2.04 DEDUCTIVE ALTERNATE: CONVENTIONAL EFFLUENT TROUGHS

A. Conventional effluent troughs provided as a deductive alternate shall include troughs, weirs and support system.

B. Troughs

1. Effluent troughs shall meet the following sizing and performance requirement:

a.	Minimum total weir length per basin	600 linear feet
b.	Maximum trough length	60 feet
c.	Minimum number of troughs per basin	5
d.	Minimum distance from basin sidewall	4 feet
e.	Maximum trough spacing	12 feet on center
f.	Maximum backwater along length of trough	2 inches

2. The troughs will be fabricated of Type 304 stainless steel.

3. Design each trough assembly to meet the following deflection limits under the described loading conditions.

   a. Vertical Deflection: Maximum vertical deflection under full buoyant or gravity load shall be the lesser of L/1,000, where L is defined as the unsupported trough length in inches, or 3/16-inch.
   b. Side Wall Deflection: Maximum horizontal deflection under full load shall be the lesser of D/100, where D is defined as the trough depth in inches, or 3/16-inch.
   c. Bottom Deflection: Maximum vertical deflection under full buoyant or gravity load shall be the lesser of W/100, where W is defined as the trough width in inches, or 1/8-inch.

4. Longitudinal stiffening shall be provided to ensure rigidity. Sufficient spacer rods shall be provided to maintain a uniform width over the length of each trough. Spacer rods shall be spaced to prevent buckling and vibration, and to provide maximum resistance to loading on the sidewalls of the trough.

C. Support System

1. The design for the anchor system shall be as provided by the manufacturer. All anchors, fasteners and hardware shall be Type 316 stainless steel. The support system shall allow 1-inch minimum vertical adjustment of the trough, and shall allow no greater than ¼ - inch vertical deflection with either trough empty and water to the weir edge, or trough full and water below bottom of trough.

2. The troughs shall be supported by Type 304 stainless steel supports attached to the basin wall with support from the floor limited to a one-foot strip down the middle of the basin so supports do not interfere with the sludge collection equipment.

D. Weir Plates

1. The weir plates will be fabricated from Type 304 stainless steel. Weir plates shall be the same thickness as troughs. All fasteners will be Type 316 stainless steel, with nylon lock nuts provided for all bolts.

2. The weir plates shall have 2-½ inch deep v-notches on 6 inch centers and shall have 2 inch diameter mounting holes on 12 inch centers to provide vertical adjustment. Four inch washers shall be provided with mounting hardware.

3. Weir butt plates and corner connection plates shall be provided as required.

4. Rubber gaskets 1/8 inch thick shall be provided for installation between the weir plates and the effluent troughs.

5. Care shall be taken by the manufacturer to prevent ferritic contamination during and after fabrication.

2.05 SPARE PARTS

A. Spare parts shall include those recommended by the manufacturer or those listed below, whichever is more comprehensive:

1. Sludge Collector

a. Five (5) shear pins for the cable drive
b. One (1) 8" polyurethane v-groove pulley
c. Six (6) UHMW Delrin wheel bushings
d. One (1) year supply of lubricants (if applicable).

B. See Division 1 for additional requirements.

2.06 MISCELLANEOUS

A. Nameplates and other data plates shall be stainless steel, suitably secured to the equipment.

B. Parts shall be completely identified with a numerical system to facilitate parts inventory control. Each part shall be properly identified by a separate number,

and those parts which are identical shall have the same number to effect minimum spare parts inventory.

C. An inventory of parts shall be maintained in every major market area to provide replacement to the Owner.

PART 3 – EXECUTION

3.01 MANUFACTURER'S SERVICE REPRESENTATIVE

A. The plate settlers manufacturer's field engineer or service representative shall inspect and check the installation after erection, and be on hand for initial start-up and testing of the equipment. A minimum of one (1) trip for an eight (8) hour work day shall be provided.

B. Provide a factory certified service technician for two (2) trips for one (1) day each trip to inspect the installation, and supervise start-up and initial operation of the sludge collector system.

3.02 INSTALLATION

A. The Contractor shall install equipment in accordance with the manufacturers' recommendations. The Contractor shall confirm all vertical and horizontal alignments are in accordance with the manufacturer's recommendations.

B. Care shall be exercised by the Contractor in unloading, transporting and placing plate settlers. Plate settlers shall remain in their containers and protected from environmental extremes until they are installed.

C. Sludge collection equipment shall be stored indoors in a dry area prior to installation.

D. Install sludge collection equipment as indicated on the Drawings and in accordance with the manufacturer's recommendations.

E. Factory certified service technician to provide a field report certifying that the equipment is properly installed, meets specifications, and ready for operation to the Engineer.

3.03 FIELD TESTING OF EQUIPMENT PERFORMANCE

A. Upon completion of installation by the Contractor and startup of the equipment by the manufacturer's field service representative, the equipment shall be tested by the Contractor and manufacturers in the presence of the Engineer under actual operating conditions. The tests shall show that the system and individual

equipment items operate properly and in all other respects fulfill the intended function properly and meet all requirements of the Specifications and Drawings. The tests shall be conducted under the supervision of the manufacturer's technical representative. Testing shall include discharge rate and range of travel.

B. The Contractor shall make, at the Contractor's expense, all necessary modifications, changes, and/or adjustments required to ensure satisfactory operation. The Contractor shall provide all labor, materials, and test apparatus necessary to conduct testing at no additional cost to the Owner.

D. The equipment shall be operated under the supervision of the Contractor and manufacturer's representatives for a minimum of eight (8) hours to insure that all operating characteristics are within acceptable limits.

3.04 MANUFACTURER'S TRAINING

A. A minimum of eight (8) hours of operator training for the sludge collector equipment shall be furnished by a fully qualified field service engineer. The training shall address all aspects of the equipment operation, maintenance, and trouble shooting. The training shall be conducted separate from startup and testing procedures.

B. A minimum of eight (8) hours of operator training for the plate settler system equipment shall be furnished by a fully qualified field service engineer. The training shall address all aspects of the equipment operation, maintenance, and trouble shooting. The training shall be conducted separate from startup and testing procedures.

END OF SECTION

SECTION 46 61 23
FILTRATION EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Work Included

All of the equipment described in this Section shall be supplied by Xylem Water Solutions (FB Leopold) or Engineer pre-approved deductive alternate manufacturers as described herein. This section requires the furnishing and installation of four (4) dual bay granular media filters as shown on the Drawings. The equipment to be supplied shall consist of:

1. Leopold Type XA Underdrain with IMS-200 Media Retainer ®.
2. Filter media consisting of sand and anthracite.
3. FRP washwater troughs.
4. Filter controls and field instrumentation for concurrent air/water backwash

B. Filtration Equipment by the following manufacturers shall be allowed as deductive alternates:

1. Severn Trent Water Purification, Inc. (LP Block™ with S Plate™ media retention cap)
2. Roberts Filter Group (Trilateral Underdrain)

C. References

1. NSF Standard 61: Drinking Water Systems Components - Health Effects.

2. AWWA B100 Water Treatment Filtering Material Latest Edition.

3. ANSI/AWWA F101 Contact-Molded, Fiberglass-Reinforced Plastic Washwater Troughs and Launders.

4. ANSI/AWWA F102 Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates Scum Baffles and Mounting Brackets.

5. ASTM Standards listed in Section 1.4.H, Table 1.

1.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. General Requirements

1. The filter underdrain system shall be designed and installed to ensure long term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects which would in time cause loss of efficiency or effectiveness in its operation.

2. The underdrain system is intended to allow for the uniform collection of filtered water and uniform distribution of backwash water and air over the total area of the filter floor.

3. The backwash system shall allow for separate air scouring and water backwashing and for the simultaneous use of air and water at the specified rates.

4. The system shall be designed to avoid localized areas of excessive flow (maldistribution) which may cause mounding, lateral displacement, or other deleterious disturbances in the filter support or media.

5. When subjected to a flow rate of 20 GPM/SF of filter area the headloss through an underdrain lateral 32 feet long shall not exceed 45 inches of water column.

6. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches water column at a backwash flow rate of 20 GPM/SF of filter area.

7. The underdrain system shall have an integral grout pocket designed to provide uplift resistance as a result of internal pressurization of 30 PSI without any external mechanical anchors.

8. An air scour system at the rate of four (4) SCFM/SF of filter area shall be supplied to ensure optimum cleaning.

9. The washwater troughs shall be as described in the Drawings and Specifications. Trough carry off capacity shall be 20 GPM/SF of filter area with a freeboard of at least 2 inches.

10. A filter control system shall be furnished for controlling and monitoring the operation of the filter system. The control system shall be supplied by the filter equipment supplier and shall include all instrumentation, consoles, hardware, fittings, supports, and related appurtenances as required for a complete and fully functional filter control system. Each filter console shall interface with the main plant process control panel. Also, the filter consoles shall provide certain levels of control in situations when the main plant control panel is not functioning or communications

are lost. Refer to Specification Section 40 96 35 for specifics regarding communication and controls.

B. Design Flow Rates: The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:

1. Downflow of filtered water up to 10 GPM/SF. Typical operating downflow will be between 2 and 6 GPM/SF.

2. Upflow of backwash air at a rate in the range of 2 to 5 SCFM/SF.

3. Upflow of backwash air, together with backwash water. Typical recommended combined air and water rates: 4 SCFM/SF and 5 GPM/SF.

4. Upflow of backwash water up to 25 GPM/SF.

C. Flow Distribution: The filter underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution (MD) of air and water flows during backwash shall be as follows:

1. Lateral Water MD: The maldistribution in a lateral 32 feet long or less shall not exceed +/- 3 percent of the average GPM/SF of filter for a backwash rate of 20 GPM/SF.

2. Flume Water MD: Consider maldistribution caused the specific flume arrangement, and resulting flow velocities and entry conditions into both flume and underdrain laterals.

3. System Air MD: Visually, the air should show a uniform pattern.

D. Structural Design Requirements

1. General: The filter underdrain system, including anchorage, supports, etc. shall be designed to safely withstand loadings for the specified conditions.

2. Internal Loading: The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 1,400 PSF or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of gravel or filter media.

3. Downward Load: The filter underdrain system shall also be designed to withstand a net downward loading of not less than 2,800 PSF.

E. Air Temperature: During backwash with air, the underdrain shall be suitable to withstand a maximum air temperature of 200° F.

1.03 QUALITY ASSURANCE

A. Manufacturer: The filter system supplier for the filter equipment and related control equipment shall be Xylem Water Solutions (FB Leopold), Zelienople, Pennsylvania.

B. Experience: The underdrain system shall be a standard product of a filter manufacturer who has been actively providing dual-parallel lateral air/water underdrain equipment for at least 15 years. Upon request, the filter manufacturer shall provide the Engineer with a list of installations of similar dual parallel lateral underdrain which totals not less than 100.

C. NSF Certification: All materials used in contact with the water and backwash air shall meet National Sanitation Foundation (NSF) Standard 61 Drinking Water System Components - Health Effects.

D. Underdrain: The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining bridges, closures, gaskets, etc., shall be the products of a single manufacturer/ supplier.

E. Uplift Certification:

1. The underdrain manufacturer shall provide third party certification that the underdrain can withstand a minimum of 30 PSI internal pressure or uplift without lifting or separating from the filter floor when properly installed with grout and no mechanical anchoring.

F. Hydraulic Demonstration

1. The underdrain manufacturer shall, at their own facilities, if requested by the Engineer, set up a test lateral run of equal length to that required by the project and provide an opportunity for the Engineer and/or Owner to visit the facility to witness a full scale demonstration of the headloss and flow distribution during backwash.

2. The test facility shall be capable of demonstrating concurrent air and water distribution in a submerged trough and water only distribution on a non-submerged test bench.

3. These demonstration services shall be provided by the filter manufacturer with reasonable notice and at no additional expense to the Owner or Engineer.

G. Media: The filter equipment manufacturer shall furnish a Quality Control Manual demonstrating that the filter media to be furnished will comply with the requirements of the Specifications. The Quality Control Manual shall define the following:

1. Qualification of the raw feedstock

2. Control procedures at the screening mill

3. Independent testing laboratories

4. Packaging definition

5. Purchase orders

6. Storage procedures

H. Filter Control System: The filter control system equipment shall be supplied by the filter system manufacturer and the design and fabrication of the control consoles shall be coordinated with the Instrumentation Supplier to ensure signal compatibility and seamless integration into the overall plant control system.

1.04 SUBMITTALS

A. Submit to the Engineer complete shop drawings showing details of fabrication, materials of construction, installation and leveling data of all items furnished under this Section. Submittals shall be in accordance with Section 01 33 00, Submittal Procedures.

B. Details submitted shall include as a minimum, headloss data for air, water and combined air/water backwash, installation details, flow distribution calculations, certification of compatibility of the underdrain system with the filter media specified in this Section, details for installing reinforcing and other items to be embedded in concrete.

C. Testing Procedures: Detailed start-up, hydraulic, and air scour test procedures.

D. Proper documentation showing NSF-61 certification of all underdrain components.

E. The media submittal and technical information shall be provided and approved by a licensed engineer regularly employed by the filter manufacturer. The engineer shall have at least 15 years' experience in water treatment. All submittal shall include the following information as a minimum:

1. Supplier's Name

2. Resume of Engineer Providing Submittal

3. Quality Control Manual

4. Gradation of Each Media Type

5. Date of Sampling/Lot Number

6. Samples of Each Media Type (If Required)

7. Representative Sample Analysis, (i.e. effective size, uniformity coefficient, specific gravity, acid solubility and MOH hardness for Anthracite only.)

8. Material Quantities

9. Diagram with Type of Material and Depth of Each

10. Estimated Shipping Schedule

11. Media Loading Procedure

12. All testing shall conform to the requirements of the latest edition of AWWA B100.

F. Wash Water Trough Testing

1. Manufacturer shall, upon request, furnish the Engineer with certified test reports consisting of the mechanical and physical tests listed below.

2. Procedure to be used in determining the properties listed in Table 1 below shall be in accordance with latest ASTM standards: Ultimate Tensile Strength - ASTM Designation D638; Flexural Strength - ASTM Designation D790; Modulus of Elasticity - ASTM Designation D790; Hardness - ASTM Designation D2583; Water Absorption - ASTM Destination D570.

3. Hardness tests shall be made on the resin-rich surface of the product.

4. Flexural tests shall be made with resin-rich surface in compression.

5. Test samples shall be full thickness of the item produced and shall not be machined on the surface.

6. Mechanical and physical properties shall conform to those of Table 1 and according to ANSI-AWWA Specification F101 Table 4 - Minimum Physical Properties of Laminates.

