPTION

- A. This section consists of designing precast post-tensioned concrete tanks and the furnishing of all materials, equipment and labor, for performing all operations for the construction of precast post-tensioned concrete tanks as indicated on the drawings.
- B. The tank shall meet the design requirements for a post-tensioned concrete structure as recommended in ACI 350, AWWA D115, and the Post-Tensioning Institute Design Manual.
- C. The prestressed concrete tanks shall also be designed and constructed in accordance with the AWWA D-115 specifications for Precast Post-Tensioned Tanks with Internal Tendons.

1.05 DESIGN REQUIREMENTS

- A. Tank: Nitrification Reactor No. 2B Tank shall be designed and constructed as shown on the Drawings.
 1. Nitrification Reactor No. 2B
 - a. Nominal Diameter: 60 feet
 - b. Required Capacity: 500,000 gallons at the High Water Level.
 - c. High Water Level: 26.0 feet from top of slab.
 - d. Sidewall Height: 28 feet from top of slab.
 2. Structurally designed to comply with applicable building codes including but not limited to:
 - a. Wind Loads
 - b. Seismic Loads
 3. Design to prevent uplift from ground water and/or flood waters. Provide pressure relief valves in the side walls or floor of the tank to prevent uplift.
 4. The tank shall be designed for a maximum liquid level inside the tank equal to the tank wall height.
 5. Tank base slab shall allow for aeration manifold supports being embedded a minimum of 6 inches into the slab.
 - a. Base slab thickening, if required, shall occur below the slab. Slab thickening within the tank shall not be allowed.
 - b. Contractor shall coordinate/confirm actual minimum embedment required for aeration system manifold supports.
- B. Tank: Anoxic Reactor No. 3 Tank shall be designed and constructed as shown on the Drawings.
 1. Anoxic Reactor No. 3
 - a. Nominal Diameter: 66 feet
 - b. Required Capacity: 600,000 gallons at the High Water Level.
 - c. High Water Level: 24.0 feet from top of slab.
 - d. Sidewall Height: 28 feet from top of slab.
 2. Structurally designed to comply with applicable building codes including but not limited to:
 - a. Wind Loads
 - b. Seismic Loads
 3. Design to prevent uplift from ground water and/or flood waters. Provide pressure relief valves in the side walls or floor of the tank to prevent uplift.

4. The tank shall be designed for a maximum liquid level inside the tank equal to the tank wall height.
5. Tank base slab shall allow for aeration manifold supports being embedded a minimum of 6 inches into the slab.
 - a. Base slab thickening, if required, shall occur below the slab. Slab thickening within the tank shall not be allowed.
 - b. Contractor shall coordinate/confirm actual minimum embedment required for aeration system manifold supports.

1.06 NOTATION

- b - Unit width (linear)
- d - Distance from face of support (linear)
- E_c - 57,000 (f') short term modulus of elasticity of concrete
- f'_c - 28-day compressive cylinder strength of concrete (force per unit area)
- f_c - Permissible compressive concrete stress (force per unit area)
- f_{pu} - Specified tensile strength of steel prestressing wire strand, (force per unit area)
- f_{se} - Effective steel prestress after losses (force per unit area)
- f_{si} - Allowable steel prestress before losses (force per unit area)
- l_d - Length for bond development
- H - Depth of fluid (linear)
- P_{fw} - Final prestressing force for water load (force)
- R - Inside radius of tank (linear)
- t_c - Core wall thickness (linear)

1.07 DESIGN METHOD

- A. Base tank design on elastic analysis methods and take into account effects of all loads and prestressing forces during and after tensioning, and conditions of edge restraint at wall junctions with floor.
- B. Stresses shall not exceed allowable stresses in paragraph E.
- C. Consideration shall be given to the effects of all loads and load combinations including stresses induced by temperature and moisture gradients.
- D. The recommendations herein pertain to service load conditions and serviceability requirements.
- E. The design must meet the strength requirements of ACI 350. All applicable sections of the latest edition of ACI 350, including supplements and the precast and prestressed concrete chapters, shall be allowed except when supplemented or modified by provisions of this specification.

1.08 DESIGN LOADS

- A. Loads indicated in this section shall be included in the design. Loadings, including post-tensioning forces shall follow governing codes.

1.09 FOUNDATION AND FLOOR DESIGN

- A. Dead Loads.
- B. Water Loads.
- C. Uplift due to ground water and/or flood water.
- D. Radial forces from base to tank wall.
- E. When tanks are to be installed in locations susceptible to frost, the foundations shall extend below grade to the maximum frost depth for the area.

- F. Minimum thickness of the slab shall be 6 inches. Floors shall be placed continuously in sections as large as practicable to decrease the length of construction joints and their related problems. Precautions shall be taken with large floor sections to limit long-term shrinkage by using low-slump concrete, adequate reinforcement, and proper curing conditions. Hydrostatic uplift when the tank is empty, or when the tank water level is lowered rapidly, shall be precluded by adequate surface drainage and underdrainage, if necessary.
- G. Where joints are provided, suitable methods and/or devices will be employed to prevent leakage. For crack control in the floor, the minimum reinforcement in each of the two perpendicular directions in the horizontal plan shall be 0.0015 times the cross sectional area of the concrete area for prestressed floors or 0.005 times the cross sectional area for non-prestressed floors. Where the wall base shear is transferred into radial tension in the slab, additional reinforcement shall be as required. A minimum of 2 in. of concrete protection shall be provided for all reinforcing steel on the sides of the walls in contact with the liquid contents of the tanks.

1.10 FOOTING

- A. Wall Footings:
 - 1. A continuously reinforced concrete footing, either as a thickened floor edge region or one separated from the floor, shall be provided to distribute the vertical loads at the base of the wall to the underlying foundation material. Foundation for membrane floors and footings shall be of uniform compaction and bearing value to support the structure without differential settlement that may damage the structure. Foundation for footings shall likewise provide uniform support to limit differential settlement.

1.11 WALL DESIGN LOADS

- A. Internal Pressure: The pressure from maximum water level to the top of the wall.
- B. Backfill Loading: The lateral pressure from earth backfill, symmetrical or asymmetrical. Net lateral loads, including those due to unequal backfill, shall be determined by rational methods of soil mechanics based on foundation and soils investigations. Surcharge loads on backfill surfaces shall be considered. Backfill pressure shall not be used to reduce the amount of post-tensioning force required for resisting internal water pressure. The assumed internal friction angle of the soil shall be no more than 20 degrees for unit soil density of 125 pounds per cubic feet. Hydrostatic pressure shall be considered unless the design ground water elevation is below the bottom of the tank foundation.
- C. Consider all effects of construction including loads resulting from equipment, materials, and construction methods to be used.
- D. Appurtenance loads.
- E. Operating loads and system surges.
- F. Compressive stresses and bending moments in the wall due to application and post-tensioning forces.
- G. Temperature gradient through the wall.
- H. Moisture gradient through the wall.
- I. Seismic loads- shall be as required by ASCE 7
- J. Wind loads- shall be as required by ASCE 7
- K. Consider compressive stresses and bending moments in the wall due to unequal distribution of post-tension cables such as banding above and below all openings.

1.12 VERTICAL STRESSES AND REINFORCEMENT

- A. Maximum tensile stress for regular mild steel reinforcement used to resist vertical bending stresses shall be 18,000 psi for Grade 60. Bar size shall be no greater than #8 and bar spacing shall not exceed 12 inches.

- B. Shear Forces: Reinforcement of joints must be sufficient to resist the following loads and any combination thereof:
 - 1. Water
 - 2. Backfill
 - 3. Prestressing
 - 4. Other conditions specific to the site
 - 5. Reinforcing steel should not be credited with resisting any portion of primary circumferential tension resulting from radial design pressure.
 - 6. Mild steel reinforcement shall not be used to resist any portion of circumferential tension.

1.13 POST-TENSIONING STEEL

- A. Maximum permissible initial stress f in any wire on the wall shall not exceed 0.75 f_{pu} .
- B. Allowance for stress losses in steel, and for maintaining residual compression in the concrete if not calculated by more precise means, should assumed as 32,000 psi. This figure includes consideration of losses due to shrinkage, plastic and elastic shortening of concrete, and relaxation of steel. A greater allowance for stress losses may be required for structures subjected to unusual creep, shrinkage, or temperatures, or where the radial design pressure is not applied for a long time after completion of construction.
- C. Friction losses should be computed in accordance with ACI 318 and should be added to other computed losses.
- D. Maximum design stress in prestressing wire, for structures subject to full design load, after deduction of the above allowances for stress losses, shall not exceed 0.60 f_{pu} .

1.14 NONSTRESSED REINFORCEMENT

- A. Reinforcing steel shall be designed in accordance with the requirements of ACI 318. Maximum crack control quantity for deformed bars provided in ACI 350 shall not be exceeded.
- B. Reinforcing may consist of bars or welded wire fabric to effectively control cracking due to bending moments in the wall.
- C. Reinforcing steel should not be credited with resisting any portion of primary circumferential tension resulting from radial design pressure.
- D. Mild steel reinforcement shall not be used to resist any portion of circumferential tension.

1.15 ALLOWABLE STRESSES IN CONCRETE

- A. The stresses for concrete shall not exceed the values indicated below:
- B. COMPRESSION: Extreme fiber
 - 1. f_c
 - a. 0.55 f_c initial
 - b. 0.45 f_c at service loads
- C. TENSION: In zones with auxiliary reinforcement and diaphragm
- D. SHEAR: As a measure of diagonal tension at a distance d from the face of the support, psi.
 - 1. Shear strength of the tank walls shall be provided in accordance with ACI 318, Sec. 11.10, Special provision for walls.
- E. BOND: Development length and bonding reinforcements: Deformed bars and welded wire fabric.
 - 1. l_d
 - a. Development length, l shall be computed as a measure of bond resistance in accordance with recommendations of ACI Committee 318.
- F. Note: coefficients shown are for values of f_c expressed in psi.

1.16 WALL THICKNESS

- A. The thickness of the concrete wall shall be such that membrane shell stresses are within the allowable stresses but not less than 8-in. thick.

1.17 WALL JOINT DETAILS

- A. Rotation and translation under circumferential prestressing and lateral wall loads.
- B. The designer shall consider wall boundary conditions resulting from the construction joint details to be used at the top and bottom of the wall.
- C. The base of the wall shall be supported on bearing pads to provide an elastomeric support.
- D. The restraint of the wall at the base shall be assumed both fixed and hinged conditions for the vertical bending stress analysis after completion of the post-tensioning.

1.18 WALL DESIGN

- A. Design Method: Wall design shall be based on elastic cylindrical shell analysis for stresses and deformations due to loads outlined herein. Effects of shrinkage, temperature change, temperature gradient, and creep should be taken in account.
- B. Circumferential Post-Tensioning Force: Circumferential post-tensioning steel shall be furnished to resist all forces due to internal loads, after accounting for all stress losses and for residual compression.

1.19 BEARING PADS

- A. In order to minimize the effect of vertical bending moments on the wall, it is important to keep the hardness in the range of 40 to 50 durometers and the pad thickness under the wall at about 1/2 in. (25 mm) minimum. When a pad is required between the wall and roof, it shall have a minimum thickness of 1/2 in. (13 mm). The required pad area will be determined after considering the vertical load, percent compression, and allowable deformation.

1.20 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings and Product Data:
 - 1. Furnish detailed design drawings, design calculations and detailed field construction procedures for review and approval by the Engineer.
 - 2. Design drawings and calculations shall be sealed by a Registered Professional Engineer licensed to practice in the State of the State in which the Project is located.
 - 3. The Engineer's approval does not relieve the Contractor of his design responsibility.
- C. All necessary documentation required to verify compliance with the American Iron and Steel provisions of the Clean Water Act.

1.21 QUALITY ASSURANCE

- A. Tank Supplier Qualifications: A firm that complies with the following requirements and is experienced in producing circular precast, post-tensioned, concrete tanks that have a record of successful in-service performance and no tank failures.
 - 1. Assumes responsibility for engineering circular precast, post-tensioned, concrete tanks to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer employed directly for the Tank designer/builder.
 - 2. Precast Tank Engineer Qualifications: A professional engineer licensed in jurisdiction where Project is located and who has no less than 5 years' experience in providing engineering services of the kind indicated. Engineering services are defined as those performed for designs and installations of circular precast, post-tensioned, concrete tanks.
 - 3. Participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group C, Category C3 at the time of bid.
 - a. Certification shall be maintained throughout the production of the precast concrete units. Production shall immediately stop if at any time the fabricator's certification is revoked, regardless of the status of completion of contracted work. Production will not be allowed to re-start until the necessary corrections are made and certification has been re-established. In the event certification cannot be re-established in a

- timely manner to avoid project delays, the fabricator, at no additional cost, will contract out the remainder of the units to be manufactured at a PCI certified plant.
4. Has sufficient production capacity to produce required members to meet the project schedule.
- B. Tank Supplier: Subject to compliance with requirements, provide circular precast, post-tensioned, concrete tanks by Dutchland, Inc. located in Gap, Pennsylvania, or pre-approved equal.
- C. Alternate Tank Supplier Pre-approval Qualifications: Alternate Tank Suppliers wishing to become pre-approved shall comply with the Tank Supplier Qualifications listed above, and the following requirements.
1. The firm shall have a minimum of 15 consecutive years in designing, producing and installing tanks of similar arrangement, size and complexity using the precast, post-tensioned system.
 2. The firm shall document the successful installation and performance of a minimum of ten similar facilities, and certify compliance of those structures will all applicable provisions of AWWA D115 for a precast, post-tensioned structure.
 3. The firm shall employ a full-time engineer on staff who meets the Precast Tank Engineer Qualifications listed above and who has served as the engineer in responsible charge of at least ten similar structures.
 4. The firm shall submit with its bid a summary sheet documenting compliance with these qualifications.
 5. The firm shall submit with its bid a reference sheet listing contact names and telephone numbers of at least five similar structures built by the firm.
- D. Post-Tensioning Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's Level 1 Bonded PT - Field Installation course.
1. Superintendent must receive training from post-tensioning supplier in the operation of stressing equipment to be used on Project.
- E. Post-Tensioning Inspector Qualifications: Personnel performing field inspections and measuring elongations shall have successfully completed PTI's Level 1 Bonded PT - Field Installation course.

1.22 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this section.

1.23 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. The Manufacturer shall provide a 10-year structural warranty to the Owner. The Manufacturer shall warrant that all items provided by the Manufacturer including the base, walls, roof, support columns, etc. shall be free from material defect due to faulty equipment design, workmanship, or materials which appear, are discovered, and are reported in writing to the Manufacturer within 10 years of the installation date. This warranty shall also extend to coatings, liners, and sealants recommended, provided and installed by the Manufacturer to provide a watertight structure. If material defects due to faulty equipment design, workmanship, or materials are reported to the Manufacturer within a 10 year period, the Manufacturer shall furnish without charge to the Owner all necessary labor and materials require to repair all defects subject to this warranty.
- C. The Owner's or the Engineer's approval of the Contractor's design, or the Owner's acceptance and final payment for the work shall not relieve the Contractor of design responsibility.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Dutchland Incorporated - Gap, Pennsylvania.

- B. Or Approved Equal
 - 1. Substitutions - See Section 01 60 00 - Product Requirements

2.02 MATERIALS

- A. Concrete
 - 1. Conforming to recommendations of ACI 350, as modified herein. Submit mix proportions for approval by the Engineer meeting the following strength requirements:
 - a. Strength: 5,000 psi minimum 28 days compressive strength.
 - b. Slump: 4-inch maximum, unless HRWR admixtures are used.
 - c. Cement: Type II conforming to ASTM C 150.
 - d. Mixing Water: Conforming to ACI 318.
 - e. Admixtures: Comply with requirements of ACI 301.
 - f. Admixtures containing chlorides, fluorides, or sulfides are not permitted.
 - 2. Perform compression tests in accordance with ACI 301.
 - 3. Non-prestress reinforcement shall conform to requirements of ACI 318 or ASTM A 615, Grade 60.