TABLE 1
LAMINATE MECHANICAL AND PHYSICAL PROPERTIES 73°F

	ASTM Test Method	For 1/4" Wall Thickness
Ultimate Tensile Strength, PSI x 10^3 min	D638	12
Flexural Strength, PSI x 10^3 min	D790	19
Flexural Modulus of Elasticity, PSI x 10^3 min	D790	0.9
Barcol Hardness (min)	D2583	35
Water Absorption - % (max)	D570	0.2

1.05 SHIPMENTS

A. Media materials shall not be shipped until the submittal is approved by the Engineer. Approval of the submittal, including the Quality Control Manual, samples and independent testing, shall constitute acceptance of the media.

B. The schedule of work shall be submitted to the Engineer for approval prior to commencement of work.

C. The Contractor shall be responsible for coordinating the shipment of supplies of materials and equipment specified herein. Coordination will be required during construction, startup and/or testing.

D. The Contractor shall provide storage space for filter media and protect it from exposure to sunlight if stored for more than two (2) weeks.

E. The Contractor shall be responsible for storage of the filter control system equipment. The storage area shall be indoors, reasonably dust-free and protected from exposure to water or any corrosive materials.

1.06 OPERATION AND MAINTENANCE DATA

A. Six (6) copies of an operating and maintenance manual shall be furnished to the Engineer as specified herein and in accordance with Section 01 78 23. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions and necessary information required to instruct operating and maintenance personnel unfamiliar with all of the equipment specified herein. A complete, corrected and approved copy of the shop drawing submittal shall be included with each manual provided.

B. Complete operation and maintenance instructions shall be submitted after the Shop Drawings are approved, but prior to shipment of equipment.

PART 2 PRODUCTS

2.01 UNDERDRAIN

A. There shall be four (4) dual bay filters having a total of eight (8) cells with 12'-0" long lateral runs and an overall width of 44'-0"

B. The underdrain system for the filters shall be Leopold Type XA dual parallel lateral whereby feeder and compensating chambers are provided within the cross section of a single block. The cross section of the underdrain shall be where the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four (4) different elevations and sized to provide uniform distribution of air and water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures to install internal orifices and underdrains with circular water orifices in the primary chamber will not be considered acceptable. The primary chamber shall provide at least 43 square inches of cross sectional area per block to reduce flow velocity during backwash.

C. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall be not less than 11/64 inch diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch. The top of each orifice shall be encircled by a depression approximately 3/8 inch x 3/4 inch, which shall act to prevent the gravel support media from resting directly on and thereby blocking the dispersion orifice.

D. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of air and water coverage which direct flow vertically for effective penetration and cleaning of the media.

E. Dual water recovery channels with return holes shall be incorporated into the top of the underdrain block to ensure uniform and continuous air flow from the top deck orifices and greater air stability. Underdrains without a water recovery channel will not be considered acceptable.

F. The secondary chambers of the underdrain shall have baffles sized and located to provide effective air control and to reduce level sensitivity. Underdrains without baffles will not be considered.

G. The secondary chambers of the underdrain shall have baffles sized and located vertically along the exterior of the primary chamber to provide effective air and water control.

H. The underdrain shall have a lug located on the exterior of the underdrain to allow simple connection and disconnection of an optional handle. The optional handle shall be removed once the filter laterals are set in place within the filter tank.

2.02 FILTER MEDIA

A. Filter sand shall be composed of hard, durable clean siliceous particles, free of all mica with an average specific gravity of 2.6 (±.05) and shall be in strict accordance with AWWA B100, and have an effective size of 0.45 – 0.55 mm, and a uniformity coefficient of 1.40 or less, for a finished depth after backwashing and scraping and removal of fines and debris of 15 inches. A skimming allowance of 1/2-inch shall be provided.

B. Filter anthracite shall be composed of specially selected and graded hard, durable anthracite coal particles. The anthracite shall be composed entirely of deep mined material. A quality control manual shall be included to show the source of the material and the quality of the material produced. The anthracite shall have an average specific gravity of 1.65 (±0.05) with a hardness (Mohs scale) of 2.7 or more and shall be essentially free of iron, clay, shale, extraneous dirt, and excessive dust with moisture less than 4.0 percent as shipped. The anthracite shall be in accordance with AWWA B100, and have an effective size of 0.95 – 1.05 mm, and a uniformity coefficient of 1.40 or less for a finished depth after backwashing and scraping and removal of fines and debris of 15 inches. A skimming allowance of 1 inch shall be provided.

2.03 FIBERGLASS WASH WATER TROUGHS

A. Loadings - The troughs shall be designed to support, within stress and deflection limitation, the following loadings:

1. Gravity Load - Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as weir plates and the spreader bars, together with the weight of water to fill the trough. Any additional loads, such as piping, etc., shall also be considered.

2. Buoyant Load - The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.

3. Lateral Load - Loads acting against the trough side walls; specifically, those induced by differential water levels on either side of the trough walls. The

maximum possible differential, existing when the trough is empty and the tank is full, or when the trough is full and when the tank is empty, shall be used when calculating deflection, fiber stress, etc.

4. Thermal Stresses - The troughs shall be designed to accommodate temperature induced stresses resulting from differences in coefficients of thermal expansion (contraction) between the trough and tank/support materials.

B. Torsional Stability - The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges. Any or all of the following trough stabilization techniques shall be considered.

1. Trough-to-trough stabilization

2. Torsional stiffness

3. Support spacing and rigidity

4. Internal baffles and/or flow straighteners

C. Deflection Under Load

1. Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to L/1000, where L is defined as the unsupported trough length in inches (mm). Under no circumstances shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16 inch (4.8 mm).

2. Maximum trough side wall horizontal deflection under full lateral load shall be less than or equal to D/100, where D is defined as the trough depth, in inches (mm). Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

3. Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to W/100, where W is defined as the trough width, in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

D. Fiber Stress Limitations - Supplemental to the deflection criteria, the troughs shall also be designed such that the maximum wall stress under the most severe loading conditions is less than or equal to 1500 psi. This stress criterion is equivalent to 7:1 safety factor (approximate) as applied to the tensile and flexural properties of contact molded troughs and launders.

E. Thermal Expansion/Contraction - The troughs shall be designed to accommodate a thermally induced expansion (contraction) of 1/8 inch per 20-foot length of trough over temperature range of 10°F to 100°F, without exceeding the deflection or strain limitations set forth in the preceding paragraphs.

2.04 FILTER CONTROL SYSTEM

A. A complete filter control system shall be provided. The control system shall include all instrumentation, consoles, hardware, fittings, supports, and related appurtenances required for a complete and operational filter system. As a minimum, the control system shall consist of the following:

Four (4)	Filter control console (one for each dual bay filter)
Four (4)	Magnetic flow meters (one for each filter effluent)
One (1)	Bubbler type level sensor (one for filter influent channel)
Four (4)	Ultrasonic level sensors (one for influent channel and one for each dual bay filter)
Four (4)	Filter headloss differential pressure transmitters (one for each dual bay filter)
Five (5)	Turbidimeters (one for each filter effluent and one for the combined filter flow)

B. All equipment and instrumentation shall be supplied in accordance with the requirements in Paragraph 2.05 of this Section.

2.05 MATERIALS AND CONSTRUCTION

A. Underdrain

1. Material: The individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces.

2. Dimensions: The block size and weight shall permit ease of handling and installation. The block nominal dimensions shall be 8.25 inches high by 11 inches wide by 48 inches long. The weight of the block shall be approximately 24.5 pounds. Underdrains with heights greater than 8.25 inches shall not be allowed.

3. Block Geometry: The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout. The bottom of the block shall have integral grout pockets located at each end.

4. Lateral Construction: The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell. The joints shall be gasketed, bell and spigot type with internal alignment tabs for proper joint alignment, and be air and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation.

5. IMS® 200: The IMS® 200 media retainer shall be made of thermoplastic through the injection molded process and sealed to the top of the underdrain. The IMS® 200 media retainer shall be made from two (2) separate sections that are permanently sealed together to form slots or openings. The opening size shall be sufficient to prevent the media from obstructing or passing through the underdrain. Vertical baffles shall be located on the bottom side of the media retainer to "compartmentalize" the fluid to keep it from moving horizontally along the bottom side of the media retainer thus ensuring each pattern of slots in the media retainer receives equal quantities of air and or water during the backwash cycle. The I.M.S® 200 media retainer shall replace the need for support gravel and shall not increase the underdrain height by more than 1 1/4 inch. The cap shall be attached and sealed to the underdrain at the factory using Type 316 stainless steel self-tapping screws and 3M Weatherban Sealant Tape.

B. Grout

1. Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become "lumpy" shall not be used.

2. Water: Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Water with a total dissolved solids of 1,000 mg/l or higher or greater than 10 NTU shall not be used.

3. Sand: Sand shall be clean and washed masonry sand. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 90% for an average of three samples, or less than 85% for any individual sample. 100% of sand particles shall pass No. 4 sieve and not more than 4% of sand particles shall pass No. 200 sieve.

4. Chemical Admixtures: No chemical admixture shall be needed in most of the applications. The grout shall be mixed in a small batch and used immediately.

5. Strength: The grout used in installing the blocks shall have a minimum compressive strength of 3,000 psi after 30 days of curing. Normally, use a grout with one part Portland cement and two parts clean silica sand properly mixed and wetted with a maximum water-cement ratio by weight equal to 0.50 to 0.55 for the base grout and 0.61 to 0.67 for the fill grout.

C. Wash Water Troughs:

1. Resin: The resin shall be a commercial grade, general purpose polyester thermosetting resin, which has either been evaluated in a laminate, or which has been determined by a previous documented service to be acceptable for the service conditions.

   a. The resin shall contain no fillers except as follows:

      1) A thixotropic agent which does not interfere with laminate quality, or with the required chemical resistance of the laminate, may be added for viscosity control.
      2) Resin may contain pigments, dyes or colorants which have been determined by at least five (5) years previous service to be acceptable for the service condition without fading or chalking from original color standard.

2. Ultraviolet Resistance: All laminates shall have ultraviolet resistance in the form of pigmentation or ultraviolet absorbers.

3 Metal Reinforcement: When metal reinforcements are used, they shall be free of rust, oil, and any foreign matter. They shall be completely encapsulated with a minimum of 1/8-inch thick laminate.

4. Glass Reinforcement: Glass reinforcements shall consist of chemically bonded surfacing mat and chopped strand or chopped strand mat as hereinafter described. Surfacing mat shall be Type C, 10-20 mils thick, with a silane finish and a styrene-soluble binder. Chopped strands shall be Type E glass, with silane finish and styrene-soluble binder. The glass content of the finished laminate shall be adequate to produce mechanical and physical properties conforming to Table 1.

5. Manufacture:

a. The inner surface of the trough shall be smooth and resin rich. The outer surface shall be reasonably smooth and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks or crazes.

b. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with chopped strand glass laminate (max. 2 oz. per sq. ft.) in a minimum of two (2) layers. Void content of the complete laminate shall not exceed 2 ½ % of laminate volume.

c. Tolerances:

1) The top edges of the trough shall be level and parallel with a tolerance of plus or minus 1/8 inch (measured when the trough is not loaded).
2) The length of a trough section shall have a tolerance of ±1/8-inch per 10 feet length.
3) The laminate thickness tolerance shall be plus 1/8 inch minus 0.

d. Thickness at locations of supports such as saddles shall be at least 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of this Specification.

e. End flanges and blind ends shall be a minimum of 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of this Specification.

f. An integrally molded water stop shall be provided on the trough whenever the trough is grouted into and/or passes through a wall.

g. One-inch diameter ABS spreaders shall be bolted between the trough walls on approximate 2-foot centers to enhance the structural rigidity of the trough system.

D. Filter Control System: The filter control system shall include the following equipment and instrumentation.

1. Filter Control Console

a. One (1) filter control console shall be provided for controlling and monitoring the operation of each dual bay filter.

b. Each console shall be a PLC-based system and shall be provided complete with the necessary control devices, signal converters, and equipment to perform the control and monitoring functions as shown on the Instrumentation Drawings and described in Section 40 96 35. Each console shall include a touch screen HMI and PLC manufactured by Siemens which conforms to the requirements of Section 40 94 00. The consoles enclosures shall be NEMA 4X Type 316 stainless steel units which include the following front console components as shown on the Drawings:

- Filter flow readout
- Filter water level readout
- Filter headloss readout
- Filter turbidity readout
- Backwash storage tank level readout
- Backwash flow readout
- 10" Siemens touchscreen HMI
- Filter influent valve local-remote-close-open selector switch with valve position indication lights
- Filter effluent valve local-remote-close-open selector switch with valve position indication lights
- Filter to waste valve local-remote-close-open selector switch with valve position indication lights
- Filter backwash supply valve local-remote-close-open selector switch with valve position indication lights
- Filter backwash air supply valve local-remote-close-open selector switch with valve position indication lights
- Filter backwash drain valve local-remote-close-open selector switch with valve position indication lights
- Filter solenoid vent valve local-remote-close-open selector switch with valve position indication lights
- Filter backwash remote-start-stop selector switch with indication lights
- Indication lights to indicate "filtering", "high headloss", "high turbidity", "backwash required", "backwash blower running," and "backwashing"

c. Programming of the filter control consoles shall be provided by the filter manufacturer. This programming shall be coordinated with the Instrumentation Supplier who will be addressing the plant-wide instrumentation and control systems.

d. Filter control console inputs and outputs shall be as shown on Instrumentation and Electrical Drawings.

e. Filter control console components and layout shall be as specified in Specification Section 40 99 90, Packaged Control Systems, and as shown on the Instrumentation Drawings.

2. Magnetic Flow Meters

a. Sizes and locations shall be as shown on the Drawings.

b. Magnetic Flow Meters shall be provided per Specification Section 40 91 23.33, Flow Measurement.

3. Field Instrumentation

a. Common Influent Channel Level Sensor

1) A level transmitter shall be provided at the common filter influent channel for generation of the filter effluent rate of flow setpoint.
2) The level sensing system shall be a bubbler type system.
3) The level sensor shall be as specified in Specification Section 40 91 23.36, Level Measurement.

b. Filter Continuous Level Sensors

1) A level transmitter shall be provided for each filter.
2) The filter level sensing system shall be an ultrasonic-type, electronic continuous level transmitter, complete with sensing element and integral electronics. The sensor shall be powered by a nominal 24 VDC loop power supply and shall generate a standard 4-20 mADC output signal.
3) The level sensor shall be as specified in Specification Section 40 91 23.36, Level Measurement.

c. Filter Loss of Head Transmitters

1) A loss of head transmitter, complete with three-valve manifold, and strainer, shall be supplied to monitor the loss of head through each filter.
2) The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be ±0.25% of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).
3) The loss of head transmitter shall be Rosemont Model 3051 or an approved equal.

d. Effluent Turbidimeters: An effluent turbidity meter shall be provided for each filter and for the combined filter effluent flow. The turbidimeter shall be a Hach 1720E as specified in Section 40 97 00.

2.06 DEDUCTIVE ALTERNATES

A. Equipment by Roberts Filter Group shall meet the requirements of this specification with the exception of the following allowable differences:

1. The filter underdrain system shall also be designed to withstand a net downward loading of not less than 1,400 PSF.

2. Dual water recovery channels and baffles shall not be required in the underdrains.

3. The Trilateral Underdrain shall be 12 inches high. The Contractor shall be responsible for any redesign required to use this underdrain.

4. Secondary drilling shall be allowed to create circular orifices in the underdrain.

5. The media support plate shall be made of ultraviolet resistant high density polyethylene beads sintered together. The media support plate shall be 3/4" thick. The average size of the pores shall be 500 microns and the pore volume shall be 40 to 50 percent of the plates overall volume. The top surface of the plate shall average no more than 10 beads with flattened sides per square inch of plate. A flattened side is defined as a flat surface surrounded by sharp edges, produced during the sintering process, that occupy more than approximately 10 percent of the total area of the bead. No more than 35% of the total beads on the top surface of the plate shall be flattened.

6. Accommodations for detachable handles on the underdrains shall not be required.

7. Underdrain system may be designed for a maximum backwash rate of 20 gpm/sf.

8. Grout pockets for block hold down shall not be required. An alternate method of resisting uplift shall be provided.

B. Equipment by Severn Trent Water Purification, Inc. shall meet the requirements of this specification with the exception of the following allowable differences:

1. The LP Block™ underdrain shall be provided. The height of the block shall be approximately 8 inches (203 mm) and the width approximately 17 inches (431 mm).

2. Dual water recovery channels and baffles shall not be required in the underdrains.

3. Each block shall have wedge shaped ribs on the bottom of the block to key into the floor grout and provide uplift resistance. The underdrain manufacturer shall provide third party certification that the underdrain can withstand a minimum of 15 PSI internal (uplift) pressure without lifting or separating from the filter floor when properly installed with grout and no mechanical anchoring.

4. S Plate™: A porous cap constructed of sintered HDPE beads shall be mounted to the underdrain block. This cap will eliminate the need for any gravel layers. The cap shall be fastened to the underdrain with a minimum of (18) 316 stainless steel screws and sealed with an NSF approved sealant. The cap shall have an average pore size of 500 microns and shall be no more than 1" thick.

5. The Contractor shall be responsible for any redesign required to use this underdrain.

6. Underdrain system may be designed for a maximum backwash rate of 20 gpm/sf.

PART 3 EXECUTION

3.01 PRODUCT HANDLING, STORAGE AND DELIVERY

A. Place or store underdrains and specialties only in designated staging areas shown on the Drawings and approved by the Engineer.

B. Store underdrains and specialties off the ground, under ultraviolet-resistant tarps from time of delivery on-site until final installation of the filters.

C. Replace, at no charge to Owner, underdrains and specialties damaged during storage and delivery.

D. Underdrains and specialties are subject to inspection at the Engineer's request if visual evidence of damage is observed.

E. All filter media shall be shipped in "semi-bulk" containers having lifting loops and bottom discharge spout. Anthracite superbags shall be 60 cubic feet (1.7 cubic meters) weighing approximately 3,000 pounds each.

F. Delivery of "bulk" shipments will not be permitted unless the Contractor can demonstrate that the materials can be handled and stored without contamination.

G. Troughs shall be suitably packaged to avoid damage during handling and shipment. Should it be necessary to store product prior to installation, precautions shall be taken to prevent warpage or distortion.

H. Troughs should be stored on a flat place and adequately supported on wooden support members to evenly distribute weight of troughs. When stored more than one (1) high, succeeding items shall be stored level and evenly supported by blocks or spacers.

3.02 INSTALLATION

A. Filter Underdrains

1. The Contractor shall install the filter underdrain system in strict accordance with: (1) the manufacturer's written instructions and recommendations and the manufacturer's installation drawings; (2) the oral and written directions provided by the manufacturer's technical representative who is supervising and observing the work; and (3) any additional requirements specified herein.

2. Floor Preparation

a. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions, but have a rough, broom finish. Do not trowel or finish the floor to a smooth finish.

b. DO NOT PAINT the floor or wall area where it will come in contact with the grout surrounding the underdrain. The filter floor and filter wall extending sixteen (16) inches (406 mm) up from the filter floor is not to be painted.

3. Underdrain Lateral Installation

a. The underdrain laterals shall be set in relatively level rows on a bed of grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer and installed by the Contractor. After joining, aligning and setting the blocks, and the bed grout is set-up, as soon as possible, all spaces between the rows of blocks and walls shall be filled with grout so

that the entire bed is totally sealed and held firmly in place. Once all grouting is complete, the grout shall be allowed to cure for at least (3) full days before any functional testing.

4. Cleaning and Protection During Installation, Testing, and Startup

   a. The Contractor shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter underdrain system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash air and water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter cell and flume shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed. As installation progresses, partially completed portions of the work shall be protected with heavy plastic sheeting or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the media is installed.

   b. Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with ½ inch minimum plywood sheeting where necessary, to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

B. Media

1. Marks shall be placed on the side of the filter designating the top elevation of each layer.

2. Carefully place each layer so as not to disturb the previous layers.

3. Complete the installation of each layer before the next layer above is started. Do not stand or walk directly upon the filter materials. Workers must stand or walk on boards that will sustain their weight without displacing the media.

4. Measure depth of each layer of media after it has been backwashed and skimmed as recommended by the filter equipment manufacturer.

5. Clean the filter tanks before any media is placed and keep them clean throughout the placing operation.

6. Sand Placement: After the underdrain system inspection and testing is complete and acceptable to the Engineer, the filter sand shall be installed in accordance with AWWA Specification B100 and the manufacturer's recommendations. Following sand placement, the filter shall be thoroughly backwashed a minimum of three (3) times and the top of the sand bed lightly scraped to remove fines and debris. After scraping the finish depth shall be 15-inches as shown on the Drawings.

7. Anthracite Placement: Following sand scraping, the filter anthracite shall be installed in accordance with AWWA Specifications B100 and the manufacturer's recommendations. Following anthracite placement, the filter shall be thoroughly backwashed a minimum of three (3) times and the top of the anthracite shall be lightly scraped to remove fines and debris. After scraping, the finish anthracite depth shall be 15-inches as shown on the Drawings.

C. Wash Water Troughs

1. All trough mounting brackets, hardware and stabilizers shall be Type 18-8 stainless steel and shall be supplied by the trough manufacturer.

2. Troughs shall be installed so that the trough weir edges are level to within ± 1/8 inch.

D. Filter Controls and Instrumentation

1. The Contractor shall be responsible for installation of the filter control consoles and all wiring from the console to field devices, instruments, and other systems.

2. Programming and start-up shall be performed after all final elements, field devices, and instruments have been installed, calibrated, and wired in the circuit.

E. Install all items in accordance with the filter equipment manufacturer's recommendations. Upon completion of the installation, the technical director shall furnish a certificate of compliance detailing that the filter equipment, including instrumentation and controls have been installed in accordance with the manufacturer's instructions.

3.03 FIELD TESTING

A. Underdrain Lateral Flow Distribution Test

1. The filter underdrain system in each filter cell shall be given a series of visual, qualitative, flow distribution tests to verify that IMS® Cap pores are

not clogged with debris and that flow distribution is uniform. These tests shall be performed before the filter media is placed.

2. During each test, the underdrain laterals shall be visually inspected for uniform distribution of air and water and for any signs of quiescent zones and excessive surface turbulence.

3.04 MANUFACTURER'S SERVICES

A. Mechanical Filter Equipment Services

1. The underdrain manufacturer shall retain on its permanent staff, field service representatives with at least 10 years of experience in the placement of underdrain.

2. The Contractor shall provide the services of the manufacturer's technical representative for not less than four (4) working days (8 hours per day) to inspect and supervise the installation and testing of the filter underdrain system in two (2) trips.

3. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses.

4. An additional one (1) day and one (1) trip shall be allocated for operator training. On-site training of the Owner's personnel shall be provided at the time of filter start-up to familiarize personnel with the filter underdrain characteristics and to instruct them in day to day operations, preventative and regular maintenance, troubleshooting techniques, and system diagnostics for the filter underdrain system.

B. Controls and Instrumentation Services

1. The filter manufacturer shall provide a technical representative to assist the Contractor's personnel with the installation, testing, and startup for not less than four (4) working days (8 hours per day) in two (2) trips. The factory service technician shall have a minimum of five years experience in the startup of air/water filter backwash systems.

2. The filter manufacturer shall provide the services of the PLC programmer who performed the programming work for the control consoles to provide programming modifications requested by the Owner to optimize the control system. Such services shall include a total of 40 hours of on-site programming time working in the presence of the Engineer and Owner. Travel time, lodging, and similar expenses shall be borne by the filter

equipment supplier. Services included under this Paragraph shall not be used to correct errors or address items that do not conform to the Specifications

3. An additional two (2) days and one (1) trip shall be allocated for operator training. On-site training of supervisors and shift operators shall be provided at the time of start-up to familiarize personnel with the hardware and to instruct them in day to day operations of the controls, preventative and regular maintenance, troubleshooting techniques, and system diagnostics.

4. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses.

3.05 DOCUMENTATION

A. As a minimum, documentation shall include:

1. Complete console shop drawings showing layouts, schematics, and interconnections among field mounted equipment and other systems

2. Manufacturers' standard instruction bulletins for all functional components

3.06 SPARE PARTS

A. Spares shall be provided as follows:

- Ten (10) underdrain o-rings.
- Five (5) plastic end caps.
- Two (2) of each switch, push-button and light used
- Two (2) of each type of relay used.
- One (1) of each type of PLC I/O card used.
- One (1) of each type of PLC power supply used.

END OF SECTION

SECTION 46 61 24
GRANULAR ACTIVATED CARBON CONTACTOR EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Work Included

All of the equipment described in this Section shall be supplied by Xylem Water Solutions (FB Leopold) or Engineer pre-approved deductive alternate manufacturers as described herein. This Section requires the furnishing and installation of four (4), dual bay granular activated carbon (GAC) Contactors as shown on the Drawings. The equipment to be supplied shall consist of:

1. Leopold Type XA Underdrain with IMS-200 Media Retainer ®.

2. Contactor media consisting of Virgin GAC

3. FRP washwater troughs.

4. GAC Contactor controls and field instrumentation for hydraulic only backwash

B. Filtration Equipment by the following manufacturers shall be allowed as deductive alternates:

1. Severn Trent Water Purification, Inc. (LP Block™ with S Plate™ media retention cap)

2. Roberts Filter Group (Trilateral Underdrain)

C. References

1. NSF Standard 61: Drinking Water Systems Components - Health Effects.

2. AWWA B100 Water Treatment Filtering Material, Latest Edition.

3. ANSI/AWWA F101 Contact-Molded, Fiberglass-Reinforced Plastic Washwater Troughs and Launders.

4. ANSI/AWWA F102 Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates Scum Baffles and Mounting Brackets.

5. ASTM Standards listed in Section 1.4.H, Table 1.

1.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. General Requirements

1. The filter (GAC Contactor) underdrain system shall be designed and installed to ensure long term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects which would in time cause loss of efficiency or effectiveness in its operation.

2. The underdrain system is intended to allow for the uniform collection of filtered water and uniform distribution of backwash water over the total area of the filter floor.

3. The system shall be designed to avoid localized areas of excessive flow (maldistribution) which may cause mounding, lateral displacement, or other deleterious disturbances in the filter support gravel or media.

4. When subjected to a flow rate of 20 GPM/SF of filter area the headloss through an underdrain lateral 32 feet long shall not exceed 45 inches of water column.

5. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches water column at a backwash flow rate of 20 GPM/SF of filter area.

6. The underdrain system shall have an integral grout pocket designed to provide uplift resistance as a result of internal pressurization of 30 PSI without any external mechanical anchors.

7. The washwater troughs shall be as described in the Drawings and Specifications. Trough carry off capacity shall be 18 GPM/SF of filter area with a freeboard of at least 2 inches.

8. A GAC contactor control system shall be furnished for controlling and monitoring the operation of the GAC contactor system. The control system shall be supplied by the GAC contactor equipment supplier and shall include all instrumentation, consoles, hardware, fittings, supports, and related appurtenances as required for a complete and fully functional GAC contactor control system. Each contactor console shall interface with the main plant process control panel. Also, the contactor consoles shall provide a certain level of control in situations when the main plant control panel is not functioning or communications are lost. Refer to Section 40 96 35 for specifics regarding communication and controls.

B. Design Flow Rates: The underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:

1. Downflow of filtered water up to 10 GPM/SF. The design downflow is 4 GPM/SF of filter area.

2. Upflow of backwash water up to 25 GPM/SF.

C. Flow Distribution: The underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution (MD) of water flows during backwash shall be as follows:

1. Lateral Water MD: The maldistribution in a lateral 32 feet long or less shall not exceed +/- 3 percent of the average GPM/SF of the underdrain area for a backwash rate of 18 GPM/SF.

2. Flume Water MD: Consider maldistribution caused the specific flume arrangement, and resulting flow velocities and entry conditions into both flume and underdrain laterals.

D. Structural Design Requirements

1. General: The filter underdrain system, including anchorage, supports, etc. shall be designed to safely withstand loadings for the specified conditions.

2. Internal Loading: The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 1,400 PSF or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of the media.

3. Downward Load: The underdrain system shall also be designed to withstand a net downward loading of not less than 2,800 PSF.

1.03 QUALITY ASSURANCE

A. Manufacturer: The GAC contactor system supplier for the GAC contactor equipment and related control equipment shall be Xylem Water Solutions (FB Leopold), Zelienople, Pennsylvania.

B. Experience: The underdrain system shall be a standard product of a manufacturer who has been actively providing dual-parallel lateral air/water underdrain equipment for at least 15 years. Upon request, the manufacturer shall provide the Engineer with a list of installations of similar dual parallel lateral underdrain which totals not less than 100.

C. NSF Certification: All materials used in contact with the water shall meet National Sanitation Foundation (NSF) Standard 61 Drinking Water System Components - Health Effects.

D. Underdrain: The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining bridges, closures, gaskets, etc., shall be the products of a single manufacturer/supplier.

E. Uplift Certification:

1. The underdrain manufacturer shall provide third party certification that the underdrain can withstand a minimum of 30 PSI internal pressure without lifting or separating from the structure floor when properly installed with grout and no mechanical anchoring.