2.03 POST TENSIONED TENDONS

- A. Post-tensioned tank walls and floors shall be designed in accordance with ACI 318, and the Post-Tensioning Institute except when supplemented or modified by provisions of this specification.
- B. Post-tensioning shall be as follows:
 - 1. Horizontal prestress reinforcement shall use a bonded or un-bonded seven wire tendon system.
 - 2. Vertical wall tendons, floor tendons, and roof tendons shall be either bonded or unbonded, encapsulated seven wire tendons.
 - 3. Tendons shall be seven wire, stress relieved low relaxation strand conforming to ASTM-416-A "Specifications for uncoated seven-wire stress relieved low relaxation strand for prestressed Concrete". Mill test reports for each pack of strand shall be furnished to the Engineer upon request.
 - 4. Corrosion Protection of Bonded Tendons:
 - a. Plastic ducts for horizontal circumferential tendons should be either corrugated or smooth, minimum 40 mil thickness. The horizontal ducts should be made continuous in the vertical joint between wall panels. Plastic ducts should be chemical inert.
 - b. Tendons are grouted in the ducts with Portland cement grout, in accordance with Chapter 18 of ACI 318.
 - 5. Corrosion Protection of Unbonded Tendons:
 - a. Corrosion protection of unbonded tendons shall consist of two layers with one layer of corrosion inhibitor on the steel strand, then a seamless layer of polypropylene. Polypropylene shall be hot melt extruded over the corrosion inhibitor with a thickness averaging 0.020-inch with no areas of coating less than 0.018-inch thick. Corrosion inhibitor shall provide a thickness over the bare strand of at least 0.003-inch.
 - b. Unbonded strands shall be in conformance with PTI "Specifications for Unbonded Single Strand Tendons" for a corrosive environment.

2.04 ELASTOMERIC MATERIALS

- A. Bearing Pads: Neoprene containing virgin polymer with physical properties complying with ASTM D2000.
 - 1. Ultimate Tensile Strength: 1,500 psi.
 - 2. Minimum Elongation: 500% (ASTM D 395).
 - 3. Maximum Compressive Set: 50% (ASTM D 395).
 - 4. Hardness: 40 to 50 durometer (ASTM D 2240).
 - 5. The method of securing sponge filler pads shall be the same as for elastomeric pads. All voids shall be caulked with an approved nontoxic sealant that bonds securely to all

surfaces of pad, filler waterstop. Particular attention shall be paid to the filling and sealing of the joint between bearing pad and waterstop.

2.05 APPURTENANCES

- A. Flanges: Provide Cast-In-Place wall flanges and Openings as indicated on the Drawings:
- B. Pipe Supports: Provide pipe supports attached to the tank wall to support pipes as shown on the Drawings. Pipe supports shown on the Drawings are only to indicate which pipe shall be supported from the tank wall and do not reflect the type, quantity or attachment details required. The tank Manufacturer shall be responsible for determining the type, quantity and attachment location of all pipe supports.
- C. Access Manway: A bolted 18" x 24" elliptical galvanized steel access manway shall be provided in the side wall of each above ground tank. The manhole frame shall have a waterstop flange attached with a continuous weld. The manway door shall be hinged to the tank wall and shall include a 40 durometer, full faced neoprene rubber gasket to provide a water tight seal.

PART 3 EXECUTION

3.01 CONCRETE PLACEMENT

- A. Unless specifically authorized in writing, concrete shall not be placed during cold weather when the ambient temperature is below 35 degrees F and rising, or below 40 degrees F and falling, when the concrete is likely to be subjected to freezing temperature before final set has occurred and the concrete strength has reached 500 psi. Most well-proportioned concrete will reach this strength when the temperature has been maintained at 50 degrees F into the second day after placement. The materials shall be heated so that the temperature of the concrete when deposited shall be not less than 50 degrees F, or as otherwise specified in ACI 306, or more than 90 degrees F. If required, all methods and equipment for heating and protecting concrete-in-place shall be subject to approval.
- B. For concrete placed during extremely hot weather, the aggregate shall be cooled by frequent spraying in such a manner as to utilize the cooling effect of evaporation. During such periods, the placement schedule shall be arranged, as approved, in such manner as to provide time for the temperature of the previously placed course to recede. The mixing water shall be the coolest available at the site, insofar as is practicable and shall conform to ACI 305.
- C. Placement of concrete during periods of low humidity shall be avoided when feasible and economically possible, particularly when large surface areas are to be finished. In any event, surfaces exposed to drying wind shall be covered with polyethylene sheets immediately after finishing and shall be water cured continuously from the time the concrete has taken initial set. Curing compounds may be used in conjunction with water curing.
- D. Concrete for each precast panel shall be placed in one continuous operation.
- E. Precast tank supplier shall provide for all penetrations and openings in the tank walls, as indicated on the Drawings, and subject to Engineer's approval.

3.02 ERECTION

- A. The precast panels shall be erected to the correct vertical and circumferential alignment. The edges of adjoining panels shall not vary inwardly or outwardly from one another by more than 3/8 inch (9.5 mm) and shall be placed to the tank radius, within the same tolerance. Tank wall penetrations and openings shall be in proper alignment and location.
- B. The vertical slots between panels shall be filled with cast-in-place concrete, compatible with the details of the joint. The strength of the concrete grout shall be at least equal to that specified for concrete in the wall panels.
- C. The steel reinforcement shall be placed in conformance with ACI 301. The minimum cover over steel and welded wire fabric reinforcement shall be as specified.
- D. Set restraint blocks to the correct radially and tangential position. Mark the center of the joint on each block. Use this to determine edge of panel location on blocks and mark within 1/8 in.

- E. Set braces with red head type inserts into the tank bottom at the correct radial position.
- F. Erect panels on low friction bearing pads, remove the lifting attachments and plumb the panel.
- G. Threading the circumferential tendons should begin after all panels are erected and plumbed. Pointing the strand ends with a grinder and/or use of lubricant between the strand and chases may be necessary if misalignment exists.
- H. Vertical joints must be either formed and air entrained concrete placed in them or the concrete shall be pneumatically applied. Concrete must be without voids. Aggregate segregation must not occur. Test cylinders must be made, cured under job site conditions, and broken to determine when circumferential post-tensioning may proceed.
- I. After post-tensioning is complete and the elongations are checked by the Engineer, the excess strand length may be removed and the anchorage hardware and exposed wire strands shall be completely coated with epoxy or encapsulated in plastic. The anchorage-coupler area shall then be covered with the required concrete cover (as per manufacturer's design) and the void inside the cover shall be grouted solid with concrete grout.
- J. Grouting of tendon ducts should be carried out as promptly as possible after tensioning. The total time the prestressing steel is exposed to other than a controlled environment prior to grouting shall not exceed 10 days, nor 7 days after tensioning, whichever is less, unless special precautions, such as use of a vapor phase corrosive inhibitor, are taken to protect the prestressing steel. The methods or products used shall not jeopardize the effectiveness of the grout as a corrosion inhibitor, nor the bond between the prestressed reinforcement and grout. Vapor phase corrosion inhibitors should be used in strict accordance with the manufacturer's recommendations. Additional restrictions may be appropriate for potentially corrosive environments.
- K. Grouting equipment shall be capable of grouting at a pressure of 200 psi (1.4 MPa). However the tendon ducts should not be over pressurized during injection if blockage exists. Instead the grout should be washed out and the blockage removed. Ducts may be flushed with clean water (not air) prior to grouting to assure there are no blockages.
- L. Horizontal grouted tendons shall have air release valves which will also act as standpipes at intentionally high points and drains at intentionally low points such as when tendons are deflected around penetrations. These vents and drains, and a vent at the opposite end of the tendon from the point of injection, should be closed when a steady stream of pure grout is ejecting. After all vents and drains are closed, the pressure in the duct can be increased to 100 psi (0.7 MPa) and a valve at the injection end closed to lock off the grout under pressure. After grout has set, but not less than 24 h after grouting, cut off any vents or stand pipes and seal.
- M. Grout injections in vertical tendons shall always be from the lowest point in the tendon to avoid entrapping air.
- N. A thixotropic admixture shall be used to prevent bleeding and grout settlement in the horizontal tendons.
- O. All cement grout should pass through a screen with 0.125 in. (3 mm) maximum clear openings prior to being introduced into the grout pump.
- P. When quick setting can occur due to hot weather, the grout should be cooled by acceptable methods such as cooling the mixing water to prevent blockages during pumping operations. When freezing weather conditions prevail during and following the placement of grout, adequate means, such as keeping the wall temperature up by heaters or blankets, shall be provided to protect the grout in the ducts from freezing until the grout attains a minimum strength of 1000 psi (6.9 MPa).
- Q. The seal between the walls and tank bottom is then installed. The concrete must be dry for seal installation. Temperature must be 50 degrees F (min.). After the seal is installed and cured, the tank should be hydrotested.

3.03 WALL TOLERANCES

- A. The maximum out-of-round tolerance for precast concrete panel walls shall be based on the ratio of +/- 1/2 in. per 100 feet diameter circle and the circumference shall be a smooth curve. Tolerance in wall thickness shall be + 1/4 inch concrete wall thickness and shall not be less than specified. All transitions shall be gradual and smooth. Walls shall be plumb within a tolerance not exceeding 3/8 in. per 10 ft. of vertical dimensions.

3.04 ELASTOMERIC BEARING PADS

- A. Where bearing pads are used, the tank wall shall be free of all obstruction that would prevent free movement of the joint. All bearing pads shall be placed at a minimum of 12 inches from panel's vertical edges toward panel center line.

3.05 SPONGE FILLERS

- A. The method of securing sponge filler pads shall be the same as for elastomeric pads. All voids shall be caulked with an approved nontoxic sealant that bonds securely to all surfaces of pad, filler waterstop. Particular attention shall be paid to the filling and sealing of the joint between bearing pad and waterstop.

3.06 TESTING

- A. Upon completion of wall construction of the tank, it shall be filled to overflowing with water furnished by the Owner. The tank shall remain filled for a period of at least 24 hours to allow for absorption. After the initial period, makeup water shall be added as required and the water level recorded and measured at the end of the 48 hour period.
- B. There shall be no flowing water allowed through the tank walls or slab. Damp spots which glisten on the surface of the tank and spots where moisture can be picked up on a dry hand will not be allowed. Maximum allowable liquid-volume loss by measurement shall not have exceeded 1/10th of one percent of the tank capacity per 24 hours. If the loss exceeds this amount, the Engineer shall require the tank to be repaired and retested.

3.07 TANK BACKFILL

- A. When backfill is required, it shall be initiated only after the tank has been satisfactorily tested and filled.

3.08 CLEAN UP

- A. The premises shall be kept clean and orderly at all times during the work, and upon completion of construction, the Contractor shall remove or otherwise dispose of all rubbish and other unsightly material caused by the construction operations. The Contractor shall leave the premises in as good a condition as was found.

END OF SECTION

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SECTION 46 33 42
DIAPHRAGM-TYPE CHEMICAL FEED PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test complete and ready for operation, two (2) positive displacement, diaphragm pumps with integral dosing adjustment and required accessories as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 01 10 00 - Summary:
- B. Section 01 60 00 - Product Requirements
- C. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION

- A. The pumps specified herein are intended to be standard equipment designed for metering the chemical specified in this Section.
- B. Carbon Source Solution Feed Pumps (Anoxic Reactor #3):
 - 1. Two (2) pumps shall be provided for the dosing of non-flammable carbon source solution (Polysweet, Micro C, Sugar Water) to the locations indicated on the Drawings.
 - 2. Each pump shall be capable of delivering from 1.5 - 15 gallons per hour @ 60 psi.
 - 3. The pumps shall be suitable for pumping carbon source solution indicated.
 - a. Viscosity: 220 centipose
 - b. Density: 11.2 lbs/ gallon
 - 4. Pumps shall be supplied with the valves and accessories as identified in Accessories Type A - Dual Metering Pumps Dosage Package .

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data shall include at least the following:
 - 1. Certified shop and erection drawings showing all important details of construction and dimensions.
 - 2. Descriptive literature, bulletins, and/or catalogs of the equipment.
 - 3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2 inch x 11-inch sheets.
 - 4. The total weight of the equipment including weight of the single largest item.
 - 5. A complete total bill of materials for all equipment.
 - 6. A list of manufacturer's recommended spare parts.
 - 7. Complete data on motors.
 - 8. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).
- C. The manufacturer shall clearly identify any exception to this Section, related sections, or the Drawings. Failure to do this shall be grounds for rejection of the submittal.

- D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
 - 1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

1.05 QUALITY ASSURANCE

- A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
- B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01600.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ProMinent Fluid Controls, Inc.
- B. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL DESCRIPTION

- A. The chemical metering pumps shall be motor-driven, reciprocating, mechanically-actuated diaphragm type. All pumping functions shall be set by membrane-switch keypad and status shall be displayed on an illuminated LCD which is readable. Keypad will allow for simple scrolling and display of programmed parameters. The housing shall be rated NEMA 4X.
- B. The power supply shall be 115VAC,60Hz, single phase.
- C. The liquid end shall be physically separated from the drive unit by a backplate with weep hole creating an air gap. The diaphragm shall be constructed of a steel core, vulcanized into nylon-reinforced EPDM, with PTFE-faced fluid contact surface.
- D. Each pump shall include integral motor, oil-lubricated gear reducer and cam-and-spring drive mounted in an aluminum housing, such housing to be sealed into an outer plastic housing for corrosion protection with heat sink fins for cooling.

2.03 LIQUID END

- A. The liquid end shall be constructed of PVDF with Teflon seals, with built-in coarse valve and needle valve for air bleed, manually adjusted for continuous degassing of process fluid and self-priming against pressure. The suction and discharge valves shall be of the double ball check design for discharge pressures greater than 100 psi.

2.04 PROGRAMMING AND CONTROL

- A. Stroke length control shall be manually adjusted between 0% and 100% with a stroke adjustment knob on the pump face control. The LCD shall digitally display stroke length setting in 1% increments in the full range between 0% and 100%

- B. Programming shall allow pump to be calibrated so as to display pump output in gallons/hour or liters/hour. Calibration shall be maintained when stroke length is altered up to plus or minus 10% on the stroke length knob. If stroke length is altered by more than 10%, a yellow warning will light and a flashing message "calib" will appear.
- C. The pump shall be equipped with the programmable function of electronic interlocking of the keypad by access code to prevent unauthorized adjustments to the pump.
- D. Keypad shall allow for scrolling and display on LCD such parameters as stroke frequency, stroke length, stroke counter, pump output in gals/hr or l/hr, dosing quantity, mA current input being received by pump, and indication of external mode.
- E. Stroke frequency control shall be manually adjusted by touch keypads, with the set stroke rate displayed on the LCD. The metering pump shall be capable of receiving a pulse input via optional external control cable such that 1 pulse gives 1 pump stroke rate. The pump shall be capable of remote ON-OFF operation using the pause function via a voltage free contact relay through an optional control cable.
- F. ANALOG- The pump shall accept an analog signal such that stroke frequency is proportional to 0/4-20mA or 20-4/0mA, the choice of which is programmable at the pump. The pump shall allow the setting of a maximum stroke rate which corresponds to the maximum analog signal, with stroke rate proportional to signal strength below that rate. Programming for curve processing shall also be possible, in which any stroke frequency ratio in proportion to the electrical signal can be configured. Analog to digital converters external to the pump shall not be allowed.