F. Hydraulic Demonstration

1. The underdrain manufacturer shall, at their own facilities, if requested by the Engineer, set up a test lateral run of equal length to that required by the project and provide an opportunity for the Engineer and/or Owner to visit the facility to witness a full scale demonstration of the headloss and flow distribution during backwash.

2. The test facility shall be capable of demonstrating concurrent air and water distribution in a submerged trough and water only distribution on a non-submerged test bench.

3. These demonstration services shall be provided by the system manufacturer with reasonable notice and at no additional expense to the Owner or Engineer.

G. Media: The GAC contactor equipment manufacturer shall furnish a Quality Control Manual demonstrating that the GAC media to be furnished will comply with the requirements of the Specifications. The Quality Control Manual shall define the following:

1. Qualification of the raw feedstock

2. Control procedures at the screening mill

3. Independent testing laboratories

4. Packaging definition

5. Purchase orders

6. Storage procedures

H. GAC Contactor Control System: The GAC contactor control system equipment shall be supplied by the GAC contactor system manufacturer and the design and fabrication of the control consoles shall be coordinated with the Instrumentation Supplier to ensure signal compatibility and seamless integration into the overall plant control system

1.04 SUBMITTALS

A. Submit to the Engineer complete shop drawings showing details of fabrication, materials of construction, installation and leveling data of all items furnished under this Section. Submittals shall be in accordance with Section 01 33 00, Submittal Procedures.

B. Details submitted shall include as a minimum, headloss data for water backwash, installation details, flow distribution calculations, certification of compatibility of the underdrain system with the media specified in this Section, details for installing reinforcing and other items to be embedded in concrete.

C. Testing Procedures: Detailed start-up, and hydraulic test procedures.

D. Proper documentation showing NSF-61 certification of all underdrain components.

E. The media submittal and technical information shall be provided and approved by a licensed engineer regularly employed by the manufacturer. The engineer shall have at least 15 years experience in water treatment. All submittal shall include the following information as a minimum:

1. Supplier's Name

2. Resume of Engineer Providing Submittal

3. Quality Control Manual

4. Gradation of Each Media Type

5. Date of Sampling/Lot Number

6. Samples of Each Media Type (If Required)

7. Representative Sample Analysis, (i.e. effective size, uniformity coefficient, specific gravity, acid solubility)

8. Material Quantities

9. Diagram with Type of Material and Depth of Each

10. Estimated Shipping Schedule

11. Media Loading Procedure

12. All testing shall conform to the requirements of the latest edition of AWWA B100.

F. Wash Water Trough Testing

1. Manufacturer shall, upon request, furnish the Engineer with certified test reports consisting of the mechanical and physical tests listed below.

2. Procedure to be used in determining the properties listed in Table 1 below shall be in accordance with latest ASTM standards: Ultimate Tensile Strength - ASTM Designation D638; Flexural Strength - ASTM Designation D790; Modulus of Elasticity - ASTM Designation D790; Hardness - ASTM Designation D2583; Water Absorption - ASTM Destination D570.

3. Hardness tests shall be made on the resin-rich surface of the product.

4. Flexural tests shall be made with resin-rich surface in compression.

5. Test samples shall be full thickness of the item produced and shall not be machined on the surface.

6. Mechanical and physical properties shall conform to those of Table 1 and according to ANSI-AWWA Specification F101 Table 4 - Minimum Physical Properties of Laminates.

TABLE 1
LAMINATE MECHANICAL AND PHYSICAL PROPERTIES 73°F

	ASTM Test Method	For 1/4" Wall Thickness
Ultimate Tensile Strength, PSI x 10^3 min	D638	12
Flexural Strength, PSI x 10^3 min	D790	19
Flexural Modulus of Elasticity, PSI x 10^3 min	D790	0.9
Barcol Hardness (min)	D2583	35
Water Absorption - % (max)	D570	0.2

1.05 SHIPMENTS

A. Media materials shall not be shipped until the submittal is approved by the Engineer. Approval of the submittal, including the Quality Control Manual, samples and independent testing, shall constitute acceptance of the media. The media supplier shall be responsible for hiring the lab and payment for the testing. Independent lab must be approved by the Engineer prior to testing.

B. The schedule of work shall be submitted to the Engineer for approval prior to commencement of work.

C. The Contractor shall be responsible for coordinating the shipment of supplies of materials and equipment specified herein. Coordination will be required during construction, startup and/or testing.

D. The Contractor shall provide storage space for the media and protect it from exposure to sunlight if stored for more than two (2) weeks.

E. The Contractor shall be responsible for storage of the control system equipment. The storage area shall be indoors, reasonably dust-free and protected from exposure to water or any corrosive materials.

1.06 OPERATION AND MAINTENANCE DATA

A. Six (6) copies of an operating and maintenance manual shall be furnished to the Engineer as specified herein and in accordance with Section 01 78 23. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions and necessary information required to instruct operating and maintenance personnel unfamiliar with all of the equipment specified herein. A complete, corrected and approved copy of the shop drawing submittal shall be included with each manual provided.

B. Complete operation and maintenance instructions shall be submitted after the Shop Drawings are approved, but prior to shipment of equipment.

PART 2 PRODUCTS

2.01 UNDERDRAIN

A. There shall be four (4) dual bay GAC contactors having a total of eight (8) cells with 12'-0" long lateral runs and an overall width of 29'-0".

B. The underdrain system shall be Leopold Type XA dual parallel lateral whereby feeder and compensating chambers are provided within the cross section of a single block.

The cross section of the underdrain shall be where the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures to install internal orifices and underdrains with circular water orifices in the primary chamber will not be considered acceptable. The primary chamber should provide at least 43 square inches of cross sectional area per block to reduce flow velocity during backwash.

C. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall be not less than 11/64 inch diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch. The top of each orifice shall be encircled by a depression approximately 3/8 inch x 3/4 inch, which shall act to prevent the media from blocking the dispersion orifice.

D. The underdrain shall have a horizontal flat top discharge surface, so that the finished structure floor is essentially flat, with above stated dispersion orifices for uniform energy intensity of water coverage which direct flow vertically for effective penetration and cleaning of the media.

E. Dual water recovery channels with return holes shall be incorporated into the top of the underdrain block to ensure uniform and continuous air flow from the top deck orifices and greater air stability. Underdrains without a water recovery channel will not be considered acceptable.

F. The secondary chambers of the underdrain shall have baffles sized and located to provide effective air control and to reduce level sensitivity. Underdrains without baffles will not be considered.

G. The secondary chambers of the underdrain shall have baffles sized and located vertically along the exterior of the primary chamber to provide effective water control.

H. The underdrain shall have a lug located on the exterior of the underdrain to allow simple connection and disconnection of an optional handle. The optional handle shall be removed once the filter laterals are set in place within the filter tank.

2.02 FILTER MEDIA

A. An eight (8) foot deep bed of GAC media shall be furnished in accordance with the following criteria:

1. Virgin GAC shall be Filtrasorb 816 as manufactured by Calgon Carbon

Corporation.

2. The coal shall be mined and the corresponding GAC shall be manufactured in the United States of America.

3. The GAC shall be manufactured by a producer certified for ISO 9001:2000, latest version, quality standards and at the specific plant or site holding such certification. A copy of the valid certificate must be submitted. It is understood that ANSI/NSF assures the GAC against toxicological hazards only. ISO 9001:2000 Certification assures the GAC of consistent conformance to stated product quality and standards listed in the Specifications.

4. The GAC shall comply with AWWA B-604, latest edition.

5. The GAC shall comply with NSF/ANSI Standard 61 Drinking Water System Components – Health Effects.

6. The GAC shall conform to Food Chemical Codex when tested under the conditions of the test outlined in the Food Chemical Codex, latest edition published by the U.S. Pharmacopeia.

7. The GAC must be 100% agglomerated bituminous coal based product with petroleum and coal based pitch binders sized to a granular form prior to baking and thermal activation. No amount of the following materials will be accepted or blended into the final product: broken pellets, lignite, peat, wood, coconut, sub-bituminous anthracite based or direct activated GAC.

8. The GAC shall be capable of removing turbidity, color, tastes, odors and other organic contamination from water previously pretreated by conventional water treatment processes.

9. Data showing successful application of the GAC in municipal water plants including turbidity and organic contamination shall be submitted.

10. Submittals must include a certificate of analysis conforming to the following parameters:

Product Specification: FILTRASORB 816M	Value	Test Method
Iodine Number (mg/g), min.	900	ASTM D4607
Moisture, weight %, max.	2	ASTM D2867
Effective size, mm	1.3 – 1.5	ASTM D2862
Uniformity Coefficient, max.	1.4	ASTM D2862
Abrasion No., min.	75	AWWA B604
Trace Capacity Number, (mg/cc), min.	9	TM-79, TM-85 (converted to TCN)
Screen Size (US Sieve), weight %		
Larger than No. 8, max.	15	ASTM D2862
Smaller than No. 16, max.	5	ASTM D2862
Typical Property	**Value**	**Test Method**
Apparent Density, g/cc, min.	0.56	ASTM D2854
Ash	8%	ASTM D2866
Water Extractables	<1%	AWWA B604
Non-Wettable	<1%	AWWA B604

B. Manufacturer shall have a minimum of 15 years experience manufacturing and shall submit proof via a manufacturer's certificate and/or an affidavit of compliance.

C. The manufacturer shall certify that it is the owner and operator of a reactivation facility.

D. Manufacturer shall furnish evidence of comprehensive general liability insurance in the minimum amount of $2,000,000 to provide protection from any and all claims that may arise from the supplier's supply, shipping, installation, removal and reactivation/disposal of the spent carbon.

E. Manufacturer shall indicate the source of coal, carbon manufacturing location, a description of the reagglomeration / thermal process and capacity of the manufacturing facility. The Engineer and Owner reserve the right to inspect the GAC manufacturing and thermal processing facility.

F. GAC manufactured by Cabot Corporation (Norit) or General Carbon shall be accepted as alternates provided the carbon meets the requirements specified herein.

2.03 FIBERGLASS WASH WATER TROUGHS

A. Loadings - The troughs shall be designed to support, within stress and deflection limitation, the following loadings:

1. Gravity Load - Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as weir plates and the spreader bars, together with the weight of water to fill the trough. Any additional loads, such as piping, etc., shall also be considered.

2. Buoyant Load - The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.

3. Lateral Load - Loads acting against the trough side walls; specifically, those induced by differential water levels on either side of the trough walls. The maximum possible differential, existing when the trough is empty and the tank is full, or when the trough is full and when the tank is empty, shall be used when calculating deflection, fiber stress, etc.

B. Thermal Stresses - The troughs shall be designed to accommodate temperature induced stresses resulting from differences in coefficients of thermal expansion between the trough and tank/support materials.

C. Torsional Stability - The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges. Any or all of the following trough stabilization techniques shall be considered.

1. Trough-to-trough stabilization

2. Torsional stiffness

3. Support spacing and rigidity

4. Internal baffles and/or flow straighteners

D. Deflection Under Load

1. Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to L/1000, where L is defined as the unsupported trough length in inches (mm). Under no circumstances shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16 inch (4.8 mm).

2. Maximum trough side wall horizontal deflection under full lateral load shall be less than or equal to D/100, where D is defined as the trough depth, in inches (mm). Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

3. Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to W/100, where W is defined as the trough width, in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

E. Fiber Stress Limitations - Supplemental to the deflection criteria, the troughs shall also be designed such that the maximum wall stress under the most severe loading conditions is less than or equal to 1,500 psi. This stress criterion is equivalent to 7:1 safety factor (approximate) as applied to the tensile and flexural properties of contact molded troughs and launders.

F. Thermal Expansion/Contraction - The troughs shall be designed to accommodate a thermally induced expansion (contraction) of 1/8 inch per 20 feet length of trough over temperature range of 10°F to 100°F, without exceeding the deflection or strain limitations set forth in the preceding sections.

2.04 CONTROL SYSTEM

A. A complete GAC contactor control system shall be provided. The control system shall include all instrumentation, consoles, hardware, fittings, supports, and related appurtenances required for a complete and operational GAC contactor system. As a minimum, the control system shall consist of the following:

Four (4)	GAC Contactor control consoles (one for each dual bay contactor)
Four (4)	Magnetic flow meters (one for each contactor effluent)
One (1)	Ultrasonic level sensor (one for influent channel)
Four (4)	Contactor headloss differential pressure transmitters
Five (5)	Turbidimeters (one for each contactor effluent and one for the combined effluent flow)

B. All equipment and instrumentation shall be supplied in accordance with the requirements in Paragraph 2.05 of this Section.

2.05 MATERIALS AND CONSTRUCTION

A. Underdrain

1. Material: The individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces.

2. Dimensions: The block size and weight shall permit ease of handling and installation. The block nominal dimensions shall be 8.25 inches high by 11 inches wide by 48 inches long. The weight of the block shall be approximately

24.5 pounds. Underdrains with heights greater than 8.25 inches shall not be allowed.

3. Block Geometry: The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout. The bottom of the block shall have integral grout pockets located at each end.

4. Lateral Construction: The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell. The joints shall be gasketed, bell and spigot type with internal alignment tabs for proper joint alignment, and be air and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation.

5. IMS® 200: The IMS® 200 media retainer shall be made of thermoplastic through the injection molded process and sealed to the top of the underdrain. The IMS® 200 media retainer shall be made from two separate sections that are permanently sealed together to form slots or openings. The opening size shall be sufficient to prevent the media from obstructing or passing through the underdrain. Vertical baffles shall be located on the bottom side of the media retainer to "compartmentalize" the fluid to keep it from moving horizontally along the bottom side of the media retainer thus ensuring each pattern of slots in the media retainer receives equal quantities of air and or water during the backwash cycle. The IMS® 200 media retainer shall replace the need for support gravel and shall not increase the underdrain height by more than 1 1/4 inch. The cap shall be attached and sealed to the underdrain at the factory using Type 316 stainless steel self tapping screws and 3M Weatherban Sealant Tape.

B. Grout

1. Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become "lumpy" shall not be used.

2. Water: Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Water with a total dissolved solids of 1,000 mg/l or higher or greater than 10 NTU shall not be used.

3. Sand: Sand shall be clean and washed masonry sand. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than

90% for an average of three samples, or less than 85% for any individual sample. 100% of sand particles shall pass No. 4 sieve and not more than 4% of sand particles shall pass No. 200 sieve.

4. Chemical Admixtures: No chemical admixture shall be needed in most of the applications. The grout may be mixed in a small batch and used immediately.

5. Strength: The grout used in installing the blocks shall have a minimum compressive strength of 3,000 psi after 30 days of curing. Normally, use a grout with one part Portland cement and two parts clean silica sand properly mixed and wetted with a maximum water-cement ratio by weight equal to 0.50 to 0.55 for the base grout and 0.61 to 0.67 for the fill grout.