2.05 FLOW ASSURANCE

- A. Flow Monitor - A flow monitor shall be installed on the discharge line to automatically stop pumping and annunciate a fault condition on the pump LCD display upon loss of discharge flow. The pump shall be programmable, between 1 and 125 strokes per minute, to actuate the fault annunciation after flow is lost.
- B. Relay Output - An SPDT relay shall be installed for fault condition (i.e. low chemical supply in tank/lack of chemical supply shut down, flow monitor, system faults, and fuse/power supply failure). Configure as NO contact closure relay.
- C. Diaphragm Failure - A diaphragm failure detector will alert the possibility of a ruptured or distressed diaphragm.

2.06 ACCESSORIES TYPE A - DUAL METERING PUMP DOSING SKID PACKAGES

- A. The pumps shall be mounted on a polypropylene/304 stainless support stand suitable for floor mounting. A single chemical metering pump manufacturer shall be responsible for supplying and assembling all components of the skid, in addition to testing the skid-mounted metering system prior to shipment. The stand shall include the following accessories, pre-piped:
 - 1. A foot valve and strainer, constructed of materials compatible with chemical to be used, shall be provided with each pump.
 - 2. An injection valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
 - 3. A universal control cable with 5-pole round plastic connector and 5-wire cable with loose ends shall be provided with each pump.
 - 4. A two stage float switch compatible with chemical to be used shall be provided to monitor tank level.
 - 5. A diaphragm failure detector shall be provided to close a contact for alarm in the event of a diaphragm failure.
 - 6. An adjustable-pressure, diaphragm-type back pressure/anti-siphon valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
 - 7. An in-line, adjustable-pressure, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
 - 8. A pressure gauge with isolator constructed of materials compatible with chemical to be used, shall be provided for each pump.

9. An air-charged, bladder type pulsation dampener constructed of materials compatible with chemical to be used, shall be provided for each pump on the discharge side.
10. A clear PVC 500 mL calibration column with FNPT fitting on top and bottom shall be provided with each pump package. The column shall be sized to provide at least 2 minutes draw down at maximum pump capacity.
11. Fifteen feet of tubing compatible with chemical to be used shall be provided with each pump.

2.07 ACCESSORIES TYPE B - MULTIPLE PUMP DOSING PACKAGE

- A. The pumps and accessories shall be provided by the manufacturer for contractor installation as indicated on the Drawings. A single chemical metering pump manufacturer shall be responsible for supplying and assembling all components. The package shall include the following accessories:
 1. A foot valve and strainer, constructed of materials compatible with chemical to be used, shall be provided with each pump.
 2. An injection valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
 3. A universal control cable with 5-pole round plastic connector and 5-wire cable with loose ends shall be provided with each pump.
 4. An adjustable discharge flow monitoring device, compatible with chemical to be used, shall be provided with each pump. The flow monitor shall be capable of signaling a fault condition to the pump.
 5. A diaphragm failure detector shall be provided to close a contact for alarm in the event of a diaphragm failure.
 6. An adjustable-pressure, diaphragm-type back pressure/anti-siphon valve, constructed of materials compatible with chemical to be used, shall be provided with each pump package.
 7. An in-line, adjustable-pressure, diaphragm-type pressure relief valve, constructed of materials compatible with chemical to be used, shall be provided with each pump.
 8. A pressure gauge with isolator constructed of materials compatible with chemical to be used, shall be provided for each pump.
 9. An air-charged, bladder type pulsation dampener constructed of materials compatible with chemical to be used, shall be provided for each pump on the discharge side.
 10. A clear PVC 500 mL calibration column with FNPT fitting on top and bottom shall be provided with each pump package. The column shall be sized to provide at least 2 minutes draw down at maximum pump capacity.
 11. Fifteen feet of tubing compatible with chemical to be used shall be provided with each pump.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.02 FIELD QUALITY CONTROL

- A. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water and auxiliary equipment required to complete the field tests.
- B. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified.

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Harbeson, DE
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- C. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

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SECTION 46 51 17
JET AERATION AND MIXING EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test complete and ready for operation the Jet Aeration and Mixing Equipment as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 01 10 00 - Summary: Work by Owner.
- B. Section 01 60 00 - Product Requirements: Owner Supplied Products.
- C. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION

- A. The Jet Aeration and Mixing Equipment shall be supplied by a single manufacturer for all equipment described in this Section and installed by the Contractor in accordance with the manufacturer's instructions.
- B. The Jet Aeration and Mixing System for each basin shall consist of a liquid jet manifold and air manifold complete with necessary supports and hardware, jet recirculation pump, and positive displacement, rotary lobe type blowers as shown on the Drawings and specified herein.

1.04 DESIGN REQUIREMENTS

- A. Anoxic Reactor No. 3:
 - 1. Nominal Basin Diameter: 66 feet
 - 2. High Water Level (Emergency) 27 feet
 - 3. High Water Level (Normal): 24 feet
 - 4. Site Altitude: < 35 feet Above Sea Level
 - 5. Design Conditions:
 - a. Maintain completely mixed conditions with no air supply blowers in operation.
 - b. MLSS Concentration: 4,000 - 6,000 mg/L
 - c. The jet mixing system will operate primarily to provide mixing energy without aeration in Anoxic Reactor No. 3. The Jet mixing system shall be capable of providing aeration with air supplied by the spare blower provided for Nitrification Reactor No. 2B.
 - d. AOTR @ 24 ft. SWD and D.O. = 2.0 mg/L 225 pounds/hour
 - 1) Airflow: 1200 scfm

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit product data, including Manufacturer's data, for specified products.
 - 1. System Description: Include the following:
 - a. Manufacturer's data, order sheet, or equivalent for each major piece of equipment, component, instrument or device being supplied.
 - b. Manufacturer's outline and mounting dimensions for all field mounted components, including, but not limited to, drives, motors, pumps, liquid jet headers, air headers, instrumentation and controls.
 - c. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

- d. Manufacturer's Dimensions and Field Fabrication Details for all mechanical equipment.
 - e. Mounting Details.
 - f. The Manufacturer shall clearly identify any exception to the specification or drawings. Failure to do this shall be grounds for rejection of the submittal.
 - g. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.
- C. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
- 1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

1.06 QUALITY ASSURANCE

- A. The equipment covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as supplied by a single manufacturer, having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and as specified herein.
- B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accomodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.
- C. The rated horsepower of the drive units shall be such that the units will not be overloaded nor the service factor reduced when the unit is operated at any point on the curve. If, due to the slope of the performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the drive unit will be considered for approval only if any and all changes in electrical work, etc. required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. The Manufacturer shall warrant all provided components for a period of twelve (12) months from date of Substantial Completion.

1.09 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Provide one spare rotating element and associated appurtenances for 40 HP Jet Recirculation Pump.
- C. Provide fifteen gallons of motor oil as recommended by the manufacturer for both the jet pumps and the blowers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. KLa Systems, Inc. - Assonet, MA
- B. Mixing Systems, Inc. - Dayton, OH
- C. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS FOR JET RECIRCULATION PUMPS

- A. General:
1. Stainless steel nameplates giving the name of manufacturer, the rated capacity, head, speed, and other pertinent data shall be attached to each pump.
 2. The manufacturer shall supply complete factory mounted equipment.
 3. All electrical materials and equipment shall be UL listed or Factory Mutual approved and NEMA rated, and shall otherwise be equal to that specified under Division 16, where applicable.
 4. Control panels shall be factory wired, such that field wiring connections shall require connection of power and control wiring to the control panel and to the pumps and alarm wiring to the control panel and the pump failure alarm light. Field wiring connections shall be to numbered terminal strips.
 5. The entire control system shall be factory tested prior to shipment.
- B. Casing:
1. The casing shall be of ASTM A 48 cast iron construction and shall be end suction with top centerline, self-venting discharge and 150# ANSI flanges.
 2. The casing shall be of a back-pull-out design to allow complete disassembly without disturbing the piping or driver.
 3. The casing shall be supported by rigid integral cast feet for maximum resistance and distribution of unanticipated loads.
 4. The casing shall be radially split and rabbetted to the stuffing box cover and adapter to assure proper alignment.
 5. The shall be sealed by use of a confined gasket between the casing and cover.
- C. Impeller:
1. The impeller shall be of ASTM A 890 Grade 3A duplex stainless steel and be of open design, statically and dynamically balanced to ISO 1940 G6.3.
 2. The impeller shall be mounted to the shaft by means of an integral spiral cut shaft key allowing the assembly and disassembly by turning no more than 540 degrees rotation.
 3. The impeller shall be locked in place with an impeller bolt with integral locking washer.
 4. The impeller shall be specifically designed to handle liquids containing up to 70% air entrainment.
- D. Side Plate:
1. A wear plate of ASTM A 890 Grade 3A duplex stainless steel shall be standard with open impellers.
 2. The wear plate shall protect the casing against wear and shall be used to set the impeller clearance and maintain pump efficiency at the highest levels.
- E. Shaft:
1. The shaft shall be of heavy-duty SS 2324 duplex stainless steel with a minimal overhang to the centerline of impeller.
 2. The maximum shaft deflection shall be less than 0.002" at the face of the seal box.
 3. The shaft and sleeve shall be sealed from the pumped liquid by use of impeller and sleeve o-rings.
- F. Dynamic Seal:
1. The dynamic seal assembly shall be of ASTM A 890 Grade 3A duplex stainless steel and must include flow interrupters to prevent solids and fibrous material build-up.
 2. The static seal should not contact the shaft during operation and automatically close when the pump is not in operation.
- G. Adapter:
1. The adapter shall be rabbet fitted to the bearing unit, back cover and casing to provide exact alignment of the rotating components.
- H. Bearing Unit:

1. The bearing unit shall be sealed by use of non-contacting labyrinth isolators to protect the bearings and lubricating oil from external contamination.
 2. A bullseye sight glass shall be provided to monitor the oil level.
 3. The bearing housing shall be drilled on both sides to allow installation of an optional oiler.
 4. The bearings shall be shoulder mounted to the shaft and fixed in the bearing housing to eliminate any axial shaft movement.
 5. Each bearing housing shall be drilled to accept optional temperature and vibration probes for use in predictive maintenance.
- I. Bearings:
1. The radial bearing (inboard) is to be a cylindrical roller design with a minimum L-10 life of 100,000 hours.
 2. The axial (thrust) bearing shall consist of two 40 degree angular contact bearings mounted back-to-back to provide a minimum L-10 life of 100,000 hours.
- J. Lubrication:
1. Bearing lubrication shall be an oil bath.

2.03 COMPONENTS

- A. Anoxic Reactor #3
1. Jet Aerator and Distribution Piping:
 - a. The jet aerator shall be comprised of an integrally fabricated air and liquid header equipped with a minimum of ten (10) air/liquid jet nozzles. The jets shall be directional-type, transferring the jet momentum into the bulk fluid creating a horizontal velocity in a direction as indicated on the Drawings. Jet nozzles shall be equally spaced along the length of the header to promote a directional mixing pattern, as indicated on the Drawings. Jet motive liquid shall enter the liquid header through an 16-inch flanged connection and compressed air shall enter the air header through an 8-inch flanged connection. The liquid header and jets shall be located at an approximately 18-inch centerline from the basin floor. The jet aerator shall provide uniform distribution of the liquid and air to each jet nozzle. The jet motive liquid and compressed air shall combine in the outer jet nozzle, discharging as a high energy, fine bubble cloud in the lower regions of the basin.
 - b. The liquid header shall be a cylindrical member that shall be internally smooth and free from protrusions that might create additional head loss or collect inert material. The nozzles shall be aligned on a common horizontal plane.
 - c. The air header shall be a cylindrical member located above and parallel to the liquid header. The air header shall be attached to and supported above the liquid header by an air duct at each jet location. Additional supports shall be provided as necessary.
 - d. The liquid header, air header and piping shall be fabricated of corrosion resistant, structurally sound, filament wound, fiberglass reinforced thermosetting resin pipe conforming to ASTM/ANSI D-2966 (2000).
 - e. The air duct for each jet nozzle shall be fabricated from structurally sound fiberglass reinforced plastic and shall be molded to the air and liquid headers in conformance with NBS PS 15-69. Pipe fittings, and air feeds shall be fabricated utilizing vinyl ester resin.
 - f. All air and liquid distribution piping within the basin shall be provided as part of the jet system. The air distribution pipe shall be 12-inch diameter and connect to the contractor-supplied out-of-basin piping located one foot above the maximum liquid level indicated on the Drawings. The air distribution pipe shall reduce to 4-inch diameter at the branch of the distribution header.
 - g. The liquid suction piping shall be 16-inch diameter and connect to the contractor-supplied out-of-basin pipe located at the tank wall penetration flange. The liquid suction piping shall include a 16-inch diameter, 90 degree elbow and a 16-inch suction bell.

- h. The liquid discharge pipe shall be 16-inch diameter and connect to the contractor-supplied out-of-basin pipe located at the tank wall penetration flange. The liquid discharge piping shall include 16-inch diameter, double 90 degree elbows on the discharge header.
 - i. The fiberglass reinforced polyester (FRP) pipe shall be fabricated from Derekane 411 or equal vinyl ester resin.
 - j. The pipe will incorporate a resin-rich liner on both the inside and outside that consists of a "C" glass veil and resin, to a 10-20 mil nominal thickness, with a minimum amount of wax in the surface resin to allow the pipe to cure.
 - k. The pipe will be rated for 75 psig service with a structural wall of continuous glass fibers wound at 54.75 degree helical angle in a matrix of vinyl ester resin.
 - l. The manufacturer shall furnish appropriately sized 150-lb. drilling flanges at supplier/contractor interfaces.
 - m. All piping is to be machine filament wound. The resin shall remain natural in color (No Pigment Allowed).
 - n. The pipe wall thicknesses shall be as follows:
 - 1) 4-inch pipe = 0.15 inch wall thickness
 - 2) 12-inch pipe = 0.21 inch wall thickness
 - 3) 14-inch pipe = 0.21 inch wall thickness
 - 4) 18-inch pipe = 0.24 inch wall thickness
 - 5) 20-inch pipe = 0.26 inch wall thickness
 - o. All distribution piping and manifold sections shall be field connected by FRP field wrap joints.
 - p. Field wrap kits shall be furnished with all necessary materials and instructions.
2. Jet Nozzle:
- a. Each jet aeration nozzle shall consist of an inner liquid nozzle and outer air/liquid discharge nozzle fabricated from FRP using vinyl ester resin in accordance with NBS PS 15-69, and shall be lined with a combined, integral C-glass, nexus, silicon carbide veil for added corrosion and abrasion resistance.
 - b. The jets shall be molded and assembled to be concentric with the inner liquid and outer air/liquid discharge nozzle in axial alignment.
 - c. The air/liquid discharge nozzles shall be of a constantly decreasing cross-sectional area so as to increase the velocity of the air/liquid mixture discharging from the liquid nozzle and air duct.
 - d. The outlets of both the inner and outer nozzles shall be circular and shall be capable of passing a 2.2-inch solid and be free from all protrusions, which may increase headloss or collect inert material.
 - e. The nozzles shall be fabricated from Derekane 470 or equal vinyl ester resin.
3. Supports:
- a. All necessary supports for the aeration manifold, and in-basin air and liquid piping shall be provided.
 - b. Supports shall be spaced on approximately 10-ft. centers.
 - c. All liquid header supports shall be 'Single Leg Type' equipped with one (1) 3-inch diameter, schedule 40 leg welded to a supporting base.
 - d. The support base shall be anchored with four (4) anchor bolts.
 - e. A contoured saddle shall hold the piping and attach to a contoured clamp with four (4) full thread cap screws with lock washers.
 - f. Air down-comer supports shall consist of a contoured saddle and one (1) 2-inch diameter, Schedule 40 leg assembly welded to a supporting base.
 - g. The support base shall be anchored with four (4) anchor bolts.
 - h. A contoured saddle shall hold the piping and attach to a contoured clamp with four (4) full thread cap screws with lock washers.
 - i. The saddles and clamps shall be furnished with EPDM pads to prevent abrasion.
 - j. Supports and clamps shall be 304L stainless steel.