C. Wash Water Troughs:

1. Resin: The resin shall be a commercial grade, general purpose polyester thermosetting resin, which has either been evaluated in a laminate, or which has been determined by a previous documented service to be acceptable for the service conditions.

   a. The resin shall contain no fillers except as follows:

      1) A thixotropic agent which does not interfere with laminate quality, or with the required chemical resistance of the laminate, may be added for viscosity control.
      2) Resin may contain pigments, dyes or colorants which have been determined by at least five (5) years previous service to be acceptable for the service condition without fading or chalking from original color standard.

2. Ultraviolet Resistance: All laminates shall have ultraviolet resistance in the form of pigmentation or ultraviolet absorbers.

3 Metal Reinforcement: When metal reinforcements are used, they shall be free of rust, oil, and any foreign matter. They shall be completely encapsulated with a minimum of 1/8-inch thick laminate.

4. Glass Reinforcement: Glass reinforcements shall consist of chemically bonded surfacing mat and chopped strand or chopped strand mat as hereinafter described. Surfacing mat shall be Type C, 10-20 mils thick, with a silane finish and a styrene-soluble binder. Chopped strands shall be Type E glass, with silane finish and styrene-soluble binder. The glass content of the finished laminate shall be adequate to produce mechanical and physical properties conforming to Table 1.

5. Manufacture:

a. The inner surface of the trough shall be smooth and resin rich. The outer surface shall be reasonably smooth and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks or crazes.

b. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with chopped strand glass laminate (max. 2 oz. per sq. ft.) in a minimum of two (2) layers. Void content of the complete laminate shall not exceed 2 ½ % of laminate volume.

c. Tolerances:

1) The top edges of the trough shall be level and parallel with a tolerance of plus or minus 1/8 inch (measured when the trough is not loaded).
2) The length of a trough section shall have a tolerance of ±1/8-inch per 10 feet length.
3) The laminate thickness tolerance shall be plus 1/8 inch minus 0.

d. Thickness at locations of supports such as saddles shall be at least 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of this Specification.

e. End flanges and blind ends shall be a minimum of 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of this Specification.

f. An integrally molded water stop shall be provided on the trough whenever the trough is grouted into and/or passes through a wall.

g. One-inch diameter ABS spreaders shall be bolted between the trough walls on approximate 2-foot centers to enhance the structural rigidity of the trough system.

D. GAC Contactor Control System: The GAC Contactor control system shall include the following equipment and instrumentation.

1. GAC Contactor Control Console

a. One (1) GAC contactor control console shall be provided for controlling and monitoring the operation of each dual bay GAC contactor.

b. Each console shall be a PLC-based system and shall be provided complete with the necessary control devices, signal converters, and equipment to perform the control and monitoring functions as shown on the Instrumentation Drawings and described in Section 40 96 35. Each console shall include a touch screen HMI and PLC manufactured by Siemens which conforms to the requirements of Section 40 94 00. The consoles enclosures shall be NEMA 4X Type 316 stainless steel units which include the following front console components as shown on the Drawings:

- GAC contactor flow readout
- GAC contactor water level readout
- Bypass flow readout
- GAC contactor headloss readout
- GAC contactor turbidity readout
- Backwash storage tank level readout
- Backwash flow readout
- 10" Siemens touchscreen HMI
- GAC contactor influent valve local-remote-close-open selector switch with valve position indication lights
- GAC contactor effluent valve local-remote-close-open selector switch with valve position indication lights
- GAC contactor filter to waste valve local-remote-close-open selector switch with valve position indication lights
- GAC contactor backwash supply valve local-remote-close-open selector switch with valve position indication lights
- GAC contactor backwash drain valve local-remote-close-open selector switch with valve position indication lights
- GAC contactor solenoid vent valve local-remote-close-open selector switch with valve position indication lights
- GAC contactor backwash remote-start-stop selector switch with indication lights
- Indication lights to indicate "operating", "high headloss", "high turbidity", "backwash required" and "backwashing"

c. Programming of the GAC contactor control consoles shall be provided by the GAC contactor manufacturer. This programming shall be coordinated with the Instrumentation Supplier who will be addressing the plant-wide instrumentation and control systems.

d. GAC contactor control console inputs and outputs shall be as shown on Instrumentation and Electrical Drawings.

e. GAC contactor control console components and layout shall be as specified in Specification Section 40 99 90, Packaged Control Systems, and as shown on the Instrumentation Drawings.

2. Magnetic Flow Meters

a. Sizes and locations shall be as shown on the Drawings.

b. Magnetic Flow meters shall be as specified in Specification Section 40 91 23.33, Flow Measurement.

3. Field Instrumentation

a. Contactor Loss of Head Transmitters

1) A loss of head transmitter, complete with three-valve manifold, and strainer, shall be supplied to monitor the loss of head through each contractor.
2) The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be ±0.25% of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).
3) The loss of head transmitters shall be Rosemont Model 3051 or an approved equal.

b. Effluent Turbidimeters: An effluent turbidity meter shall be provided for each GAC contactor and for the combined effluent flow. The turbidimeter shall be a Hach 1720E as specified in Section 40 97 00.

c. Common Influent Channel Level Sensor

1) A level transmitter shall be provided at the common GAC contactor influent channel for generation of the GAC contactor effluent rate of flow setpoint.
2) The level sensing system shall be an ultrasonic-type, electronic continuous level transmitter, complete with sensing element and integral electronics. The sensor shall be powered by a nominal 24 VDC loop power supply and shall generate a standard 4-20 mADC output signal.
3) The level sensor shall be as specified in Specification Section 40 91 23.36, Level Measurement.

2.06 DEDUCTIVE ALTERNATES

A. Equipment by Roberts Filter Group shall meet the requirements of this specification with the exception of the following allowable differences:

1. The underdrain system shall also be designed to withstand a net downward loading of not less than 1,400 PSF.

2. Dual water recovery channels and baffles shall not be required in the underdrains.

3. The Trilateral Underdrain shall be 12 inches high. The Contractor shall be responsible for any redesign required to use this underdrain.

4. Secondary drilling shall be allowed to create circular orifices in the underdrain.

5. The media support plate shall be made of ultraviolet resistant high density polyethylene beads sintered together. The media support plate shall be 3/4" thick. The average size of the pores shall be 500 microns and the pore volume shall be 40 to 50 percent of the plates overall volume. The top surface of the plate shall average no more than 10 beads with flattened sides per square inch of plate. A flattened side is defined as a flat surface surrounded by sharp edges, produced during the sintering process, that occupy more than approximately 10 percent of the total area of the bead. No more than 35% of the total beads on the top surface of the plate shall be flattened.

6. Accommodations for detachable handles on the underdrains shall not be required.

7. Underdrain system may be designed for a maximum backwash rate of 20 gpm/sf.

8. Grout pockets for block hold down shall not be required. An alternate method of resisting uplift shall be provided.

B. Equipment by Severn Trent Water Purification, Inc. shall meet the requirements of this specification with the exception of the following allowable differences:

1. The LP Block™ underdrain shall be provided. The height of the block shall be approximately 8 inches (203 mm) and the width approximately 17 inches (431 mm).

2. Dual water recovery channels and baffles shall not be required in the underdrains.

3. Each block shall have wedge shaped ribs on the bottom of the block to key into the floor grout and provide uplift resistance. The underdrain manufacturer shall provide third party certification that the underdrain can withstand a minimum of 15 PSI internal (uplift) pressure without lifting or separating from the filter floor when properly installed with grout and no mechanical anchoring.

4. S Plate™: A porous cap constructed of sintered HDPE beads shall be mounted to the underdrain block. This cap will eliminate the need for any gravel layers. The cap shall be fastened to the underdrain with a minimum of (18) 316 stainless steel screws and sealed with an NSF approved sealant. The cap shall have an average pore size of 500 microns and shall be no more than 1" thick.

5. The Contractor shall be responsible for any redesign required to use this underdrain.

6. Underdrain system may be designed for a maximum backwash rate of 20 gpm/sf.

PART 3 EXECUTION

3.01 PRODUCT HANDLING, STORAGE AND DELIVERY

A. Place or store underdrains and specialties only in designated staging areas shown on the Drawings and approved by the Engineer.

B. Store underdrains and specialties off the ground, under ultraviolet-resistant tarps from time of delivery on-site until final installation of the equipment.

C. Replace, at no charge to Owner, underdrains and specialties damaged during storage and delivery.

D. Underdrains and specialties are subject to inspection at the Engineer's request if visual evidence of damage is observed.

E. All media shall be shipped in "semi-bulk" containers having lifting loops and bottom discharge spout.

F. Delivery of "bulk" shipments will not be permitted unless the Contractor can demonstrate that the materials can be handled and stored without contamination

G. Troughs shall be suitably packaged to avoid damage during handling and shipment. Should it be necessary to store product prior to installation, precautions shall be taken to prevent warpage or distortion.

H. Troughs shall be stored on a flat place and adequately supported on wooden support members to evenly distribute weight of troughs. When stored more than one (1) high, succeeding items should be stored level and evenly supported by blocks or spacers.

3.02 INSTALLATION

A. Underdrains

1. The Contractor shall install the underdrain system in strict accordance with: (1) the manufacturer's written instructions and recommendations and the manufacturer's installation drawings; (2) the oral and written directions provided by the manufacturer's technical representative who is supervising and observing the work; and (3) any additional requirements specified herein.

2. Floor Preparation

a. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions, but have a rough, broom finish. Do not trowel or finish the floor to a smooth finish.

b. DO NOT PAINT the floor or wall area where it will come in contact with the grout surrounding the underdrain. The floor and wall extending sixteen (16) inches (406 mm) up from floor is not to be painted.

3. Underdrain Lateral Installation

a. The underdrain laterals shall be set in relatively level rows on a bed of grout over the floor slab. Plates for closing the ends of each row of blocks shall be furnished by the manufacturer and installed by the Contractor. After joining, aligning and setting the blocks, and the bed grout is set-up, as soon as possible, all spaces between the rows of blocks and walls shall be filled with grout so that the entire bed is totally sealed and held firmly in place. Once all grouting is complete, the grout shall be allowed to cure for at least three (3) full days before any functional testing.

4. Cleaning and Protection During Installation, Testing, and Startup

a. The Contractor shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the underdrain system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash water piping shall be thoroughly flushed clean. All loose debris and dirt within the cells and flumes shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow.

Any grout so deposited shall be removed. As installation progresses, partially completed portions of the work shall be protected with heavy plastic sheeting or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the media is installed.

b. Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with ½ inch minimum plywood sheeting where necessary, to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

B. Media

1. Marks shall be placed on the side of the contactor designating the top elevation of each layer.

2. Carefully place each layer so as not to disturb the previous layers.

3. Complete the installation of each layer before the next layer above is started. Do not stand or walk directly upon the media materials. Workers must stand or walk on boards that will sustain their weight without displacing the media.

4. Measure depth of each layer of media after it has been backwashed and skimmed (if necessary) as recommended by the equipment manufacturer.

5. Clean the tanks before any media is placed and keep them clean throughout the placing operation.

6. Place the GAC and backwash the bed as directed by Calgon Carbon Corp. or GAC supplier.

C. Wash Water Troughs

1. All trough mounting brackets, hardware and stabilizers shall be Type 18-8 stainless steel and shall be supplied by the trough manufacturer.

2. Troughs shall be installed so that the trough weir edges are level to within ± 1/8 inch.

D. Controls and Instrumentation

1. The Contractor shall be responsible for installation of the GAC contactor control consoles and all wiring from the console to field devices, instruments, and other systems.

2. Programming and start-up shall be performed after all final elements, field devices, and instruments have been installed, calibrated, and wired in the circuit.

E. Install all items in accordance with the GAC Contactor equipment manufacturer's recommendations. Upon completion of the installation, the technical director shall furnish a certificate of compliance detailing that the filtering materials, including instrumentation and controls, have been installed in accordance with the manufacturer's instructions.

3.03 FIELD TESTING

A. Underdrain Lateral Flow Distribution Test

1. The underdrain system in each cell shall be given a series of visual, qualitative, flow distribution tests to verify that IMS ® Cap pores are not clogged with debris and that flow distribution is uniform. These tests shall be performed before the media is placed.

2. During each test, the underdrain laterals shall be visually inspected for uniform distribution of water and for any signs of quiescent zones and excessive surface turbulence.

3.04 MANUFACTURER'S SERVICES

A. Mechanical Filter Equipment Services

1. The underdrain manufacturer shall retain on its permanent staff, field service representatives with at least 10 years of experience in the placement of underdrain.

2. The Contractor shall provide the services of the manufacturer's technical representative for not less than four (4) working days (8 hours per day) to inspect and supervise the installation and testing of the underdrain system in two (2) trips.

3. An additional one (1) day and one (1) trip shall be allocated for operator training. On-site training of the Owner's personnel shall be provided at the time of start-up to familiarize personnel with the underdrain characteristics and to instruct them in day to day operations, preventative and regular maintenance, troubleshooting techniques, and system diagnostics for the underdrain system.

4. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses.

B. Controls and Instrumentation Services

1. The contactor equipment manufacturer shall provide a technical representative to assist the Contractor's personnel with the installation, testing, and startup for not less than four (4) working days (8 hours per day) in two (2) trips. The factory service technician shall have a minimum of five (5) years' experience in the startup of GAC contactor systems.

2. The GAC contactor manufacturer shall provide the services of the PLC programmer who performed the programming work for the control consoles to provide programming modifications requested by the Owner to optimize the control system. Such services shall include a total of 40 hours of on-site programming time working in the presence of the Engineer and Owner. Travel time, lodging, and similar expenses shall be borne by the GAC contactor equipment supplier. Services included under this Paragraph shall not be used to correct errors or address items that do not conform to the Specifications

3. An additional two (2) days and one (1) trip shall be allocated for operator training. On-site training of supervisors and shift operators shall be provided at the time of start-up to familiarize personnel with the hardware and to instruct them in day to day operations of the controls, preventative and regular maintenance, troubleshooting techniques, and system diagnostics.

4. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses.

3.05 DOCUMENTATION

A. As a minimum, documentation shall include:

1. Complete console shop drawings showing layouts, schematics, and interconnections among field mounted equipment and other systems.

2. Manufacturers' standard instruction bulletins for all functional components.

3.06 SPARE PARTS

A. Spares shall be provided as follows:

- Ten (10) underdrain o-rings.
- Five (5) plastic end caps.
- Two (2) of each switch, push-button and light used
- Two (2) of each type of relay used.
- One (1) of each type of PLC I/O card used.
- One (1) of each type of PLC power supply used.