- k. Connection hardware shall be 18-8 stainless steel.
- l. Anchor bolts shall be furnished and be 304L stainless steel.
- 4. Jet Recirculation Pump:
 - a. Liquid recirculation shall be provided by one (1) 40 HP horizontal, end suction centrifugal pump. The pump shall be sized to deliver a minimum of 4,400 gpm at 23 ft. total dynamic head, and be furnished with the following accessories:
 - 1) Fabricated steel base plate for pump and motor with an overhead z-belt drive.
 - 2) Painting of pump, motor, base plate and guard shall be in accordance with the Pump Manufacturer's Specifications and Section 09 90 00.
 - 3) 40 HP TEFC motor, rated for 460 Volt, 60 Hz, 3-Phase Power.
 - 4) Belts and Belt Guard.

2.04 FABRICATION

- A. The jet nozzles, air ducts, flanges, elbows, and other fittings shall be attached to the air and liquid headers and connection piping (as required) using hand lay up fabrication methods in accordance with NBS PS 15-69 and ASTM C 582 (1995).
- B. All sharp edges, cuts and burrs are to be sanded and resin coated to seal exposed edges.
- C. All flange connections are to straddle the vertical and horizontal centerlines of the equipment in the installed position.
- D. Whenever possible, flanges and fittings to pipe joints are to be hand-layed-up and resin coated internally so there are no internal seams.
- E. All external areas of the fiberglass equipment are to be resin coated after completion of all assembly and hand-lay-up procedures.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's instructions and recommendations.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01400.
- B. After Contractor and Engineer have mutually agreed that the equipment installation is complete and ready for continuous operation, Contractor and a qualified field service representative of the manufacturer shall conduct an operating test of the equipment and the controls in the presence of Engineer to demonstrate that the Jet Aeration and Mixing Systems and their controls will function correctly to the satisfaction of the Owner and Engineer.

3.03 MANUFACTURER'S FIELD SERVICES

- A. The services of a factory trained representative of the manufacturer shall be provided to inspect the installation of the equipment, make any necessary adjustments (before initial start-up), place it in initial trouble-free operation, and instruct the operating personnel in its operation and maintenance.
- B. The factory trained representative shall be provided for four (4) trips and a total of eight (8) days on-site for:
 - 1. Installation inspection of jet headers, pumps and blowers.
 - 2. Start-up and operating instructions for the in-basin equipment.
 - 3. Start-up of pumps, blowers, and D.O. Control System.
 - 4. Operations and Maintenance Training for Owner's Personnel.

END OF SECTION

**SECTION 46 51 21
 FIXED AERATION HEADER DIFFUSER SYSTEM**

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test complete and ready for operation the coarse bubble diffuser systems in FEB #1 and FEB #2 including piping and appurtenances as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 01 10 00 - Summary: Work by Owner.
- B. Section 01 60 00 - Owner Supplied Products.
- C. Section 43 11 33 - Rotary Lobe Positive Displacement Blowers
- D. Section 43 41 23 - Bolted Stainless Steel Storage Tank
- E. Section 03 48 10 - Precast Post Tensioned Concrete Tanks

1.03 DESIGN REQUIREMENTS

- A. Air shall be conveyed from the blowers to the diffuser equipment through an air distribution piping network comprising the aeration and mixing system.
- B. The diffused aeration equipment shall diffuse the air uniformly into the tank or basin in which it is installed.
- C. Nitrification Reactor No. 2B:
 - 1. Nominal Basin Diameter: 60 feet
 - 2. Emergency Side Water Depth: 27 feet
 - 3. Operational Side Water Depth: 26 feet
 - 4. Site Altitude: <35 feet Above Sea Level
 - 5. Design Conditions:
 - a. Maintain completely mixed conditions at minimum scfm = 1,000 and at 26 foot liquid depth.
 - b. TSS Concentration: < 3,000 mg/L
 - c. Dissolved Oxygen Concentration: 2.0 mg/L
 - d. AOTR Design Conditions

Design Condition	AOR (lbs/hr)	Air Flow (scfm)	Liquid Depth (feet)	DO (mg/l)
Design Condition #1	125	1,000	26	2.0
Design Condition #2	250	2,000	26	2.0
Design Condition #3	600	4,400	26	2.0

- e. Minimum Airflow: 1000 scfm
- f. Maximum Airflow: 4,400 scfm
- g. Alpha: 0.85
- h. Beta: 0.95
- i. Water Temperature: 20 degrees C
- 6. Minimum Number of Diffusers: 88

- 7. Minimum Drop Leg Size: 16"
- D. Aerobic Reactor No. 4:
 - 1. Nominal Basin Diameter: 31 feet
 - 2. Maximum Side Water Depth: 23 feet
 - 3. Site Altitude: <35 feet Above Sea Level
 - 4. Design Conditions:
 - a. Maintain completely mixed conditions at minimum scfm = 250 and at 23 foot liquid depth.
 - b. TSS Concentration: < 3,000 mg/L
 - c. Dissolved Oxygen Concentration: 2.0 mg/L
 - d. AOTR Design Conditions

Design Condition	AOR (lbs/hr)	Air Flow (scfm)	Liquid Depth (feet)	DO (mg/l)
Design Condition #1	35	400	23	2.0
Design Condition #2	-	-	-	-
Design Condition #3	-	-	-	-

- e. Minimum Airflow: 250 scfm
- f. Maximum Airflow: 600 scfm
- g. Alpha: 0.85
- h. Beta: 0.95
- i. Water Temperature: 20 degrees C
- 5. Diffuser Length: 14 inches
- 6. Minimum Drop Leg Size: 8"

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Submittal drawings showing plan, elevation and cross sections of the equipment.
- C. Component details of the aeration equipment showing diffusers, diffuser connectors, supports, expansion joints and flanges
- D. Materials and manufacturing specifications.
- E. Equipment booklet to include:
 - 1. Equipment data sheets
 - 2. Performance data including oxygen transfer calculations.
 - 3. Head loss calculation and pressure requirements.
 - 4. Descriptive literature and bulletins.
 - 5. Customer contact list with telephone numbers (minimum of 10 contacts from similar size facilities).
- F. Operation and maintenance manual with installation instructions. Submit after approval of equipment and prior to shipment.
- G. Detailed list of any or exceptions taken to these specifications. Include specification reference and proposed alternative with reason stated for exception.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. In accordance with Section 01 60 00.

1.06 WARRANTY

- A. Provide a manufacturer's written one-year full warranty from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aquarius Technologies, Inc.
- B. Sanitaire Division of ITT Industries
- C. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DROP-LEGS AND AIR DISTRIBUTION HEADER SYSTEM

- A. Drop-leg shall start at flange connection on air supply header and extend down to two to four feet above air distribution header system.
- B. Air distribution header system shall convey air from drop-leg to coarse bubble diffuser inlet connections.
- C. Air distribution pipe shall be fabricated in sections up to 30 feet in length. Air distribution pipe sections shall be joined with fixed joints, expansion joints, or combination of fixed joints and expansion joints.
- D. Air distribution header sections shall be shop fabricated with provisions for mounting diffusers.
- E. Bottom elevation of air distribution header shall be same throughout each air distribution header system. Provide eccentric reducers at changes in diameter, for both runs and branches. Orient eccentric reducers so that flow line elevation does not change and crown of pipe elevation changes.
- F. Provide removable cap, plug, or flange at dead end of each air distribution header.

2.03 DROP LEG AND AIR DISTRIBUTION SYSTEM MATERIALS

- A. Drop-legs and air distribution system shall be fabricated of stainless steel pipe, fittings and flanges and shall meet the following requirements:
 - 1. Stainless Steel Pipe, 4" through 36"
 - a. Material for Stainless Steel Pipe, 4" through 36": AISI 304L Stainless steel.
 - b. Pipe Standards for Stainless Steel Pipe, 4" through 36": ASTM A312 or ASTM A778.
 - c. Dimension Standard for Stainless Steel Pipe, 4" through 36": ANSI/ASME B36.19M, 12 gage thickness.
 - 2. Stainless Steel Pipe, 3" or smaller
 - a. Material for Stainless Steel Pipe, 3" and smaller: AISI 316L stainless steel.
 - b. Pipe Standard for Stainless Steel Pipe, 3" and smaller: ASTM A312.
 - c. Dimension Standard for Stainless Steel Pipe, 3" and smaller: ANSI/ASME B36.19M, Schedule 40S.
 - 3. Stainless Steel Fittings 4" through 36"
 - a. Material for Stainless Steel Fittings, 4" through 36": AISI 304L stainless steel.
 - b. Material Standard for Steel Fittings, 4" through 36"
 - 1) Fittings for ASTM A312 Pipe: ASTM A403
 - 2) Fittings for ASTM A778 Pipe: ASTM A774
 - c. Dimension Standards for Stainless Steel Fittings, 4" through 36"
 - 1) Fitting Wall Thickness: ANSI/ASME B36.19M, 5 gage.
 - 2) Fitting Dimensions: ANSI B16.9
 - 4. Stainless Steel Fittings, 3" and smaller
 - a. Material for Stainless Steel Fittings, 3" and smaller: ASTM 316L stainless steel.
 - b. Fitting Standard for Stainless Steel Fittings, 3" and smaller
 - 1) Forged/Wrought Stainless Steel Fittings: ASTM A182, Grade 316L
 - 2) Cast Stainless Steel Fittings: ASTM A351, Grade CF 8M.
 - c. Dimension Standard for Stainless Steel Fittings, 3" and smaller: ANSI B316.3, Class 150
 - d. Stainless Steel Pipe and Fitting Joints

- e. Stainless Steel Pipe and Fittings, 4" through 36": Flange, welded, or clamp type coupling.
- f. Stainless Steel Pipe and Fittings, 3" and smaller: Threaded or Flange.
- 5. Flanges for Stainless Steel Pipe and Fittings
 - a. Stainless Steel Flange Material
 - 1) Flanges for 4" through 36" Stainless Steel Pipe and fittings: AISI 304L stainless steel.
 - 2) Flanges for 3" and smaller Stainless Steel Pipe and Fittings: AISI 316L stainless steel.
 - b. Stainless Steel Flange Standard: ASTM A182.
 - c. Stainless Steel Flange Dimension Standard: ANSI B16.5, Class 150.
 - d. Stainless Steel Flange Type
 - 1) Flanges for Stainless Steel Pipe, 4" through 36": Welding neck, lap joint, or slip-on.
 - 2) Flanges for Stainless Steel Fittings, 4" through 36": Welding Neck.
 - 3) Flanges for Stainless Steel Pipe and fittings, 3" and smaller: Threaded.
 - e. Flange Face Type: 1/16" raised face.
- 6. Stainless Steel Flange Joint Accessories
 - a. Stainless Steel Flange Joint Gaskets
 - 1) Gasket Type: ring.
 - 2) Gasket Thickness: 1/8"
 - 3) Gasket Material: Ethylene-Propylene diene terpolymer (EPDM) rubber.
 - b. Bolts, Studs, and Nuts for Stainless Steel Flange Joints
 - 1) Bolt, Stud, and Nut Material: AISI Type 316 or Type 316N stainless steel.
 - 2) Bolt and Stud Standard: ASTM A193, Grade B8M, B8MN, or B8MLN.
 - 3) Nut Standard: ASTM A194, Grade 8M, B8MN, or M8MLN.
 - 4) Bolt, Stud and Nut Threads: UNC threads.
 - 5) Stud Length: Studs shall extend through nuts a minimum of 1/4".
- B. Provide expansion couplings in air distribution header systems between fixed supports. Expansion couplings shall allow air distribution header system pipe to move longitudinally so that pipe and support system are not stressed or deflected. Expansion coupling shall allow free movement of pipe end over temperature range of 125°F. Expansion couplings shall be AISI Type 304L Stainless Steel with EPDM gaskets.
- C. Each unused diffuser tap shall be plugged with hex head stainless steel threaded plug.
- D. Fabrication of stainless steel drop-legs and air distribution header system shall be as specified in this Section.

2.04 DIFFUSER CONNECTIONS

- A. Each diffuser connection shall be special cast tee. Each diffuser connection shall be designed to connect two diffusers to air distribution header pipe.
- B. Diffuser connections shall be stainless steel casting and shall meet the following requirements:
 - 1. Stainless Steel Diffuser Connection Material: AISI 316L stainless steel.
 - 2. Standard for Stainless Steel Diffuser Connections
 - a. ASTM A 182, Grade 316L;
 - b. Or ASTM A743, Grade CF3
- C. Diffuser connection tee branch shall be factory welded to bottom centerline of air distribution header pipe. All diffuser connections in each air diffusion system shall be on common horizontal plane. Diffuser connection tee branch shall be of sufficient length that air exits diffusers below flow line of air diffusion header pipe.

- D. Diffuser connection, including cast tee and connection to air diffusion header, shall withstand a moment of 1,000 inch-pounds applied at diffuser connection without any permanent deformation of diffuser connection or air diffusion header. Diffuser connection shall be reinforced with, gussets, plates, or a combination of gussets or plates as required to meet the requirements specified in this Section.
- E. Each diffuser connection shall have air passage from air diffusion header pipe to diffusers. Air shall pass from air diffusion header pipe into diffuser connection through neat, clean hole in bottom of all diffusion header pipe. Hole in bottom of air diffusion header pipe shall be centered over axis of diffuser connection tee branch. Diameter of hole in bottom of air diffusion header pipe shall be same inside diameter connection inlet.
- F. Diffusers shall connection to diffuser connection tee run ends. Run ends of diffuser connection tee shall have ¾" NPT female threads.

2.05 COARSE BUBBLE DIFFUSERS

- A. Diffusers shall be non-clogging coarse bubble diffusers with no flexing or moving parts. Each diffuser shall consist of inlet connection, inlet air control device, inverted air reservoir, and graduated air exit ports.
- B. Diffuser body shall be formed to provide air reservoir in top of diffuser body for full length of diffuser body. Graduated air exit ports shall be distributed along sided of diffuser body for full length of diffuser body. Free air discharge slots, or opening, shall be provided in lower part, or bottom, of diffuser body for full length of diffuser body. Lower part of diffuser body shall be designed to direct liquid being aerated along exterior of diffuser body walls. Air existing diffuser shall through air exit ports be sheared into relatively small bubbles and distributed into liquid being aerated. Diffuser body shall be formed of AISI Type 304L Stainless Steel plate, 20 gauge minimum. Nominal length of diffuser body shall be 12" or 24".
- C. Diffuser ends shall be Stainless Steel castings.
 - 1. Diffuser end castings shall meet the following requirements:
 - a. Stainless Steel Diffuser Connection Material: AISI 304L Stainless Steel.
 - b. Standard for Stainless Steel Diffuser Connections: ASTM A743, Grade CF3.
 - 2. Diffuser inlet end cap shall have diffuser inlet connection and air control device. Diffuser cap opposite diffuser inlet shall be plane with no openings.
 - 3. Diffuser end caps shall support ends of diffuser body. Diffuser end caps shall be welded to diffuser body.
 - 4. Diffuser inlet end cap shall have ¾" nipple with NPT mail threads. Diffuser end cap nipple dimensions shall meet the requirements of ANSI/ASME B36.19M, Schedule 80S. Diffuser inlet shall screw into diffuser connection tee. Diffuser inlet end connection shall have integral square or hexagon nut for installation and removal of diffuser.
 - 5. Provide air inlet control device in each diffuser inlet end cap. Air control device shall be orifice or nozzle. Air inlet control orifice, or nozzle, shall limit air flow to diffusers so that uniformity of air flow to diffusers is between 0.95 and 1.05.

2.06 AIR DISTRIBUTION HEADER SYSTEM AND DIFFUSER SUPPORT SYSTEM

- A. General
 - 1. Air distribution header system and diffuser support systems shall support air distribution header system and diffusers when tanks are empty and when air distribution header system and diffusers are submerged at any depth to maximum depth of water in tanks. Air distribution header system and diffuser support systems shall prevent air distribution header system and diffusers form floating when air distribution header system and diffusers are submerged at any depth to maximum depth of water in the tank. Air distribution header system and diffuser support systems shall not loosen when air diffusion system is operated continuously or intermittently for minimum of three years.
 - 2. Air distribution header system and diffuser supports shall be fabricated from AISI Type 304L stainless steel.

3. Submit calculations that show support system meets the requirements of this Section. Calculations shall be certified by an Engineer registered in the State of the State in which the Project is located.
- B. Air Distribution Header Supports
1. Each air distribution header pipe shall be supported by a minimum of two supports. Spacing between manifold supports shall not exceed 12 feet.
 2. Air distribution header supports shall resist thrust generated by expansion and contraction of air distribution pipe.
 3. Air manifold supports shall resist bending moment of 550 inch-pounds without exceeding 22,500 psi design stress.
 4. Inside surface of air manifold support elements that directly contact air distribution header pipe shall be contoured to match exterior surface of air distribution header pipe. Width of bearing surface contacting air distribution header pipe shall not be less than 2".
 5. Air distribution header system support system shall include mechanism that provides ± 2 " vertical adjustment and $\pm \frac{1}{2}$ " rizontal adjustment for field alignment of air distribution header pipes. Adjusting and aligning mechanism shall be infinitely adjustable within specified vertical and horizontal adjustment limits.
- C. Air Distribution Header System and Diffuser Support System Anchors
1. Supports shall be anchored to tank, or channel, floors, or concrete support bases, with stainless steel epoxy adhesive anchor bolts designed for embedment in existing reinforced concrete.
 2. Coordinate anchor bolt locations and attachment requirements with structural Drawings.
 3. Anchor bolt material shall be AISI Type 316, Type 316D, Type 316L or Type 316N stainless steel.
 4. Support System shall be designed so that, under full buoyancy anchor withdrawal force shall not exceed 450 pounds.

2.07 STAINLESS STEEL FABRICATION

- A. Welding of Stainless Steel Fabrications
1. Welded stainless steel fabrications shall be shop welded. Field welding of stainless steel components will not be accepted.
 2. Shop welding shall use shielded arc, inert gas, MIG, or TIG method.
 3. Filler wire shall be added to welds and shall provide cross sections and weld metal thickness equal to or greater than parent metal.
 4. Butt welds shall fully penetrate to interior surfaces. Gas shielding shall be provided to interior and exterior of joint.
 5. Interior weld beads shall be smooth and evenly distributed with interior projection not exceeding 1/16".
- B. Pack equipment to provide ample protection from damage during shipment, handling, and storage. Cap and seal openings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Follow equipment manufacturer's recommendations for sequencing of equipment installation.
- B. Layout and install support anchors in accordance with equipment manufacturer's recommendations and anchor setting plan.
- C. Level aeration system such that all diffusers connected to a header are within plus or minus 3/8 inch of a common horizontal plane.

3.02 TESTING

- A. Following installation, adjustment, elimination of leaks, and replacement of defective diffusers, test air diffusion system.

- B. Place water in tank to minimum allowable operating depth of diffusers. Turn on air flow to diffusers at minimum rate required to observe operation of diffused air system.
- C. Slowly fill tank. Observe operation of air control valve, diffusers, air distribution and mixing of tank contents during filling of tank.
- D. Record air flow rate during filling of tank.
- E. If any part of air diffusion system fails, or is damaged during testing, correct defects by adjustment, repair, modification or replacement. Re-test equipment following correction of defects. Re-test equipment at no additional cost to Owner.
- F. If air diffusion system does not, in the opinion of the Engineer, meet requirements of this Section through observation of system operation or measurements of dissolved oxygen concentration, field performance testing shall be conducted under provisions of the General Conditions.

3.03 CLEANING

- A. Clean grease, oil, or any other debris from the exterior surfaced of air diffusion system piping and diffusers.
- B. Remove debris from diffusers.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Provide services of a factory representative for (1) day to verify the proper installation of the equipment.
- B. Provide services of a factory representative for (1) day to instruct owner's personnel on operation and maintenance.

END OF SECTION

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SECTION 46 61 29

TRAVELING BRIDGE AUTOMATIC BACKWASH FILTER EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to, install, test, and ready for operation, two (2) packaged automatic backwash filter(s) as shown on the drawings and as specified herein.
- B. The filter shall include the steel tank, compartmental filter bottom, porous plates, filter media, cleaning and backwash mechanism complete with interconnected automatic operating controls including electrical wires, influent weir and effluent ports, electrical feed line system and suspension system, carriage drive system, and washwater launders.
- C. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 DESCRIPTION OF SYSTEM

- A. The automatic backwash filter system shall be suitable for filtering final clarifier effluent from an activated sludge process. Each filter shall be designed to operate on a continuous basis and shall be designed to operate while receiving varying flows.
- B. Each filter shall be capable of operating at an average hydraulic loading of 2 gallons per minute per square foot of filter surface area and a peak loading rate of 5 gallons per minute per square foot of filter surface area.
- C. Under average hydraulic loading rate, the effluent suspended solid concentration shall not be greater than 5 mg/l based on a monthly average.
- D. The average backwash water volume shall not exceed 5 percent of the through put volume under normal operating conditions.

1.03 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Number of Filters: Two (2)
- B. Configuration: Parallel
- C. Minimum Filter Bed Area: 360 Sq Ft (per Filter)
- D. Average Daily Influent Flow (per Filter): 0.75 MGD (two Filters in Operation)
- E. Maximum Daily Influent Flow (per Filter): 1.10 MGD (two Filters in Operation)
- F. Peak Influent Flow (per Filter): 2.20 MGD (one Filter in Operation)
- G. Filtration Rates (Two Filters in Service)
 - 1. At 0.75 MGD per Filter: 1.5 gpm/Sq Ft
 - 2. At 1.10 MGD per Filter: 2.1 gpm/Sq Ft
- H. Filtration Rates (One Filter in Service)
 - 1. At 1.50 MGD per Filter: <3.0 gpm/Sq Ft
 - 2. At 2.20 MGD per Filter: 4.2 gpm/Sq Ft
- I. Provide filtering equipment that meets the following design parameters:
 - 1. Filter Influent Quality:
 - a. TSS (Average): 5 - 15 mg/L
 - b. TSS (Maximum): 20 mg/L
 - c. BOD (Average): 2 - 10 mg/L
 - d. BOD (Maximum): 15 mg/L
 - e. Total Phosphorus (Average): 0.3 mg/L
 - f. Total Phosphorus (Maximum): 0.5 mg/L

- g. Total Nitrogen (Average): 4 - 6 mg/L
- h. Total Nitrogen (Maximum): 8 mg/L
- 2. Filter Effluent Quality:
 - a. TSS (Average): <2 mg/L
 - b. TSS (Maximum): <4 mg/L
 - c. BOD (Average): <2 mg/L
 - d. BOD (Maximum): <5 mg/L
 - e. Total Phosphorus (Average): <0.2 mg/L
 - f. Total Phosphorus (Maximum): <0.3 mg/L
 - g. Total Nitrogen (Average): 2 - 4 mg/L
 - h. Total Nitrogen (Maximum): <5 mg/L

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit product data, including Manufacturer's data, for specified products.
 - 1. System Description: Include the following:
 - a. Manufacturer's data, order sheet, or equivalent for each major piece of equipment, component, instrument or device being supplied.
 - b. Manufacturer's outline and mounting dimensions for all field mounted components, including, but not limited to, tank dimensions, flange connections, overflow weirs, motors, and instrumentation and controls.
 - c. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).
 - d. Manufacturer's Dimensions and Field Fabrication Details for all mechanical equipment.
 - e. Mounting Details.
 - f. The Manufacturer shall clearly identify any exception to the specification or drawings. Failure to do this shall be grounds for rejection of the submittal.
 - g. All equipment to be furnished under this Section must be approved prior to being released for manufacturing unless otherwise noted by the Engineer.
- C. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
 - 1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

1.05 QUALIFICATIONS

- A. All equipment furnished under this specification shall be new and unused, and shall be the standard product of the manufacturer.
- B. The manufacturer must have a minimum of five installations of this same design (only length of the filter bed may vary) steel tankage, and have been in operation a minimum of five years.

1.06 OPERATING INSTRUCTIONS

- A. Operating and maintenance manuals in English shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, description, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment.

- B. The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of 2 trips and 4 eight-hour days to instruct representatives of the Owner and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3. If there are difficulties in operation of the equipment due to the manufacturer's design of fabrication, additional services shall be provided at no cost to the Owner.

1.07 PROJECT CONDITIONS

- A. Coordinate equipment installation with size, location and installation of service utilities.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aqua-Aerobics Systems, Inc.
- B. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FILTER TANK

- A. The tank for the automatic backwash filter mechanism shall be 11' wide x 43'-½" long x 7' deep. The assembled tank shall be constructed so as to allow loading and unloading as a unit.

2.03 FILTER BED

- A. The actual filter bed shall be 9' wide x 40' long, and shall consist of a series of self-supporting lateral partitions (cell dividers) which shall divide the filter into a multitude of 8" wide compartments. Each compartment shall be arranged for connection to a separate backwash port.
- B. A support angle of 1" width shall be an integral part of the cell divider. A 1" retaining angle shall be attached to the cell dividers with 1/4 inch stainless steel fasteners through factory pre-drilled holes.
- C. Filter Media Support System: The filter media support system shall consist of fused aluminum oxide porous plates that meet the following requirements:
 - 1. Porosity: 30% to 45%
 - 2. Flexural strength: 1,000 P.S.I. minimum
 - 3. Air Permeability: 170 to 190 C.F.M. per ft 2 per 1.0" thick plate at 2" water column
 - 4. Thickness: 1" (nominal)

2.04 CARRIAGE MECHANISM

- A. The traveling carriage shall contain and support the positive drive mechanism, pumps, automatic backwash system, and washwater removal system.
- B. The carriage drive unit shall consist of a gear reducer, sprockets, stainless steel drive shaft, a NEMA B design single speed 1/4 HP T.E.F.C. motor for 3 phase, 60 hertz, 460 volt power supply, provided with a sealed conduit box.
- C. All gearing shall be fully enclosed in an oil-tight cast housing with the gears running in oil and all bearings of anti-friction type.
- D. The drive shaft shall be of sufficient size to adequately and safely withstand all bending and torsional loads of starting and operating.

2.05 PUMPS

- A. The backwash and washwater systems shall each be powered by a submersible pump suspended from the filter carriage. Only dual pump submersible systems are acceptable; no single pump systems are allowed.

- B. Each pump shall provide a minimum pumping rate of 17 gallons per minute per square foot of cell area at 20 feet T.D.H. The pumps shall be equipped with stainless steel shafts, and abrasive-resistant impellers.

2.06 AUTOMATIC BACKWASH SYSTEM

- A. A fabricated backwash support frame shall be attached to the traveling carriage on the effluent chamber side. A backwash shoe shall be mounted on the frame such that it can independently follow any irregularities of the matching replaceable wear strip along the effluent ports. This flexible movement shall be controlled by 300 series stainless steel springs. The shoe shall attach to ridged piping by means of a flexible hose.
- B. The replaceable wear strip shall be factory bolted to the effluent header by means of countersunk Type 304 stainless steel fasteners. Systems not using a replaceable wear strip are unacceptable.

2.07 WASHWATER REMOVAL SYSTEM

- A. The washwater hood shall be fabricated from 304 stainless steel. It shall be designed to permit the uniform expansion of the filter media. The hood width shall be 2.0 times the cell width. A stainless steel manifold shall be installed in the upper portion of the washwater hood and shall connect to the washwater pump. The washwater hood shall contain two full length scarifier blades constructed from high density polyethylene.

2.08 LAUNDERS

- A. The washwater launder shall be constructed from 1/4" A36 steel with a seven inch depth and be an integral part of the filter tank wall. Both backwash and washwater pumping systems shall be capable of discharging into the launder. A "V" notch weir shall be provided to calibrate and balance the flow of the backwash and washwater pumping systems independently.

2.09 OPERATING CONTROLS

- A. The automatic controls for the filter operation shall be furnished as an integral part of the carriage mechanism. The automatic controls shall be mounted on the end of the filter tank. The carriage mechanism and all attaching components shall be factory assembled and tested for mechanical and electrical operation prior to shipment. Field assembly shall consist of piping to tank assembly, and installing porous plates and filter media.
- B. The control panel shall be provided with a hinged door for access to the control equipment. There shall be mounted, on the front of the panel door, "Hand-Off-Auto" selector switches with indicating lights for each pump motor and the carriage motor. There shall be provided a 3-pole, 460 volt main disconnect switch to de-energize the control panel with a pendulum handle operator, extending through the control panel door. The enclosure shall be Nema 4X stainless steel construction, factory wired and tested.
- C. The pump and carriage motor controls shall be magnetic contactors with thermal overcurrent protective devices.
- D. Included in the panel shall be controls, a timing device, relays and magnetic motor starters for each pump motor and carriage motor. These motors may be actuated automatically by a predetermined increase in hydraulic head, or by the timing device to control the interval between each cleaning cycle. The cleaning cycle is terminated by a signal from the low water sensing electrode. The "off time" of the cleaning cycle shall be controlled by a reset timer with a range of one minute to sixty hours. When the timer times out, the motors shall be actuated. During the "on time," the timer shall be de-energized and reset for starting "off time" at the end of the cycle. Should high water occur during "off time," the motors shall be started by a relay actuated from the high water electrode signal, with a corresponding resetting of the timer. The control sequence for the backwash mechanism shall be wired so the backwash mechanism stops at either end of the filter upon termination of the backwash cycle, which will be at the low operating probe signal. A low water shutoff probe shall prevent pumping the filter tank below the minimum level point.

- E. A stretch cable electrification system shall be provided. The cable shall be 1/4 inch diameter stainless steel. A stainless steel turnbuckle shall be provided at one end for cable tension adjustment.
- F. The electrification system shall be equipped with a number of non-friction nylon trolley carriers which shall support the electrical flat cable used to power the carriage.

2.10 SEALANT

- A. The porous plates shall be completely sealed, at installation, with a special one-part polyurethane sealant.
- B. The sealant shall have the following minimum physical properties:
- C. Hardness 40-65 Shore A
- D. Tensile Strength 150 psi minimum
- E. The sealant shall not contain asbestos fillers.

2.11 MEDIA

- A. The filter media shall consist of high grade silica sand approximately 11 inches deep, complying with Sections 1, 2.2 and 5 of the standard specifications for the Filtering Material (AWWA Designation B100-89). The 10% size or effective size shall be between .55 and .65 millimeters. The uniformity coefficient (ratio of 60% size to 10% size) shall not exceed 1.50.

2.12 FACTORY PAINTING

- A. All carbon steel tank surfaces (except hot-dipped galvanized components) shall be shoppped cleaned by sandblasting to bare metal in accordance with Steel Structures Painting Council Specification (SSPC) SP-10 prior to coating (painting) of the interior of tank and (SSPC) Sp-6 prior to coat of the exterior of the tank. Shop painting (prime and finish) shall be carefully done by the filter manufacturer and all coatings applied in a workmanlike manner in strict accordance with the paint manufacturer's published recommendation. The interior shall be painted TNE MEC series 66 Epoxoline-two coats (color "Chipmunk"), 4-6 mils, DFT per coat for a total of 8-12 mils DFT. The exterior shall be painted TNE MEC series 66- two coats (color "Chipmunk"), 3-4 mils DFT per coat for a total of 6-8 mils DFT, then one coat TNE MEC series 175 Endura-shield at 2-3 mils DFT total.
- B. The carriage and all attaching fabricated carbon steel components shall be hot-dipped galvanized after fabrication.