END OF SECTION

SECTION 46 71 13
GRAVITY THICKENER EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

A. This Section describes the requirements for one (1) rake-type circular gravity sludge thickener. The unit shall be designed for loading rates as specified herein.

B. The sludge thickener mechanism shall include: column support structure, energy dissipating feedwell, side feed influent pipe, walkway bridge, walkway surface, center platform, platform surface, handrail, sludge thickener drive assembly, sludge thickening arms, torque cage, effluent weirs, control panel, and all necessary assembly and anchor bolts.

C. The thickening unit shall be designed for extra-heavy duty service. The unit shall be complete in all respects and ready for installation in the basin by the Contractor.

D. The Contractor shall be responsible for coordinating all activities required for a complete installation. Activities requiring extensive coordination would include, but not be limited to, shop drawing submittals, embedded items required to be installed during construction of the concrete tank and, fabrication and installation of the thickener equipment. Construction of the tank or fabrication of the thickener equipment shall not commence until all key dimensions, equipment and pipe locations, and any other interdependent items are approved by the Engineer and any conflicts or ambiguities are resolved. It shall remain the Contractor's sole responsibility to resolve any errors or conflicts arising during construction due to improper coordination between the tank construction and the thickener equipment fabrication and installation.

1.02 QUALITY ASSURANCE

A. Qualifications: All of the equipment specified herein shall be furnished by a single manufacturer who regularly engages in the production of this type equipment and who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. Each component and ancillary equipment item furnished under this Specification shall be new and unused and of the type, size, design, and efficiency installed in previous projects. The system components shall be designed, constructed, delivered and installed in accordance with the best practices and methods.

1. The manufacturer of the equipment must have at least ten (10) years experience in the design and manufacture of the type of equipment proposed and must be able to refer to a least ten (10) similar installations, five (5) years old or older still in operation.

B. The equipment specified in this Section shall be furnished, coordinated, serviced and guaranteed by one (1) supplier who shall be experienced in the design, manufacture, coordination, installation, and servicing of equipment of the type, size, and complexity specified in this Section. The supplier shall have a permanent organization of office and field technical personnel and facilities necessary for fulfilling all requirements of this Specification. The supplier shall have an established service organization in the State of Alabama capable of providing fully knowledgeable, experienced service personnel and replacement parts for normal replacement items at the Project site not later than 24 hours after telephone notification by the Owner.

C. The equipment shall comply with these referenced standards:

1. Anti-Friction Bearing Manufacturer's Association (AFBMA)

2. American Gear Manufacturer's Association (AGMA)

3. American National Standards Institute (ANSI)

4. American Society for Testing and Materials (ASTM)

5. National Electrical Manufacturers Association (NEMA)

6. American Welding Society (AWS)

D. Additional Description of Standards:

1. All fabricated structural steel shall conform to the requirements of "Standard Specification for Steel for Bridges and Buildings", ASTM Designation A-36. All shop welding shall conform to the latest standards of the American Welding Society.

2. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall have a minimum thickness of 1/4 inch. All erection and mounting hardware required for the installation of the gravity sludge thickener shall be Type 316 stainless steel.

3. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection. The

units shall be erected and lubricated in strict accordance with the instructions of the manufacturer's field engineer.

4. All fabricated steel components of the gravity sludge thickener shall be hot-dip galvanized per ASTM A123, unless otherwise noted on the Drawings or specified herein.

5. Feed pipe and pier shall be ASTM A53 steel pipe.

6. The complete machine shall be of sufficient strength to sweep in a 2-inch layer of grout over the gravity sludge thickener tank bottom under its own power. Grouting shall be done in strict accordance with the manufacturer's instructions.

7. Welding:

   a. The equipment manufacturer's shop welding procedures, welders and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "WELDING IN BUILDING CONSTRUCTION" of the American Welding Society.

   b. Clearly show complete information regarding location, type, size, and length of all field welds in accordance with "STANDARD WELDING SYMBOLS" AWS A2.0 of the American Welding Society, and fully explain special conditions by notes or details on the equipment manufacturer's shop drawings.

   c. The Contractor's welding procedures, welders and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "WELDING IN BUILDING CONSTRUCTION" of the American Welding Society.

   d. Perform all welding in conformance with the information shown on the equipment manufacturer's drawings regarding location, type, size and length of all welds in accordance with "STANDARD WELDING SYMBOLS" AWS 12.0 of the American Welding Society, and special conditions as shown by notes and details.

   e. No field welding of the galvanized steel mechanism shall be allowed.

E. Approved Manufacturers: Equipment shall be designed, fabricated and installed in accordance with the manufacturer's recommendations. The gravity sludge thickener equipment shall be that manufactured by: Ovivo (Eimco Water Technologies); Walker Process, or Westech.

1.03 SUBMITTALS

A. Materials and Shop Drawings: Copies of all materials required to establish compliance with these Specifications shall be submitted in accordance with the provisions of the Section 01 33 00: Submittal Procedures. Submittals shall include at least the following:

1. Equipment catalog cut sheets.

2. Outline dimensions of all equipment.

3. Cross sectional drawings of all equipment with parts identification and materials specifications.

4. Fabrication and erection drawings.

5. Motor nameplate data and specifications sheet for all electric motors.

6. Bill of material.

7. Piping details of connections to Contractor supplied piping.

8. Electrical schematics and interconnecting wiring diagrams showing extent of factory prewiring and details of control panels.

9. Manufacturer's drawings with parts list for all accessory equipment.

10. Shop painting specification(s) for ferrous surfaces.

11. Special tools to be supplied.

12. Recommended spare parts with current pricing.

13. List of local facilities to obtain parts for all equipment.

14. Separate AWS Certificates (certification required within the past year) for the fabrication shop and all welders performing welds on the equipment including shop fabrication and field installation.

15. Test data for equipment as specified herein.

16. List of manufacturer approved service organizations for all equipment.

17. Handling and storage instructions.

18. Operation and maintenance manuals in accordance with Section 01 78 23.

19. List of recommended grades of lubricants with at least two (2) alternate references.

20. Drive mechanism design calculations verifying the compliance of the drive gears and bearings with the specified continuous life.

21. The thickener drive calculations shall clearly specify the values used for the design parameters specified in Section 2 - Products.

22. The manufacturer shall submit structural design calculations for the torque cage, support column, rake arms, supports, walkway and platform. The calculations shall include specified loads and substantiate minimum deflections and stresses of the combined thickener mechanism as specified in Section 2 - Products.

23. All Shop Drawings and calculations shall be certified/stamped by a Registered Professional Engineer.

B. Operating Instruction:

1. Six (6) copies of an operating and maintenance manual shall be furnished in accordance with Section 01 78 23: Operation and Maintenance Data. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions, and necessary information required to instruct operating and maintenance personnel unfamiliar with all of the equipment specified herein. A complete, corrected and approved copy of the shop drawing submittal shall be included with each manual provided.

2. A factory representative who has a complete knowledge of proper operation and maintenance requirements for the equipment shall be provided for a minimum of one (1) eight-hour working day to instruct representatives of the Owner on proper operation and maintenance of the equipment. Provide at least ten (10) days advance notice to the Owner before scheduling the instruction day. This work is in addition to, but may be conducted in conjunction with, the inspection of installation and test run as provided under Part 3. The operation and maintenance manuals shall be provided at a time in advance of the instruction/training period that is approved by the Owner. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service required to make approved modifications, repairs or corrections to the equipment shall be provided at no additional cost to the Owner.

C. Equipment Certification: The Contractor shall submit to the Engineer six (6) copies of a certified report from the factory service representative certifying that the thickener equipment has been properly installed and operates satisfactorily under the specified operating conditions. The certified report shall include all requirements as stated in Paragraphs 3.04, Performance Demonstration Test and 3.05, Factory Service Representative.

1.04 WARRANTY AND GUARANTEES

A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during warranty period, it shall be replaced at no expense to the Owner.

B. Refer to Section 01 74 00 for specific guarantee and warranty requirements.

1.05 SHIPPING REQUIREMENTS

A. All fabricated steel assemblies shall be shipped in convenient sections, or as specified herein and permitted by carrier regulations, properly match-marked and identified for ease of field erection.

B. All equipment shall be handled during delivery, storage and installation in a manner to prevent damage of any nature in accordance with the manufacturer's approved instructions.

C. All electrical controls and equipment shall be stored in a clean, dry, weather tight building.

PART 2 - PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only.

B. The thickener unit shall be furnished and installed complete with all supports, all mechanical equipment required for proper operation, including a complete drive unit, all steel, iron, aluminum handrails and walkways, and other metal construction indicated by the Drawings, and any additional materials or construction required by the manufacturer's design.

2.02 INFLUENT SLUDGE SERVICE CONDITIONS

A. Material Handled: Sedimentation basin sludge and wash water recovery basin sludge, 0.9 percent dry solids by weight minimum.

2.03 PERFORMANCE REQUIREMENTS

A. Units shall produce 3 percent solids or the maximum achievable thickness of the sludge in the underflow based on a maximum solids loading of 4.0 lbs./day/sf. The unit shall handle hydraulic loads for influent flow rates up to 197,000 gpd.

2.04 EQUIPMENT DESCRIPTION

A. The thickener systems shall be suitable for installation in a new 70-foot diameter concrete basin with a 12'-0" sidewater depth (SWD) and a floor slope of 2" per foot as shown on the Drawings. The service life of the sludge thickener mechanisms and structural parts specified herein operating under its continuous rated capacity shall be not less than 20 years.

B. Dilute sludge will enter the sludge thickener basin through a side feed influent pipe as shown on the Contract Drawings and discharge into a center feedwell for energy dissipation. Solids will be allowed to settle to the floor of the basin and encouraged to thicken with pickets rotating on the sludge thickening and collection arms. Settled solids will be positively raked to the center of the sludge thickener mechanism and discharged into a sludge thickening sump for withdrawal.

C. The thickener system shall be a complete operating unit as specified herein and as shown on the Drawings, including a column-supported center drive, access walkway, aluminum grating and handrails, drive assembly control panel with overload protection system, drive mechanism with gear reducer, stationary influent feed well, sludge thickener rake arms with pickets, effluent weir, torque cage, and all necessary appurtenances and anchorage parts.

D. The gravity thickener mechanism shall be pier supported with a side feed to a central influent feed well and peripheral weir overflow. The drive mechanism shall support and rotate a torque cage that rotates two (2) structural steel rake arms. The mechanism shall be designed so there will be no field welding required. All necessary field connections shall be bolted using specified stainless steel bolting materials.

E. Except where specifically indicated otherwise, all plates and structural members shall have a minimum thickness of 1/4-inch.

F. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations and properly match-marked for ease of field erection.

G. All ferrous metal parts for the thickener unit including the torque cage, the rake arms, the influent feed well, the access walkway supports and the center platform supports shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Prior to hot-dip galvanizing, all welds shall be ground to remove all weld spatter and slag. All sharp edges and corners shall be rounded to a smooth contour by grinding.

2.05 MATERIALS

A. Structural Steel: ASTM A36

B. Steel Galvanizing: ASTM A123

C. Structural Aluminum: ASTM B204, ASTM B221, ASTM B308, Alloy 6061-T6

D. Structural Stainless Steel: ASTM A666, Type 304L, annealed

E. Castings: ASTM A48, gray iron having a minimum tensile strength of 20,000 pounds per square inch (psi)

F. A325 high strength hot dip galvanized steel to match the drive construction.

G. Welding: Conform to the latest edition of AWS standards. All welding for mild steel components of the thickener unit shall be continuous and seal welded throughout shop fabrication and field erection.

2.06 THICKENER DRIVE ASSEMBLY – OPTION 1

A. The drive unit shall be completely factory assembled and consist of a primary and final gear reduction unit provided in an enclosed gear housing with anchor bolts and all necessary appurtenances. The main gears, main bearings (with the exception of precision bearings), and drive control that comprise the drive assembly shall be a regularly manufactured in-house product of the sludge thickener manufacturer. Drive assemblies purchased from third party vendors are not acceptable because the drive assembly is a key element in a successful sludge thickener installation.

B. The drive unit and mechanism shall have a continuous torque rating of 70,000 foot-pounds based upon AGMA and British Standards. The continuous torque rating shall be defined as capable of operating at the specified maximum torque and collection arm maximum speed for 24 hours per day, 365 days per year for 20 years. All parts of the thickener system and drive mechanism shall be rated in

accordance with the latest applicable AGMA standards with a 1.25 service factor applied to the specified AGMA continuous torque rating. The drive unit shall be designed to withstand, without failure or deformation of any part, a momentary peak torque loading of 176,000 foot-pounds. The momentary peak torque rating shall be equal to the yield strength of the main gear for the drive unit.

C. In addition, a shear pin shall be provided to protect the drive, at a load determined by the manufacturer, in case of control system failure.

D. The primary gear reducer shall be a helical or cycloidal gear reducer.

E. The drive unit shall utilize cycloidal reduction units directly connected to the pinion. Requirements for a cycloidal drive are as follows:

1. Speed Reducing Unit: The speed reducing unit shall consist of cycloidal or helical speed reducers directly connected to a motor without the use of chains or v-belts, and shall be keyed to the pinion.

2. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The movement of the cycloidal discs shall be transmitted then by pins to the low speed shaft.

3. Primary speed reducer helical gearing shall be manufactured to AGMA standards. The primary speed reducer shall have a service factor of 1.25.

4. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and run in a totally submerged oil bath or be grease lubricated.

F. The final reduction worm or spur gear shall be a cut-tooth casting mounted on a separate anti-friction ball bearing assembly. The balls shall be of the finest quality, high carbon alloy steel, running on replaceable hardened alloy steel strip liners or contoured precision bearing races. The bearings shall be mounted in a two-piece housing of high-strength cast iron or ASTM A36 fabricated steel with a minimum base thickness of one (1)-inch. The final reduction gear and the anti-friction ball bearings shall run in an oil bath within the final gear reduction housing. The housing shall be effectively sealed against contaminants by a felt or rubber strip. A readily accessible oil filling and level pipe with sight gauge shall be furnished.

1. Gears shall be rated to the above requirements in accordance with the latest applicable American Gear Manufacturer's Association Standards for gear durability and strength.

G. Gear Design and Rating Criteria:

1. Gearing shall be designed and rated to equal or exceed the specified torques and life using the criteria established by the following British or American Gear Manufacturers Association (AGMA) Standards:

a. Surface Durability (Pitting) of Enclosed Cylindrical Worm Gear Speed Reducers: AGMA 6034-B92.

b. British Standard 721: 1963

The output torque rating of the drive shall be based on the smaller of the two (2) values determined from the above AGMA Standards.