PART 3 EXECUTION

3.01 EQUIPMENT SUPPLIER'S SERVICES

- A. A qualified representative of the filter equipment manufacturer shall instruct the contractor on the following items.
 - 1. Installing porous plates, caulking (sealing the plates) and assembling the hold-down angles. This shall consist of one trip, on day for porous plate installation supervision.
 - 2. General preparation for the start-up. This shall consist of one trip, two day at the time of startup.
- B. The Contractor shall provide for the equipment supplier's representative to supervise the Owner's operating personnel during the start-up period. Start-up operations shall be continued until it is satisfactorily demonstrated that the filter equipment is suitable for continuous on-line services.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 46 76 22
SCREW PRESS SLUDGE DEWATERING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals to install and test complete and ready for use One (1) Volute Dewatering Press including integrated automated polymer preparation system as specified and indicated on the drawings and as required to meet the specified performance requirements.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 RELATED SECTIONS

- A. Section 46 76 30 - Dewatered Sludge Shaftless Screw Conveyor
- B. Division 26 - Electrical

1.03 SYSTEM DESCRIPTION

- A. The sludge dewatering system will be capable of dewatering the feed sludge consisting of only secondary waste activated sludge; or, a blend of DAF primary sludge and secondary waste activated sludge and producing a solids cake with no free water present. The system will be able to start up, operate as required and shut down in the absence of any operators.
- B. All components of the sludge dewatering equipment shall be engineered for long, continuous, and uninterrupted service with minimal operator intervention. Provisions shall be made for easy maintenance, adjustment, or replacement of all parts.
- C. The sludge dewatering system shall consist of One (1) Volute Dewatering Press, One (1) polymer preparation system, and all appurtenances.
- D. The Volute Dewatering Press System shall be a complete prefabricated system consisting of:
 - 1. Sludge conditioning system consisting of a mixing tank with gear motor and mixing impeller to allow efficient mixing of polymer in the sludge and a flocculation tank including gear motor and large cross-sectional area agitator
 - 2. Dewatering drums" including spray wash down system and gear drives
 - 3. Support structure for the Dewatering Drum including filtrate collection pan and outlet plumbing
 - 4. A self-contained electrical and control panel including control for ancillary equipment such as polymer dosing equipment
 - 5. Polymer dilution and dosing equipment (may be physically integral or separate to the Volute Dewatering press)

1.04 DESIGN REQUIREMENTS

- A. The volute dewatering press shall operate within the design conditions of service and meet the following performance criteria:
 - 1. Hydraulic Loading Rate:
 - a. Average: 150 gpm at 1% or less waste activated sludge feed solids
 - b. Maximum 200 gpm at 1% or less waste activated sludge feed solids
 - 2. Maximum Solids Loading Rate:
 - a. 750 # dry solids/hour at 1% or less waste activated sludge
 - 3. Minimum Dewatered Sludge Cake Solids: 20%
 - 4. Minimum Solids Capture: 97%
 - 5. Number of Dewatering Screw Presses: One (1)

- B. Conditions of Service:
 - 1. Type of Sludge: Blend of Waste Activated Sludge (WAS) and Primary DAF Sludge
 - 2. Feed Solids Concentration: 1%
 - 3. Temperature: 10-20 degrees C
- C. The sludge dewatering equipment shall be designed to adequately condition and dewater the sludge such that a dewatered sludge cake is produced that easily discharges from the dewatering unit, without blinding or plugging, and that may be handled by solids conveying equipment.
- D. Each unit shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope. In addition, the unit will operate with no requirement for operator attention other than periodic inspection and chemical replenishment.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, parts, instrumentation devices and other accessories forming a part of the equipment furnished shall be submitted for review. The following information shall also be submitted with shop drawings:
 - 1. Drawings showing the manufacturers recommended equipment base(s), including dimensions, weights, loadings, drainage piping and other information necessary to install the equipment.
 - 2. Details of electrical components including enclosures, and machine mounted components.
 - 3. Elevation of local control panel and operator control station showing panel mounted devices. Provide details of power distribution and full load current draw of panel. Provide list of all terminations required to receive inputs or a transmit inputs from the local control panel.
 - 4. Nameplate data of each electric motor proposed to be furnished with the equipment package.
 - 5. Wiring diagrams of field connections with identification of terminations between local panel, junction boxes, equipment items, instrument devices, and the like.
 - 6. Complete electrical control schematic diagram.
 - 7. List of spare parts to be furnished.
 - 8. List any exceptions or deviations from the contract documents.
 - 9. Statement of machine warranties.
 - 10. Control philosophy provided in both written and schematic form.
- C. Owner's Manuals: Operations and Maintenance information and equipment maintenance summary sheets for all equipment.
- D. Certification: The Manufacturer shall provide a certification stating that they have reviewed the Drawings and Specification for this project and have verified that the applicability of the specified equipment to be provided by the Manufacturer for the intended use per the Drawings and Specifications.
 - 1. The Manufacturer shall provide to the Engineer, as part of the certification, in writing any recommended revisions to the design based upon the Manufacturers review of the Specifications and Drawings.

1.06 PATENTS

- A. The manufacturer warrants that the use of this system and its equipment, in the process for which the system has been expressly designed, will not infringe on any U.S. or foreign patents or patents pending. In the event of any claim of infringement the manufacturer shall defend and indemnify the owner free from any liabilities associated with the use of the patented equipment or process.

- B. The contractor hereby grants to the owner, in perpetuity, a paid-up license to use any inventions covered by patent or patents pending, owned, or controlled by the supplier in the operation of the facility being constructed in conjunction with the equipment supplied under this contract, but without the right to grant sublicenses.

1.07 WARRANTY

- A. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twenty four (24) months from the date of startup, not to exceed eighteen (18) months from the date of delivery, unless noted otherwise within the specifications.

1.08 QUALITY ASSURANCE

- A. System Responsibility
 - 1. Vested responsibility for operation and control of the Volute Dewatering Press System, which is comprised of all equipment controlled by the Volute Dewatering Press control panel, resides with the manufacturer of the Volute Dewatering Press.
- B. Factory Quality Control Test
 - 1. Prior to shipment, the Volute Dewatering Press and control panel shall be factory tested at the place of assembly. Factory test each pre-assembled, pre-wired, Volute Dewatering Press and its associated control panel to be supplied to the job site. Prior to shipment, verify through a one-hour continuous operating test that the Volute Dewatering Press and associated equipment operate smoothly, noiselessly, vibration free, and without overheating of any bearing or motor.
- C. Owners Right to be Present
 - 1. The owner/engineer shall, at their option, be permitted to witness the factory quality control test at the manufacturer's facility. The manufacturer shall give the owner/engineer a minimum of one- (1) weeks' notice prior to testing.
- D. The volute dewatering system covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.
- E. In the event that equipment which differs from this Section be offered and determined to be equal that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Engineer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Process Water Technologies, LLC. (PWTech)
- B. Or Approved Equal
 - 1. Approved Equal manufacturers shall perform an onsite pilot test of their proposed equipment at no cost to the Owner. Any required modifications to the design or additional expenses for installation of the "Approved Equal" equipment shall be the responsibility of the Contractor.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements

2.02 MATERIALS AND COATINGS SCHEDULE

- A. All materials utilized in the construction of the sludge dewatering equipment shall be entirely suitable in every respect for the service required. All metals in contact with polyelectrolyte or sludge, and all other metal components other than those specified below in Table 1 shall be stainless steel, type 304 or 316.

- B. The following indicates the materials and coatings that shall be provided for the volute Dewatering Press and related components unless specified otherwise herein:
1. Mixing and Flocculation Tanks Type 304 Stainless Steel
 2. Plumbing Type 304 Stainless Steel
 3. Dewatering Drums Type 304 Stainless Steel
 4. Dewatering Drum Screw Type 304 Stainless Steel with frame coating 10Co-4Cr
 5. Gear Motors Die cast aluminum and Type 304 Stainless Steel
 6. Gear Motor coating Acrylic paint
 7. Spray bars and water plumbing Type 304 Stainless Steel
 8. Spray nozzles Polypropylene
 9. Electrical control panel enclosure NEMA 4X Type 304 Stainless Steel
 10. Electrical wiring housing Non-metallic flexible liquid-tight conduit and liquid tight fittings
 11. Electrical switch enclosures Stainless steel or non-metallic NEMA 4X
 12. Frame / Skid mounting Type 304 Stainless Steel
 13. Valves - Wetted Sections Stainless Steel, EPDM Seating

2.03 STRUCTURAL SKID FRAME

- A. The structural support frame shall be fabricated of type 304 stainless steel members conforming to the latest ASTM Standard Specifications for Structural Steel, Designation A36. It will be a rigid structure, adequately braced to withstand intended loads without excessive vibration or deflection.
- B. The framework shall be of welded and/or bolted construction. All welding shall conform with the American Welding Society Structural Welding Code.
- C. The structure shall be designed for installation on a prepared concrete foundation or suitable flat concrete slab and secured with anchor bolts.
- D. The construction shall allow easy access and visual inspection of all internal components.

2.04 DEWATERING DRUMS

- A. Description
 1. The dewatering drums will be constructed of ATSM type 304 SS except for the rings in the thickening section of the drum which will be manufactured in a polycarbonate resin. All circular components will be laser cut to ensure maximum evenness of wear and therefore operating life. The Drum will be constructed with 5 main components. These are:
 - a. Tie Rods
 - b. Fixed Rings
 - c. Moving Rings
 - d. Spacers
 - e. End plates
- B. Performance
 1. Assembly will be undertaken in such a way that all fixed rings are concentric and parallel. All fixed rings will be equally spaced apart for each section of the dewatering drum. When mounted on the retaining rods and installed, all moving rings will move freely between the fixed rings.

2.05 DEWATERING DRUM SPRAY SYSTEM

- A. Description
 1. Each Dewatering Drum shall be equipped with individual spray bars. Each spray bar shall consist of a spray pipe fitted with spray nozzles, located above the dewatering drum. The spray pipe and spray nozzle assembly shall be readily removable.
 2. Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another on the dewatering drum surface.

- B. Performance
 - 1. The sprays will operate periodically and will remove solids built up externally on the drum such that over time no significant buildup of solids occurs on the drum.

2.06 DEWATERING DRUM DRIVE

- A. The Dewatering Drum drive motor will be a one piece gear motor. Gear motors will be hollow shaft design designed to drive the dewatering drum screws with no additional couplings or joints. Motors will be filled with grease on assembly and sealed for life. Screw rotational speed shall be obtained through a hypoid reduction gear. Input power to the dewatering drum drive shall be supplied through an A.C. variable frequency drive unit.
- B. Drive Motor Data
 - 1. Maximum Horsepower: 0.54
 - 2. Power Requirements: 208/240/480 VAC, 3 phase, 60 hertz
 - 3. No load motor speed: 1760 RPM
 - 4. Gear Reduction: 750:1
 - 5. Output shaft speed: 2.4 RPM @ 60Hz
 - 6. Insulation Class: IP65
 - 7. Enclosure: TEFC
 - 8. Enclosure material: Die Cast Aluminum
 - 9. Service Factor: 1.15

2.07 MIXING AND FLOCCULATION TANKS

- A. Description
 - 1. Mixing and flocculation tanks will be manufactured in type 304 stainless steel and will be a minimum of 20 gauge (1mm). Tanks and spill containment trays will be fully welded internally and externally.
- B. Performance
 - 1. Design and manufacture of tanks and spill trays must ensure no leakage or spillage of fluids under normal working conditions. Tank design will minimize the possibility of any short circuiting of flow. Tank size will allow for sufficient residence time for flocculation to occur.

2.08 MIXER AND FLOCCULATION DRIVES

- A. The mixer and flocculation tank drive motors will be a one piece gear motor. Gear motors will be hollow shaft design designed to drive the mixing impeller shafts with no additional couplings or joints. Motors will be filled with grease on assembly and sealed for life. Mixer rotational speed shall be obtained through a hypoid reduction gear. Input power to the dewatering drum drive shall be supplied through an A.C. variable frequency drive unit allowing variable mixing energy to be input to the system.
- B. Mixing tank drive motor data
 - 1. Maximum Horsepower: 0.2
 - 2. Power Requirements: 208/240/480 VAC, 3 phase, 60 hertz
 - 3. No load motor speed: 1760 RPM
 - 4. Gear Reduction: 10:1
 - 5. Output shaft speed: 180 RPM @ 60Hz
 - 6. Insulation Class: IP65
 - 7. Enclosure: TEFC or TENV
 - 8. Enclosure material: Die Cast Aluminum
 - 9. Service Factor: 1.15
- C. Flocculation tank drive motor data
 - 1. Maximum Horsepower: 1
 - 2. Power Requirements: 208/240/480 VAC, 3 phase, 60 hertz
 - 3. No load motor speed: 1760 RPM
 - 4. Gear Reduction: 60:1

- | | |
|------------------------|-------------------|
| 5. Output shaft speed: | 30 RPM @ 60Hz |
| 6. Insulation Class: | IP65 |
| 7. Enclosure: | TEFC or TENV |
| 8. Enclosure material: | Die Cast Aluminum |
| 9. Service Factor: | 1.15 |

2.09 POLYMER PREPARATION SYSTEM

A. Description

1. Each Volute Dewatering Press shall be provided with a polymer preparation system to take liquid polymer, dilute and blend it such that it can be used to effectively flocculate the sludge. The polymer preparation system will be integral to the Volute Dewatering Press operation and will be automated and controlled by the units control panel. The polymer preparations system will be a Veloblend VM-5P-600-X0D as manufactured by VeloDyne, Inc. of Boulder, CO.

B. Performance

1. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution ranging from 0.1% to 1% concentration of emulsion polymers with active contents up to 75%.
2. The polymer blending system is a critical part of the process and must be designed to provide optimal performance and reliability under all operating conditions. These specifications are based on the VeloBlend technology. Other technologies shall be considered only if they are proven to provide the same level of performance and reliability under all operating conditions as the system specified herein.

C. Multi-zone Hydro-mechanical Mixing Chamber:

1. A hydro-mechanical blending device shall be provided. The device shall be capable of operating on plant water pressure alone at 30 psid. In addition, the system shall be capable of producing its mixing energy independent of plant water pressure through a variable intensity, controllable mechanical mixer. The system shall be capable of producing high, non-damaging mixing energy at all flow rates without damage to the polymer's molecular structure.
2. The mixing chamber shall be clear to view the mixing action and blending effectiveness. Clear pipe shall not be acceptable to meet this requirement. The mixing chamber shall have a maximum rated pressure of 100 psi. All holes tapped in plastic shall have helicoil inserts for increased strength.
3. In order to handle the wide range of polymers available, independent of water pressure, a variable speed stainless steel mechanical mixing impeller shall be provided. The mixer shall be designed specifically to effectively inducing high, non-damaging mixing energy over the systems full flow range. The specially designed impeller shall be controlled by an SCR controller. The impeller shall be driven by a wash-down duty motor. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flushing valve. A drain port behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. Systems without a seal flushing system shall not be considered.
4. Systems that rely solely on water pressure to create mixing energy shall not be acceptable. Systems that rely solely on water pressure to create mixing energy will be considered only if provided with an integrally mounted dilution water booster pump and if the system meets the above polymer mixing criteria. A VFD motor controller shall be provided to control the pressure and therefore mixing energy generated by the booster pump. Booster pumps shall be multi-staged and of stainless steel construction. The booster pump shall be capable of generating 75 psid independent of water supply pressure which shall be verified at system start-up. In the event the booster pump cannot produce 75 psid of water pressure a properly sized booster pump shall be installed at supplier's expense. Under no circumstances shall systems that rely solely on plant water pressure to create mixing energy be acceptable.

5. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. The valve body shall be constructed of Teflon with Viton seals. The valve poppet and spring shall be stainless steel and designed to prevent polymer from flowing through the spring, causing build-up and plugging. Plastic spring covers shall not be used. The valve shall be readily accessible for cleaning and shall not require tools for removal, cleaning or replacement. Conventional check valves, valves that rely on ball seals, and or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted. The locking pin used to hold the valve in place shall be attached to the mixing chamber with a lanyard.
- D. Dilution Water Assembly
1. The dilution water flow rate shall be monitored by a Rotameter type flow meter having a range of 1 - 10 GPM. A union shall be provided on the Rotameter to allow easy removal for cleaning.
 2. Unit shall have an electric solenoid valve for on/off control of total dilution water flow.
 3. A differential pressure type low water differential pressure alarm shall be provided. The switch shall be adjustable between 10 and 25 psi.
 4. Provide a 2-1/2" stainless steel liquid filled pressure gauge to monitor dilution water inlet pressure.
 5. Provide a 1" FNPT dilution water inlet connection
- E. Progressive Cavity Neat Polymer Metering Pump
1. The unit shall have one (1) neat polymer metering pump(s) integrally mounted on the systems skid. The metering pump(s) shall have a range of 0.25 - 5 GPH. The pump shall be a positive displacement, progressive cavity type constructed of stainless steel and Viton. The pump seal shall be packing type. Mechanical seals shall not be used. The pump shall have a minimum of three stages to minimize slip. A TEFC motor shall drive the pump. A right angle gear reducer shall be provided to produce a maximum pump shaft speed of not more than 600 RPM. The motor shall be controlled by an SCR motor controller located in the dewatering systems main control panel.
 2. Provide a calibration column with two full port PVC ball valves having Viton o-rings. The column shall be calibrated for a one minute draw-down and read in GPH and milliliters.
 3. Provide a thermal type loss of polymer flow sensor.
- F. Solution Discharge Assembly
1. Provide a 2-1/2" stainless steel liquid filled pressure gauge to monitor system discharge pressure.
 2. Provide a 1" FNPT solution discharge connection
 3. Provide a high discharge pressure switch
 4. Provide a swing type check valve to prevent back flow. The check valve shall be sized for the total solution flow of the system, constructed of PVC and Viton.
- G. Controls
1. Control for the system will be provided from the main control panel and associated operator interface of the dewatering system.
 2. A Junction box integral to the systems frame shall be provided. The enclosure shall be rated NEMA 4X and constructed of FRP. The junction box and all components shall be industrial duty. All skid mounted electrical components interconnected to the junction box shall terminate at numbered and labeled terminal blocks. The terminal blocks shall be sized for 14 ga. wire. Wires shall be neatly run through wire race-way and numbered with adhesive type labels.

2.10 ELECTRICAL AND CONTROL SYSTEM

- A. General Requirements
 - 1. Each Volute Dewatering Press shall have an integrated electrical and control system that will allow for safe, simple and automated operation of the unit. All electrical work, motors and drives will comply with any relevant NEMA standards. The electrical control system will be able to accept remote start and stop signals, and will have outputs for unit in operation, and unit alarms to an external PC.
- B. Control Panel
 - 1. Each Volute Dewatering Press shall be provided with a control panel that will contain the necessary control devices and equipment for controlling the dewatering process as described herein. The control panel shall meet the following general requirements:
 - a. Control Panel will be UL listed.
 - b. Enclosures: Control panel enclosures shall be free-standing, fabricated of type 304 stainless steel and shall be suitable for NEMA 4X service.
 - c. The control panel shall accept a 480 volt, 60 hertz, 3 phase ac power input. A main disconnect circuit breaker and operator mechanism shall be included. When the disconnect is in the open position, all power shall be removed from the control system.
 - d. IEC rated motor starters shall be provided for all non-VFD and DC motors.
 - e. Variable frequency drives (VFD) shall be provided for the dewatering drum drive and mixing and flocculation tank agitators as well as any feed pumps.
 - f. Short circuit protection for system components shall be accomplished utilizing fuses. Individual thermal overload protection shall be provided.
 - g. A transformer shall be included that will provide 120 volts, ac for the polymer dilution and dosing system and control system
 - h. A Programmable Logic Controller (PLC) will control all timing and switching functions
 - i. A dialer will be included to alert remote staff to any operational issues with the system
 - j. The control panel will have externally mounted controls for key operational items as per Section "External Enclosure Features".
 - 2. External Enclosure Features
 - a. The external door of the panel will have the following switches and indicators:
 - 1) Main Isolating Switch (Circuit Breaker)
 - 2) An emergency stop button which shall be a mushroom head style pushbutton that when depressed shall immediately de-energize all moving equipment in the system.
 - b. Within a widowed enclosure mounted on the panel door:
 - 1) Unitronics PLC interface
 - 2) An H-O-A system switch to switch the system from Auto to off to manual modes
 - 3) Power on Light (white)
 - 4) An Operating Light -for when the unit is actually in operation - (green)
 - c. In addition to items located on the main enclosure door:
 - 1) An Alarm Light - a flashing light located on the top of the panel (red)
- C. Programmable Logic Controller (PLC)
 - 1. Each Volute Dewatering Press will be provided with a Unitronics Brand Vision 570 PLC, installed, wired and programmed to perform the following functions:
 - a. Operational Control
 - 1) Control of all components of the Volute Thickener- system including the ability to set times and operating speeds for the sludge feed pumps, dewatering drums, mixers, polymer dosing system, wash-down sprays, and the dewatered solids conveyor.
 - b. System Tuning
 - 1) PLC will allow suitably qualified operators to adjust operating parameters such as delay timers for fault alarms and system calibration constants.

- c. Monitoring Operation
 - 1) PLC will allow the operator to inspect the operation of all the components including indicators such as output frequency, current draw, thermal condition, elapsed operating times, and any faults present. Operator will be able to view approximated readouts of all operational speeds and flow rates relevant to the operation of the system.
 - d. Manual operation of components
 - 1) Operator will be able to manually operate each item of equipment from the PLC interface for inspection and maintenance reasons.
 - e. Time Clocks
 - 1) Operator will be able to set the unit to operate at specific time or on specific days with no operators present.
- D. Electrical Hardware
- 1. Power Wiring
 - a. All power and wiring shall be 600 volt, type SIS insulation stranded copper and shall be sized for the required load, 14 AWG minimum.
 - 2. Control Wiring
 - a. Control wiring shall be 250 volt, type SIS insulation stranded copper and shall be sized for the required load, 18 AWG minimum.
 - 3. Circuit Breakers
 - a. Circuit breakers for the main disconnect shall be thermal magnetic molded case units. Circuit breakers shall be Square D, Class 650, Type FAL or equivalent.
 - 4. Motor Starters
 - a. Motor starters shall be full voltage, non-reversing, IEC style across-the-line units. Coils shall be 120 volts ac. Siemens type Sirius 3RT10 or equivalent.
 - 5. Selector Switches
 - a. All selector switches shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10 ampere continuous service. Selector switches shall be Idec Series TWTD.
 - 6. Pilot Lights
 - a. Pilot lights shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Units shall be 120 VAC full voltage incandescent type. Pilot lights shall be Idec Series TWTD or equal
 - 7. Terminal Blocks
 - a. Terminal blocks shall be high density, solderless box lug style, with 600-volt rating. Terminal blocks shall be Allen Bradley type 1492 or equal
 - 8. Control Relays
 - a. Control relays shall be general purpose type with a 10 amp contact rating, miniature square base and internal on status pilot light. Relays shall be Allen Bradley Type 700-HF Series or equal.
 - 9. Programmable Logic Controller
 - a. The programmable relay shall be a Unitronics Brand "Vision 570 OPLC" (Graphic Operator Panel & Programmable Logic Controller).
 - 10. Variable Frequency Drives (VFD)
 - a. The VFDs shall be UL listed and shall be manufactured by Altimar.
- E. Functional Specification - The control panel will undertake the following operations:
- 1. Auto-Manual operation
 - a. The Volute Thickener-Dewatering Press system may be set to either Auto/Manual/Off on the control panel via a 3 position switch. This will be the "main switch" for the plant.
 - b. When set to manual, all items may be switched on and off at the control panel by the 2 position switches.

- c. When set to off, no items will work whether switched on or off either at the control panel or anywhere else.
- d. When set to Auto, all items of equipment will work as per the following descriptions.
2. Clock Operation
 - a. The clock function will be controlled by the PLC in the control panel. Two clock functions will be allowed for in the program. The clock may be set to either "On" or "Auto/timer" via at the PLC. If the clock is set to "On" the plant will run for as long as the main switch is set to "Auto". When the clock is set to "Auto/Timer" the plant will operate in accordance with the clock settings.
 - b. Clock function settings will allow the operator to set the dewatering press and all associated equipment to switch on and off, at pre-designated times on pre-designated days with no operators being present. A minimum of two(2) different "clock programs" will be allowed for in the PLC program.
3. Sludge Feed
 - a. Sludge is fed to the plant by a pump controlled from the control panel. A VFD will control the speed of the pump. In the event of a pump overload or a VFD fault the plant will shut down and an alarm will occur.
 - b. A flow meter will monitor the sludge flow. The operator will be able to set the flow and the feed pump will operate to maintain that flow via a PID loop. Any variations from the preset flow will cause the system to shut down and an alarm to occur.
4. Polymer Feed
 - a. Polymer feed to the plant is achieved by the integral polymer preparation system connected to the plant. This system is controlled and powered by the control panel. Outputs from the control panel to the polymer preparation system will include power, start and stop signals, and variable speed control for the polymer feed pump.
 - b. Manual adjustment of the speed control for the polymer dilution mixing chamber will be make from the control panel. The control panel will also monitor the polymer preparation system for faults due to low water pressure, or no polymer flow and shut the system down with an alarm should this occur.
5. Flocculation Tank Agitation
 - a. Whenever the plant is operating 2 motorized agitators will operate continuously, stirring the contents of the flocculation tank. These are geared motors and will be controlled by a VFD in the control panel. The VFD will be adjustable from 5 Hz up to 75 Hz
 - b. A high level sensor will detect any high fluid level in the flocculation tank and will shut the plant down and cause an alarm should this occur.
6. Dewatering Drums
 - a. The Dewatering Drums will operate whenever the plant is operating. The motor is controlled by a single VFD. The Range of Adjustment for this will be 15 Hz to 100Hz. When the plant shuts down the dewatering drum will continue to operate for a pre-set time before they shut down. Sprays will periodically switch on while the dewatering drum is operating. The frequency and duration of the spray are adjustable in the PLC.
7. Conveyor
 - a. The Conveyor will operate whenever the dewatering drums are operating and will shut down following a pre-set delay following the shutdown of the dewatering drums. E-stop and no-motion sensors on the conveyor will shut down the system and cause an alarm in the event they are activated. The conveyor will also shut down the system and cause an alarm on over torque

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.02 MANUFACTURER'S SERVICES

- A. Installation Supervision
 - 1. Services of the manufacturer's factory trained representative, who is specifically knowledgeable in the type of equipment specified herein, shall be provided during the equipment installation period. The manufacturer's representative shall assist the installation contractor in determining the location of anchor bolts, setting and leveling the equipment, and coordinating the process piping and electrical connections to all the equipment specified herein.
- B. Start-Up and Commissioning
 - 1. Upon completion of the installation, the services of the manufacturer's factory trained representative shall be provided at the project site for equipment start-up and calibration. During the start-up and calibration phase the manufacturer's representative shall inspect all system components for proper connection and alignment and assist the installation contractor in placing the equipment in a proper operating condition.
 - 2. Start-up or commissioning service provided by anyone other than the equipment supplier shall limit or void equipment warrantee.
- C. Operator Training
 - 1. Upon satisfactory completion of the start-up and calibration, a representative of the manufacturer shall be provided to instruct Owner's personnel in the proper operation and maintenance of the equipment.
- D. Operation and Maintenance Manuals
 - 1. Upon completion of commissioning, the manufacturer will provide the owner with four (4) copies of the operation and maintenance manuals for the Volute Dewatering Press.
- E. Other Services
 - 1. Additional services, other than those provided for by warranties or as specified herein, may be charged to the Owner/Contractor at the manufacturer's standard service rates.

END OF SECTION

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SECTION 46 76 30
DEWATERED SLUDGE SHAFTLESS SCREW CONVEYORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals to install and test, complete and ready for operation, one (1) shaftless screw conveyor as shown on the Drawings and as specified herein.
- B. The material specified herein shall comply with the American Iron and Steel provision of the Clean Water Act as it applies to the State Revolving Loan Funds and as administered by the State of Delaware. It is the Contractor's responsibility to determine if the Approved Manufacturers comply with the requirements of the provision.

1.02 SUMMARY

- A. This section covers the supply and delivery of one (1) shaftless screw conveyor for the conveyance of dewatered sludge to a dumpster.
- B. Screw Conveyors with shafts and intermediate hanger bearings will not be acceptable for this project.

1.03 RELATED SECTIONS

- A. Division 26 - Electrical

1.04 PERFORMANCE REQUIREMENTS

- A. Design the shaftless screw conveyor system to meet the performance and design requirements per section 1.04 - Design Requirements. Conveyor selection design standards to be based on the operational experience of the manufacturer with shaftless screw conveyors, and not shafted screw conveyors.
- B. Conveyor rotational speeds shall not be greater than herein specified, unless availability of the reducer ratio requires slight adjustment (+- 3 rpm) or if shown by the conveyor manufacturer calculations to be required to meet design load. Deviations from specified speed cannot be utilized to reduce the conveyor trough and spiral size. Faster speeds are utilized to prevent the fluidization or apparent thinning when conveying dewatered sludge, to reduce liner and spiral wear from abrasive material.

1.05 DESIGN REQUIREMENTS

- A. Screw Press Dewatered Sludge Conveyor shall conform to the following:

B. Performance:

1. Material conveyed:	Dewatered Sludge Cake
2. Density, average, lbs/cu.ft.:	60
3. Volume, ft ³ /hr.:	84
4. Max. screw speed, rpm:	20
5. Trough fill rate @ Design load, %:	45

C. System Design:

1. Length, approx. ft:	25
2. Degrees Incline, approx.:	35
3. Feed Inlet From:	Screw Press
4. Discharge outlet to:	Truck Trailer
5. No. Discharges:	one
6. Discharge Type:	Inclined
7. Conveyor size, U or OK trough:	U250
8. Trough width, ID inches, min.:	9.8
9. Trough thickness, min.:	11 gauge
10. Minimum lid thickness:	11 gauge

- | | |
|--|----------|
| 11. Lid length, inches max.: | 60 |
| 12. Chute thickness, min.: | 11 gauge |
| 13. Spiral OD, inches min.: | 8.5 |
| 14. Spiral, outer thickness, min.: | 1.0 |
| 15. Spiral pitch (full or 2/3): | Full |
| 16. Spiral insert/outsert: | Yes/No |
| 17. Liner type: | SPX |
| 18. Liner length, ft, max: | 4' |
| 19. Liner thickness, inch, min.: | 1/2" |
| 20. Location of drives: | Push |
| 21. Drive Hp, min.: | 1.5 |
| 22. Motion failure probes, # per conv: | one |
| 23. NEMA rating at probe: | 4 |
- D. Materials of Construction:
- | | |
|--|-------|
| 1. U Trough, lids, end plates & flanges: | 304 |
| 2. Hardware: | 304 |
| 3. supports, vertical, less than 6': | 304 |
| 4. drive shafts: | 1045 |
| 5. Bell-housings: | HDG |
| 6. Liners: | UHMW |
| 7. Spiral: | HTMAS |

1.06 SUBMITTALS

- A. The equipment Supplier shall, as a minimum, submit the following information for review and approval by the Engineer:
- B. Descriptive literature regarding the conveying equipment to be supplied.
- C. Reference information and certifications as required under subsection 3.
- D. Detailed specifications for the Equipment proposed
- E. Manufacturer's certification, signed by a corporate officer, confirming that the proposed Equipment fully complies with these specifications, including paragraph 2.3.2 of this section.
- F. General arrangement drawing(s) for the proposed Equipment.
- G. Cut sheets for electric motors and ancillary items manufactured by others.
- H. Conveyor torque requirement calculations.
- I. Torque calculations for the gear reducer and reducer motor.
- J. Horsepower calculations for the drive motor(s).
- K. Utilize spiral strength calculations for spring (spiral) compression and elongation showing the supplied spiral meets or exceeds spring effect intent of 2.6 herein. Complete schematic diagrams for electrical control panel(s) if applicable.
- L. Operations & Maintenance Manual (generic sample with submittal, complete and specific O&M six weeks from submittal approval).
- M. The contractor is responsible for coordination of all mechanical & electrical equipment, and structural interconnecting or otherwise interfacing with the conveyor and any site measurements required for a detailed conveyor submittal. If a Contractor requests a conveyor submittal prior to furnishing all the required data to complete full and precise general arrangement drawings, the Contractor shall bear the cost of re-submittal and drawing revisions to the equipment manufacturer.