2. Prior to unit fabrication, the manufacturer shall submit calculations to the Engineer for approval substantiating the ability of the proposed drive to meet the specified torque requirements. Calculations shall include all worm gears in the drive train.

a. The calculations shall clearly specify the design values to be applied for materials used, pressure angle, addendum modifications, and allowable stresses with appropriate re-rating for the life cycles required. The following design parameters shall be included in the drive calculations for Surface Durability ratings:

1. Number of gear teeth.

2. Actual face width.

3. Tooth geometry factor (I and J factors) and tooth pressure angle.

4. Load distribution factor.

5. Allowable contact stress.

6. Allowable bending stress.

7. Pinion pitch diameter.

8. Tooth diametrical pitch.

9. Hardness ratio factor.

10. Elastic coefficient.

11. Life factor.

12. Gear materials and physical properties.

13. Worm material, heat treatment, and finish.

b. The load distribution factor from AGMA 6034-B92 shall be calculated as defined. The net face width for surface durability calculations shall not exceed the actual face width of the narrowest of the two mating gears.

c. For parameters which are materially dependent, such as allowable contact stress, the calculations shall include a full description of the materials and heat treatment used.

H. The drive housing shall be designed so that all gears and bearings shall run in an oil bath or be grease lubricated. Oil pumps for lubrication shall not be allowed. Provision shall be made for condensate collection below the main bearing and gear to positively prevent the bearings and gears from running in water.

I. For worm gear teeth which are not fully submerged in oil, the tooth mesh shall be designed to force lubricant to the upper portion of the tooth face.

J. The housing shall be provided with readily accessible oil level sight gauges, oil fill and valved drain connections and condensate drain connections from the low points of the oil reservoir. Removal of structures or plates shall not be required for access to sight gauges and drains. The reservoir shall have 1-1/2 inches minimum below the bottom of the main bearing for oil storage.

K. The main gear shall be solid one (1) piece construction if possible. If a split gear is utilized, mating sections shall be machined and a minimum of two (2) dowels on each side shall be used for proper alignment of gear teeth. All bolts used shall be Type 316 stainless steel and sized for 200 percent of the load imposed.

L. The final reducer unit shall be constructed using an ASTM A48, Class 40B cast iron housing or an ASTM A36 fabricated steel housing, and shall include a worm or spur gear with a minimum pitch diameter of 34 inches. If a fabricated steel housing is provided, it shall be fabricated using 1-inch thick steel plate stock, minimum. The material from which the sludge thickener drive base is constructed shall be of adequate thickness to provide the rigidity necessary for proper bearing

support, but shall not be less than 1-inch thick. Precision bearings used with fabricated steel housings shall have a minimum B_{10} life of 30 years and shall be located by machined, registered fit. The worm shall be made of AISI 4142 heat-treated alloy steel ground and polished, driving a centrifugally cast manganese bronze worm gear. The worm and worm gear shall be designed based upon the requirements of AGMA 6034-B92 for the torque specified. Planetary gear units shall not be considered equal in design.

M. The complete drive assembly shall be assembled in the manufacturer's shop and tested to assure the drive is running properly and to calibrate the drive control. The completed test report shall be sent to the Engineer prior to shipping to the project site, verifying the drive meets the quality assurance from the manufacturer and that the torque control has been correctly calibrated.

N. The main gear shall rotate on a precision ball bearing assembly that is completely separate from the worm gear. Bearings shall have a minimum B_{10} life of 30 years as defined by AFBMA. The precision ball bearing assembly shall be made up of premium alloyed chrome/steel bearing balls and a raceway hardened to at least Rockwell C60 and then ground. Ball bearings shall be minimum 1-inch diameter.

O. Drive components shall be located via a machined, registered fit or pilot to insure proper alignment. In order to preserve the alignment of key drive components, no welding on the drive shall be permitted following final machining operations.

2.07 THICKENER DRIVE ASSEMBLY - OPTION 2

A. The sludge thickener drive mechanism shall consist of an integral motor and primary speed reducer coupled through roller chain and sprockets to a secondary worm/worm gear reducer driving the main gear through a pinion, and an overload protection system.

B. All bearings shall run in a full oil bath. Oil pumps for lubrication will not be allowed. Provision shall be made for condensate collection below the main bearings and gears to positively prevent the bearings and gears from running in water. Sight glasses and condensate drains for the drive shall be easily accessible. Inspection of the completed drive unit shall be accomplished at the sludge thickener manufacturer's shop, with reports of all tests and certifications of material hardness being made available for review at the Engineer's request prior to shipment to the job site.

C. Drive components shall be located via a machined, registered fit or pilot to insure proper alignment. In order to preserve the alignment of key drive components, no welding on the drive will be permitted following final machining operations.

D. Drives utilizing horizontal chains or open, grease lubricated gearing will not be permitted.

E. The drive mechanism components shall be designed in accordance with referenced standards for 24 hour continuous duty, moderate shock load. The torque value used in the sizing calculation shall be a minimum ANSI/AGMA Standard 2001-D04 continuous torque of 70,000 foot pounds based upon 24 hour per day operation for a minimum of 20 years. In addition, the drive must be able to sustain a momentary peak torque of 176,000 foot pounds. The drive main gear support bearing shall be designed for a minimum B_{10} life of 100,000 hours.

F. In order to ensure long main gear life through distribution of loads on gearing and adequate resistance in the main gear to moment loads, the main gear shall have a minimum gear face surface area of 750 square inches (Gear pitch diameter x Gear face depth x Pi).

G. The main gears, main bearings, and drive control that comprise the drive assembly shall be a regularly manufactured in-house product of the sludge thickener manufacturer. Drive assemblies purchased from third party vendors are not acceptable because the drive assembly is a key element in a successful sludge thickener installation.

H. An integral motor and primary speed reducer shall drive a worm and worm gear secondary reducer through roller chain and sprockets enclosed in a steel guard. The chain shall be standard roller chain or lubricated joint roller chain. Sprockets shall be designed for the connected horsepower of the drive with a minimum service factor of 1.5. Provision shall be made for adjustment of chain tension.

I. The main drive unit shall consist of a worm, worm gear, pinion and spur gear assembly. The secondary reducer shall be a worm/worm gear reducer specifically designed for this application. The worm gear shall be centrifugally cast manganese bronze. The worm shall be hardened alloy steel. A single piece pinion shall transmit power from the worm gear to the spur gear. In order to maintain proper alignment between the pinion and the spur gear, the pinion shall be supported by bearings both above and below the spur gear.

J. The main gear shall be completely enclosed in an ASTM A-48 Class 40A cast iron housing provided with neoprene seals, oil fill plugs, and oil drain plugs. All gear housings shall be of full sidewall construction, integral with the base. Prior to assembly, the base shall be thoroughly inspected for seep holes or inclusions and given a full hydrostatic test to insure no leaks are in the oil containment area. Shop inspection reports must be made available for review. All gears and bearings shall be lubricated by an oil bath with the main bearing totally submerged in oil and the teeth of the main spur gear submerged at least 85% in

the oil bath. Provision must be made for collection of condensate below any bearings or gears contained within the drive unit.

K. The main gear shall rotate and be supported on a ball bearing assembly provided with four replaceable liner strips fitted into the turntable and turntable base. Liner strips shall be special vacuum degassed carbon corrected alloy steel hardened to a Rockwell hardness of at least 38 to 46 Rc. The main base shall be a minimum of 1 inch thick to insure adequate structural rigidity to properly support the drive bearings.

L. Major drive components, main gears and bearings must be replaceable separately and individually to allow economical extension of the drive life.

M. The drive shall be designed for the specified continuous torque rating. Continuous torque shall be defined as the minimum torque at which the drive mechanism may operate continuously 24 hours per day, 365 days per year, for 20 years, at the specified maximum sludge thickening and collection arm speed. Main gear calculations shall be based upon ANSI/AGMA Standard 2001-D04 for rating the pitting resistance and bending strength. Calculations shall clearly specify the values used for the following design parameters:

- Number of pinions
- Actual face width
- Tooth geometry (I and J factors)
- Load distribution factor
- Allowable contact stress
- Allowable bending stress
- Pinion pitch diameter
- Hardness ratio factor
- Elastic coefficient
- Life factor

The load distribution factor shall be determined by the empirical method. For parameters which are material dependent, such as allowable contact stress, the calculations shall include a full description of material and heat treatment used. Worm gearing shall be designed and rated to equal or exceed the specified continuous torque and life. The basis for rating shall be ANSI/AGMA Standard 6034-B92, or other gear design criteria, which includes design values to be applied for materials used, pressure angle, addendum modifications, and allowable stresses with appropriate re-rate for life cycles required. The following design parameters shall be included in the drive calculations:

- Gear materials, and physical properties
- Gear pitch or effective diameter
- Actual face width

- Tooth pressure angle
- Number of gear teeth
- Worm material, heat treatment and finish
- Number of starts

2.08 CENTER COLUMN

A. A 36-inch diameter stationary center column shall be provided to support the sludge thickener mechanism.

B. On one end of the center column shall be a support flange with a minimum thickness of 1-inch drilled for minimum 1-inch diameter anchor bolts. A similar flange shall be provided at the top of the center column for mating to the drive assembly.

2.09 TORQUE CAGE

A. The torque cage shall be designed to withstand the mechanism design strength while maintaining structural steel stresses within the AISC allowable stress.

B. The torque cage shall be attached to the four (4) connection points on the sludge thickener drive.

C. Provisions shall be made for connection of the sludge thickening and collection arms.

D. The minimum angle size used in construction of the torque cage shall be 2 inch by 2 inch by 1/4-inch.

2.10 RAKE ARMS

A. The sludge thickener system shall include two (2) sludge collector rake arms of steel truss construction spaced 180 degrees apart, equipped with steel raking blades, steel sludge thickening pickets, and adjustable stainless steel squeegees. Sludge thickening and collection arms shall be attached to the sludge thickener drive mechanism by means of a steel torque cage. Support tie rods in the sludge thickening and collection arm design will not be allowed. Rake blades shall be properly spaced to ensure complete raking of the tank bottom twice per revolution.

B. Each sludge thickening and collection arm shall be designed to withstand the mechanism design strength while maintaining structural steel stresses within the AISC allowable stress.

C. Rake blades 7-1/2 inches deep shall be provided on each sludge thickening and collection arm.

D. Attached to the bottom of the rake blades shall be adjustable stainless steel squeegees extending 1-1/2 inches below the rake blade. Squeegees shall be attached with Type 316 stainless steel bolts.

E. Sludge thickening pickets shall be attached to the sludge thickening and collection arms on 2 foot centers to promote proper sludge thickening. Pickets shall extend from an elevation even with the tops of the rake blades to an elevation even with the top of the sludge thickening and collection arm truss at its highest point.

F. The rake arms shall be installed to conform to the slope of the tank floor. The arms shall rotate at the speed of 0.05 rpm. The rake arm and torque cage mechanism structure shall be designed and constructed to withstand a momentary peak torque load of 176,000 foot-pounds.

2.11 INFLUENT FEED WELL

A. The sludge thickener influent feed well shall be 14'-0" diameter minimum. The sludge thickener influent well shall be supported from the center platform and shall extend a minimum of 6'-0" below the water surface with a 2-inch minimum freeboard above the water surface. The entire unit shall be fabricated of minimum 1/4-inch steel plate and reinforced as required for horizontal and vertical stability.

B. The influent well shall be designed to dissipate the energy of the incoming liquid flow, thus preventing any turbulence or currents within the thickening basin.

C. Feedwell shall have a flanged opening to connect to a side feed influent pipe.

2.12 INFLUENT PIPING

A. The unit shall incorporate a 12 inch diameter carbon steel influent pipe having a minimum wall thickness of 1/4-inch, to extend from a point 18-inches inside the basin wall to a flanged opening on the center feedwell.

B. Eighteen (18) inches inside the basin wall will be a flexible dresser type coupling supplied by the Contractor to connect the influent pipe to the wall spool.

C. The influent pipe shall have an energy dissipating diffusion tee on the inlet side of the feedwell.

D. The influent pipe shall be supported from the walkway per manufacturer's recommendations and as shown on the Drawings.

2.13 CENTER PLATFORM AND ACCESS WALKWAYS

A. Center platform and access walkway shall include support members, grating, handrails, and kickplates. Platform and walkway decking shall be 1 1/2-inch aluminum bar grating complying with the requirements of Section 05 53 00, Metal Grating, securely anchored to the support members. Handrails shall be aluminum and comply with the requirements of Section 05 52 00. The walkway and platform shall include a 4-inch high kickplate as part of the handrail system. The walkway and center platform shall be supported by structural steel beams. No truss-type support shall be allowed.

B. The center platform shall be a minimum of 10'-0" x 10'-0". The access walkway shall have a minimum clear width of 3'-0". The top of the platform and walkway decking shall be at the same elevation.

C. Design walkway and center platform for their own dead loads and equipment loads plus a live load of 150 psf. The maximum deflection of any component of the walkway and center platform shall be 1/360 of the span or 1 inch, whichever is smaller.

D. Platform and walkway shall meet all OSHA and local building code requirements. The components and fabrication of these items shall be in conformance, wherever applicable, to Division 5.

E. All structural steel members and assemblies for walkways and platforms shall be hot dip galvanized after fabrication in accordance with ASTM A123. Prior to hot dip galvanizing, all welds shall be ground to remove all weld spatter and slag. All sharp edges and comers shall be rounded to a smooth contour by grinding. No field welds shall be allowed on members that have been hot dip galvanized. Walkways and platforms may be fabricated and welded in the shop in major sections or assemblies prior to hot dip galvanizing, ready for bolted assembly in the field.

2.14 EFFLUENT WEIRS

The effluent weirs shall be fabricated of 1/4-inch thick x 12-inch fiberglass reinforced plastic plate. The weirs shall have 90°, 3-inch deep "V" notches spaced 6 inches on center and designed for bolting to the effluent trough as detailed on the Drawings. All fasteners shall be of Type 316 stainless steel.

2.15 ELECTRIC MOTORS

A. General:

1. The motor for the drive mechanism shall be of the TEFC design.

2. The motor shall be built in accordance with latest NEMA., IEEE, ANSI, and AFBMA standards where applicable.

3. Motor shall be as manufactured by Baldor Reliance Electric Company, U.S. Electrical Motors, General Electric Company or Toshiba.

4. The motor shall be non-overloading, without use of the service factor, for the maximum design torque of the equipment.

B. Performance Requirements:

1. Motor shall be rated for operation on 3-phase, 460-volt power supply.

2. Each motor shall have a 1.15 service factor.

3. Motor shall be rated at a minimum horsepower of 1.5.

4. Motor shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level not to exceed 85 dBA as measured 5 feet from any surface.

5. Maximum temperature rise of motor windings shall not exceed 80°C, as measured by resistance, when motor is operated continuously at service factor horsepower, rated voltage and frequency in ambient air at a temperature of 40°C.