1.07 QUALITY ASSURANCE

- A. Fabricate and assemble all equipment under this section in full conformity with this specification and as shown in the contract drawings.

- B. Furnish equipment complete with all supports; all mechanical equipment required for proper operation, including complete drive units; all steel and other metal construction specified herein; and all additional materials or fabrication as required by the supplier's design.
- C. Unless otherwise noted;
 - 1. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and the satisfactory operation of the system.
 - 2. For optimum quality control, spirals furnished with the shaftless conveyor(s) shall be produced from spiral manufacturing equipment actually owned by the conveyor supplier.
- D. Provide evidence of at least fifteen (15) years demonstrable experience in the design and manufacture of shaftless conveyor systems. The Supplier shall have at least twenty-five (25) full-scale shaftless conveyor systems operating successfully for at least five (5) years in North America at municipal wastewater treatment plants that were designed and furnished under the Supplier's own name. Equipment bought and re-sold; or supplied under a license or marketing agreement shall not be considered for meeting the experience clause.

1.08 1.07 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after the equipment was first placed into operation at the jobsite or eighteen (18) months after the equipment was first delivered to site, whichever date occurs first. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.
- B. The shaftless screw liner and spiral shall be warranted for a period of three years from factory start-up against wear.
- C. Liner: For a wear indicator (two color) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30% of the conveyor length during the first three years of service. If these wear indications occur the conveyor supplier shall provide new formed and banded liner to replace all the liner in the conveyor that has excessive wear.
 - 1. If a one color liner is used the excessive wear shall be indicated if the thickness of the liner, at three points over a 30% long section of the conveyor, is a 1/4" thick or less at the thinnest point of the liner, during the first three years of service. Since one color liners prohibit a simple visual inspection confirmation for the liner thickness status at the spiral-liner contact point, the conveyor manufacturer shall supply a field technician to the jobsite on the annual acceptance date for three consecutive years, to remove a minimum 30% of all liners and demonstrate to the owner that at a minimum of 1/4" of liner is remaining. If excessive liner wear is found the conveyor supplier shall provide new formed and banded liner to replace all the liner in the conveyor that has excessive wear.
 - 2. Screw: Excessive wear on the screw shall be indicated by loss of more than 50% of the height of the main outer screw section over 30% of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw to replace the screw in the conveyor that has excessive wear.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The system shall be of the shaftless type as manufactured by SPIRAC (USA) INC., Newnan, Georgia.
- B. Or Approved Equal
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A. Materials used in the fabrication of the equipment under this section shall conform to the following and attached "Table A":
 - 1. Chutes, Troughs, End Plates, Covers, Hoppers & Supports
 - a. AISI 304 stainless steel

2. Spiral Flighting
 - a. Special Chrome-Alloy Steel w/minimum 225 Brinnell Hardness
3. Wear Liner
 - a. UHMW Polyethylene, Duraflo[®] SPX™
4. Hardware
 - a. AISI 304 Stainless Steel

2.03 FABRICATION

- A. The shaftless screw conveyor equipment shall include the following:
 1. Troughs, Liners & Covers
 2. Spiral Flighting
 3. Chutes
 4. End Shaft
 5. Electric Motor & Gear Reducer
 6. Mounting and Support Structure
 7. Electrical Control Panel
 8. Safety Accessories
 9. Spare Parts
- B. All welds to be continuous unless otherwise specified. Facing surfaces of field-welded components shall be beveled and match marked.
- C. Sharp corners of all cut and sheared edges shall be made smooth by edge grinding.

2.04 POWER SUPPLY

- A. Power supply to the equipment will be 230/460 volts, 60 Hz, 3 ph. Power supply for electrical controls shall be 120 volts, 60 Hz, single phase.

2.05 SURFACE PREPARATION

- A. All iron and mild steel surfaces to be painted shall be dry abrasive blasted in accordance with SSPC-SP6, and in accordance with the painting section of these specifications. Surfaces shall be painted or hot dip galvanized within 24 hours to prevent rusting and surface discoloration.
- B. Stainless steel shall be cleaned with mild abrasive wheels and/or nonferrous blast media to remove heavy scale and welding carbon and/or passivated with stainless steel cleaner then rinsed.
- C. After surface preparation, ferrous metal surfaces, if any, except for the spiral flighting shall receive a minimum of one (1) coat of epoxy primer. Provide a total minimum dry film thickness of 3 mils prior to shipment to jobsite. Primer shall be compatible with the paint system specified for the equipment under "Painting" section of these specifications. Finish coats shall be applied at the jobsite by the General Contractor.
 1. The spiral shall be furnished with one coat of shop primer only.
 2. Electric motors, gear reducers, electrical control panels, and other purchased sub-components shall be furnished with the manufacturer's standard finish.
 3. Stainless steel surfaces do not require painting.

2.06 SPIRAL

- A. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.
- B. Spiral flights shall be cold-formed high strength chrome alloy steel with a minimum hardness of 225 Brinnell. The spiral flights shall be designed with adequate stability to prevent distortion and jumping in the trough. A second, inner spiral, concentric with the outside spiral shall also be provided. The torsional rating of the auger flighting shall exceed the torque rating of the drive motor at 150% of its nameplate horsepower. The "spring effect" of the spiral shall not exceed + 1.0 mm per 100 mm of length at maximum load conditions. The minimum outer spiral thickness shall be 0.75" for spiral diameters up to 9" and 1" for spirals diameters exceeding 9".

- C. The spiral flighting shall be formed in sections from one continuous flat bar and shall be concentric to within +2mm. Sectional flighting formed from plate shall not be permitted.
- D. Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled in the field and shall be made in accordance with the supplier's requirements. The spiral flights shall be coupled to the end shaft by a flanged, bolted connection.
- E. Field welds at the jobsite by the Contractor for installation may be necessary when any overall conveyor length presents shipping or handling constraints.

2.07 SPIRAL MOUNTING

- A. A gland packing ring consisting of two Teflon fiber packing rings shall seal the drive shaft at its penetration through the end plate, along with a greased labyrinth sealing system.
- B. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating flange and shall be bolted to the spiral connection plate. Additionally, a grease lubricated labyrinth seal shall be shaft mounted internally in the conveyor between the back plate and spiral coupling connection.

2.08 HORIZONTAL AND INCLINED TROUGHS

- A. Troughs shall be U-shaped and similar to the dimensional standards of CEMA 350 and enclosure classification IIE.
 - 1. A flanged drain outlet shall be provided with each conveyor to facilitate cleaning if required by contract drawings. The drain outlet shall be piped to a drain as shown on the drawings, with adequate cleaning facilities. Drain flushing connections are to be provided if and where specified by the contract drawings. The Contractor shall furnish all labor and materials to connect the conveyor flush water and/or drains with the plant water and drain system.
 - 2. Each trough shall be equipped with inlet and/or discharge openings as shown on the contract drawings. If required, each inlet and discharge opening shall be flanged suitable for interconnection to other devices. Any interconnecting devices such as chutes and hoppers shall be fabricated from the same grade of material as the troughs and with a gauge thickness to suit the application requirements.
- B. Bolted covers shall be furnished for any portion of each trough that is not covered by the filling chute. Covers shall be manufactured in maximum five (5) foot length section to allow for easy access and ease of liner replacement. To prevent unsafe access to the conveyors, quick opening covers will not be allowed unless they are also bolted to prevent access during operation. Each conveyor shall be fixed with the appropriate warning labels to call for lock out - tag out of the electrical system before the covers are removed. If required, inspection hatches or sample ports with finger guards will be supplied as indicated on the contract drawings.
- C. In order to avoid excessive wear and increased maintenance the conveyors shall be designed without the use of steel hold down bars. Proprietary hold-down guide liners mounted under the lids will be accepted that do not interfere with the flow of conveyed product.

2.09 WEAR LINERS

- A. Liner - The inside trough surfaces of the conveyors shall be lined with a layer of ultra high molecular weight polyethylene UHMW-PE. The wear liner shall be SPIRAC Duraflo SPX or Xylethon by Durawear. The liner shall be a single piece, formed and bonded with two (2) layers of the same material, each of a different color, to provide a visible indication when the liner is nearing the end of its useful life. Liners with a second layer of different material are not acceptable. The liner shall be supplied in maximum 3.3 foot long sections to provide ease of replacement. The liner shall be held in place with stainless steel clips; no fasteners will be allowed. Liner thickness shall be at a minimum 3/8" for vertical conveyors; 1/2" thick for spirals up to 14" diameter, and 5/8" thick for larger spirals. Liners less than the specified minimum thickness and molecular weight shall not be acceptable.

- B. The liner material shall have the following physical properties, as a minimum:
- | | | |
|------------------------------------|--------------------------------|------------------|
| 1. Property | Value / Unit | Testing Method |
| 2. Density | 61.2 lbs/CF | DIN53479 |
| 3. Molecular Weight | 9.2×10^{-6} g/mol | Margolies |
| 4. Ball Indentation Hardness | 5,946 lbs/in ² | DIN53456 |
| 5. Shore Hardness D | 64 | DIN53505 |
| 6. Crystalline Melting Range | 278 deg. F | |
| 7. Dynamic Coefficient of friction | 0.1-0.12 ratio of tension/load | Plastic to steel |

2.10 CONVEYOR SUPPORTS

- A. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the contract drawings and as required by the supplier's design of 304 stainless steel structural angle, minimum 0.25" thick. The supports shall be shop fabricated from structural steel shapes and plates, and shall be assembled and fitted to the conveyor prior to its delivery to the jobsite. Supports and conveyor segments shall be match marked and shipped to the jobsite for assembly by the contractor. The manufacturer shall allow for 1 inch of grout beneath each support foot pad for the Contractor to compensate for uneven floor elevation. At a minimum, each conveyor shall be provided with supports at the inlet and discharge end, with intermediate supports as required.
- B. All shop welding shall conform to the latest standards of the American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports.
- C. All hanging supports furnished by the conveyor manufacturer shall be one (1) foot longer than required for field fit by the Contractor, who shall supply connections approved by the Engineer. The Contractor shall be responsible for all fasteners both for hanging and floor anchors.

2.11 HOPPERS AND DISCHARGE CHUTES

- A. Furnish inlet and discharge hoppers of the same gauge and construction material as the conveyor troughs, at locations as shown on the drawings. Flanges shall be a minimum 5 mm thick.

2.12 DRIVE UNITS

- A. Each spiral conveyor shall be driven by a constant-speed gear reducer motor drive unit mounted to a bellhousing adapter flange mounted to the end plate of the conveyor.
- B. The adapter flange shall allow the leakage of any material from the conveyor trough to atmosphere rather than into the gear reducer/ motor drive unit. Direct coupling of the gear reducer/motor drive unit to the end flange of the conveyor will not be acceptable.
- C. The drive unit shall be rigidly supported so there is no visible "wobble" movement under any operating condition. In the event of a prolonged power failure or emergency system shutdown the drive system shall be designed, at a minimum, to start the conveyor from a dead stop with the trough filled at 2 X the design load for loads designed up to 67% fill rate and 1.5 X for loads designed exceeding 67% fill rate.
- D. All motors shall be of energy efficient design meeting or exceeding NEMA MG1- table 12-10 and EP Act guidelines. The motors shall be 230/460 volt, 60 Hz, 3 phase conforming to the General Equipment specifications, except as modified herein. Each motor shall be 40°C ambient rated, 3300 feet (1000m) altitude or lower operation, with a maximum temperature rise of 80 degree C by resistance at 1.0 service factor (95 degree C rise at 1.15 s.f.) The motors have Class B insulation with Design B speed/torque characteristics in accordance with NEMA MG1-12.35 and 12.38, and be C face type, with NEMA frame sizes.
- E. Motors shall have a 1.15 service factor and a TEFC enclosure.
- F. Gear Reducers
1. All gears shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have an AFBMA B-10 life of 30,000 hours.

2. The reducer will be air-cooled unit with no auxiliary cooling requirement. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

2.13 ELECTRICAL EQUIPMENT

- A. All electrical equipment shall conform to applicable standard of the National Electrical Manufacturers Association (NEMA) and the National Electrical Code (NEC). Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.
- B. Motion Failure Alarm Unit: An external conveyor mounted motion failure alarm; (alternately known as "zero speed" or "under-speed" switch) to detect spiral or drive shaft failure shall be utilized in this design. Miltronics Model MFP 4 with a NEMA 4 enclosure.
- C. Emergency Shutdown: Each conveyor shall be furnished with an emergency trip cord and safety switch. The cord shall run the full length of each conveyor. The trip switch shall immediately stop all conveyors when the switch is actuated. The switch shall be RS type by Conveyor Components Corporation or approved equal.
- D. Electrical Controls
 1. Except as specified above, electrical controls for the shaftless conveying equipment furnished under this section shall be provided by others, as part of the control panel(s) for the Sludge Dewatering System equipment being furnished under Section 11371.

2.14 SPARE PARTS

- A. Furnish the following spare parts (if applicable to scope of supply) as a minimum;
 1. One (1) Packing gland set, for each conveyor supplied
 2. One (1) Spare light bulbs and fuses of each size used in the electrical control panels
 3. One (1) complete set of liners for all conveyors if the second color of the liner is not the same material as the base liner.
- B. All spare parts except electrical shall be boxed in substantial wooden crates for storage.

2.15 LUBRICANTS

- A. Furnish lubricants of the type and quantity as recommended by the conveyor manufacturer for (start-up) operation.

PART 3 - EXECUTION

3.01 FIELD SERVICES

- A. The conveyor system supplier shall furnish the services at site of a factory-trained representative for a period of one (1) day to the jobsite. Service shall be provided as necessary after the Contractor has installed the equipment. These services shall be furnished for the purposes of;
- B. The equipment manufacturer's inspection of the equipment following installation by others, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner's personnel in the operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.
- C. Field services at the jobsite shall be performed during normal daylight working hours from Monday - Friday; legal holidays accepted. The Supplier's personnel shall not be expected to work overtime.
- D. The Contractor shall coordinate the manufacturer's technical services in a timely professional manner. At a minimum, two weeks' notice must be given to the manufacturer for travel planning purposes unless previously agreed by manufacturer. To avoid project delays, every effort should be made to coordinate inspection, training and startup of the equipment in one trip. If the manufacturer is asked to make trips in excess to the stated contract document requirements due to lack of coordination, planning or efforts of the contractor, then the contractor is responsible for additional costs incurred by the manufacturer.

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- E. After inspection of the installed equipment the Supplier shall furnish 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 anchorage, has been operated under full load conditions and that it operates satisfactorily.

END OF SECTION