C. Construction:

1. Motor shall be suitable for operation in moist, outdoor air, and rated for standard duty.

2. The motor shall be of all cast iron construction for frame, end brackets, conduit box and fan shroud. Motor shall be of such design and proportions as to hold all components rigidly in proper position and provide adequate protection for the type of enclosure employed.

3. The motor shall be of totally enclosed fan cooled (TEFC) construction, suitable for standard duty. Motor shall have a Class B nonhygroscopic epoxy sealed insulation system. Class F insulation may be used but shall be limited to Class B temperature rise.

4. Motor windings for stator and rotor leads shall be manufactured using solid copper wire. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.

5. A neoprene shaft slinger shall be provided and lead wires shall be nonbraided and nonwicking to prevent entrance of moisture and contaminants.

6. All leads shall be brought out to a separate terminal box and shall be marked and identified. The terminal box shall be split construction, double gasketed, containing provisions for grounding the motor and shall comply with NEMA standards for minimum volume.

7. Motor shall have stainless steel breather drains at both ends to allow proper drainage of condensation from the motor housing.

8. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.

9. Stator and rotor cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be random wound and of size, shape, insulation and number of turns required. Coils shall be epoxy sealed after fabrication.

10. Motor shall be equipped with shielded, regreasable, vacuum degassed steel ball bearings made to AFBMA Standards, and be of ample capacity for the motor rating. Bearings shall have a minimum B-10 bearing life of 100,000 hours.

11. Nameplates shall be stainless steel, fastened with stainless steel pins or screws. Lifting lugs or "O" type bolts shall be supplied on all motors. Enclosures shall have stainless steel screening and shall be protected from corrosion, fungus and insects.

12. All grease plugs, fittings, bolts, nuts, and screws shall be stainless steel. Bolts and nuts shall have hex heads. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.

13. Each motor shall be provided with a heat overload protection device to protect the motor from overheating during operation. The device shall immediately stop the drive motor in the event of excessive heat buildup.

2.16 OVERLOAD MECHANISM

A. Furnish an electro-mechanical overload control device for the thickener rake arm drive mechanism in a NEMA 4X stainless steel or aluminum enclosure with an integral conduit box and terminals. Amperage sensing devices shall not be

acceptable for torque overload protection due to their inability to react quickly enough to prevent damage to the drive.

B. The overload device shall be mounted on the drive head at the thrust end of the worm shaft and shall consist of a plate spring assembly, a plunger, indicator dial, and shall actuate three (3) independently adjustable electrical limit switches. The end thrust of the worm shaft against the plate spring shall actuate the plunger, which in turn, shall move the indicator dial. Electrical limit switches shall be SPDT type and rated for 10 amps at 120 VAC. The following switches shall be provided:

1. One (1) torque limit switch for control, set at 40 percent of mechanism design torque for "High Torque Alarm".

2. One (1) torque limit switch for "Fail Safe Torque Cutout", set at 85 percent of mechanism design torque to shutdown the unit.

3. One (1) torque limit switch for “High-High Torque Alarm”, set at 100% of the mechanism design torque

C. Provide a shear pin device set at 130 percent of maximum design torque for mechanical protection of equipment.

D. Controls, timers, and relays shall be as shown on the Drawings.

E. The three (3) limit switches in the control device shall be factory calibrated and set to the required torque.

F. Provide a visual torque dial indicator graduated on a 0 to 100 percent scale, in 10 percent increments. Orient the indicator so that it may be read from the walkway.

2.17 CONTROL PANEL

A. General:

1. Provide the thickener with a control panel in materials and rating noted below. The panel shall be of the dead-front design and include all transformers, starters, breakers, switches, relays, timers, lights, contacts, and other devices to provide automatic operation at the thickener. The panel shall be sized to adequately dissipate heat generated by equipment mounted inside or on the panel face.

Panel Name	Rating	Qty	Material	Power Feed
Sludge Thickener Control	NEMA 4X	1	316 SST	480 VAC

2. The control panel shall be furnished with a separate, weatherproof alarm light. The control panel shall be mounted in the sludge pump building. The alarm light shall be mounted adjacent to the thickener drive on a handrail.

3. Panel control layout and wiring interface shall be as shown on the Drawings. Exceptions to these layouts and wiring requirements shall be noted in the shop drawing review and brought to the attention of the Contractor.

4. Changes to the field wiring requirements shall be fully coordinated by the Contractor and all modifications to field wiring shown on the Drawings, as a result of these changes, shall be provided by the Contractor at no additional cost to the Owner.

B. Panel shall comply with requirements in Section 40 99 90, Packaged Control Systems.

C. Front-Face Panel Instrument Components

1. Front face instrument components shall be installed as shown on the Drawings.

2.18 SHOP COATINGS

A. Surface preparation: After fabrication, all ferrous surfaces of the thickener system and accessories except stainless steel, galvanized, or previously finish coated surfaces shall be prepared for shop coating as, follows:

1. Remove all weld spatter and slag by grinding smooth. All sharp edges and corners shall be rounded to a smooth contour by grinding.

2. All ferrous surfaces shall be white metal abrasive blast cleaned to SSPC-SP5 to remove all visible oil, grease, dirt, dust, mill scale, rust, oxides, corrosion products and other foreign matter. Blast profile shall be 1 to 3 mils.

B. Shop Primer: All abrasive blasted surfaces, except plate edges or areas to be field welded, shall be coated with a universal high solids, high build, chemical resistant epoxy-polyamide primer. Shop primer shall be applied in one or more coats to achieve a minimum dry film thickness of 5 mils, DFT. Shop primer shall be equal to Kop-Coat 340 Gold Primer. Shop primer used shall be compatible with the intended finish coats to be applied in the field. Shop primer shall be NSF-approved for potable water applications.

C. All machined metal surfaces will be coated with a suitable, easily removable rust inhibitive compound prior to shipment. Upon receipt of any materials coated with a rust inhibitive compound, the Contractor shall insure that the coating is intact prior to storage and maintain the coating until installation of the sludge thickener equipment.

2.19 ANCHOR BOLTS AND HARDWARE

A. All anchor bolts, assembly bolts, hanger rods, washers, nuts, clips, and other hardware items for installation shall be provided by the thickener manufacturer. All bolt diameters and lengths shall be as required by the manufacturer. Cast-in-place, J-type anchor bolts shall be provided for the center pier and for the bridge connection to the concrete tank walls. Epoxy adhesive type anchor bolts shall be provided for other structural connections, to the cemetery pier and for concrete. All other anchor bolts shall be expansion-type wedge anchors. All threads for nuts and bolts shall be in accordance with ANSI B1.1, Class 2A fit, coarse thread series. All nuts, bolts, and washers for structural anchor bolts and connections shall be manufactured of Type 316 stainless steel (Grade B8M), in accordance with ASTM A320, Class 2. All other nuts, bolts and washers used for anchors, equipment assembly, hanger rods, etc., for the thickener shall be Type 316 stainless steel, Alloy Group 2, Condition "A" in accordance with ASTM F593 for bolts and studs and ASTM F594 for nuts. All washers, clips and other hardware shall be Type 316 stainless steel. Nuts shall have a hardness that is lower than that of the bolts and washers by a difference of 50 Brinnell hardness to prevent galling during installation. Hot dip galvanized high strength hardware is acceptable only when justified to address structural considerations.

2.20 SPECIAL TOOLS AND SPARE PARTS

A. One (1) set of any special tools required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable heavy duty, non-metallic tool chest complete with lock and duplicate keys.

B. The Contractor shall furnish manufacturer recommended spare parts necessary for the first five (5) years of operation. As a minimum, the following spare parts shall be provided for the thickener mechanism furnished for the project.

1. One (1) set of seals for the sludge thickener drive
2. One (1) set of overload control device switches
3. One (1) set of squeegees
4. One (1) oil sight glass
5. A quantity of fasteners equal to 10% of each type of fastener used with the exception of anchor bolts
6. One (1) year supply of each type of lubricant required.

C. All spare parts shall be properly packaged for long periods of storage and packed in containers which are clearly identified with indelible markings as to the contents including the following: model numbers, part numbers, manufacturer of part, manufacturer's local representative. Instructions for preparation and installation of each spare part or group of parts shall be packed with the spare part or parts.

D. Spare parts and lubricants, as received, shall be turned over to the Owner immediately upon receipt by the Contractor. Verification of delivery to the Owner shall be submitted to the Engineer.

2.21 ACCESSORIES

A. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on each piece of equipment in a readily visible location. The plates shall bear the 1/4-inch die-stamped equipment identification number.

B. Lifting Lugs: Individual equipment and/or each field removable part weighing over 100 pounds shall be provided with lifting lugs.

PART 3 EXECUTION

3.01 INSTALLATION

A. The mechanism shall be installed in accordance with the manufacturer's recommendations and as shown on the Drawings and erection drawings approved by the Engineer. A factory representative shall inspect the installation prior to grouting and shall advise the Contractor regarding the proper grouting procedure consistent with other requirements in this Section and other Sections of the Specifications. After completion and prior to startup the factory representative shall make the necessary adjustments to the equipment for satisfactory operation.

B. Erection drawings shall be submitted and approved prior to shipment of equipment. Mechanism parts shall be securely anchored to the concrete tank by stainless steel fastening hardware furnished by the manufacturer, as specified above and as shown on the Drawings.

C. All necessary bolts, nuts, washers, hanger rods, clips, and other hardware items for the anchoring and erection of the unit shall be included. The manufacturer shall ship anchor bolts, bolting template drawings, and accurate bolt setting patterns to the Contractor in advance of shipping fabricated items and other equipment. The Contractor shall not proceed with construction of the concrete tank until all anchor bolting materials, templates, and patterns are received.

D. Edge Grinding: Sharp corners of cut or sheared edges and all other corners shall be rounded to a smooth contour by grinding.

E. A 2-inch layer of cement grout shall be applied to the thickener tank floor as shown on the Drawings, using temporary wooden screeds attached to the rake arm. The mechanism shall sweep in the cement grout under its own power.

3.02 FIELD PAINTING

A. All ferrous surfaces not previously primed, and all areas that were shop primed that were damaged during installation, shall be abrasive blast cleaned to SSPC-SP5, white metal blast cleaning. Blasted areas shall be reprimed with the same epoxy primer used for shop priming to achieve a minimum dry film thickness of 5 mils, DFT. Shop primed and field primed adjacent edges shall be feathered in.

B. All surfaces of the thickener and concrete tank interior and exterior, except galvanized steel, stainless steel and aluminum grating and handrails, shall be finish coated in the field. Finish coatings shall be compatible with the shop primer used. Finish coating of all thickener equipment below the support walkway bridge and the concrete tank interior shall be with an NSF approved high solids, high build polyamide epoxy. All equipment installed above the bridge shall be coated with an epoxy coating. All field coating shall be applied as specified in Section 09 90 00, Painting and Coating.

3.03 PERFORMANCE DEMONSTRATION TEST

A. Sludge thickener equipment shall be field tested, after erection, and in the presence of the Engineer, to verify the structural and mechanical integrity of the mechanism and sludge thickener drive and to verify compliance with the torque requirements specified. The testing shall be carried out under the supervision of the manufacturer's representative after start-up and prior to final acceptance. Tests shall be scheduled with the Engineer at least two (2) weeks prior to the planned test date.

B. A torque test shall be conducted to prove the structural integrity of the mechanism. The torque test will be carried out by the Contractor under the supervision of the field service engineer employed by the manufacturer.

1. The torque test shall consist of securing the sludge thickening and collection arms by cables to anchor bolts installed by the Contractor in the tank floor at locations recommended by the sludge thickener equipment manufacturer. A load shall be applied to the sludge thickening and collection arms by means of a ratchet lever and cylinder connected to the cable assembly.

2. Readings shall be taken at 40%, 85%, and 100% of the mechanism design torque. The test load shall be noted on the overload control device.

3. The field service representative shall certify that the alarm torque and motor cutout torque of the overload control device are calibrated for the settings required in this Section.

C. Complete test procedures shall be submitted to the Engineer for review and approval prior to testing.

D. All labor, materials, and test apparatus necessary for conducting the above tests shall be furnished at the sole expense of the Contractor.

E. Following satisfactory completion of the performance demonstration test, oil casings shall be drained and refilled with fresh gear oil.

3.04 FACTORY SERVICE REPRESENTATIVE

A. The Contractor shall provide the services of a trained, competent, qualified and experienced factory field representative during construction, inspection, testing, and start-up of the equipment. To provide adequate construction, inspection, testing, and start-up services for the sludge thickener unit, the factory representative shall have a complete knowledge of proper installation, operation and maintenance of the sludge thickener unit. The Contractor shall provide factory services on at least two (2) occasions for a total minimum duration of three (3) days for the project. One (1) visit shall be during erection and installation of equipment and one (1) visit shall be during checkout, start-up, and training of the Owner's personnel.

B. The purpose of the services provided by the factory representative will be for the performance of the following work.

1. Verify that the Contractor is proceeding properly during the erection and installation of equipment.

2. Following installation but before the equipment is operated by others, the representative shall inspect the completed installation for soundness,

completeness, correctness, alignment, arrangement, proper lubrication, vibration, control settings, and operation. The representative shall make or cause to be made any and all adjustments, corrections or repairs necessary.

3. Start-up of the equipment in the presence of the Contractor and Owner's operating personnel.

4. Training of Owner's operating personnel in proper operation and maintenance procedures, lubrication, startup/shutdown procedures, response to emergency conditions, and troubleshooting. The responsibility of the Contractor and the factory service representative with regard to start-up shall be fulfilled when the start-up is complete, the equipment is functioning properly and has been accepted by the Owner.

    a. The training period for the Owner's operating personnel shall be scheduled at least ten (10) days in advance with the Engineer and shall take place prior to plant start-up and acceptance by the Engineer. The final copies of operation and maintenance manuals shall have been delivered to the Engineer prior to scheduling the instruction period.

C. Upon completion of his work, the manufacturer's factory representative shall submit to the Engineer six (6) copies of a written report for the sludge thickener mechanism, as a result of his inspection, adjustments, corrections, repairs, start-up, and testing. The report shall address the inspection, adjustments, corrections and repairs made, testing, and start-up and training of the Owner's personnel. The report shall also include a notarized certification signed by the manufacturer's representative that the installed equipment:

1. Has been installed per manufacturer's requirements

2. Has been lubricated per manufacturer's instructions

3. Has been accurately aligned and proper running clearances set

4. Is free from undue stress imposed by piping or mounting bolts

5. The equipment has been tested as required above in Paragraph 3.03 and is in conformance with normal operating parameters. Test procedures and results shall be included in the report.

6. Is ready for permanent operation on a continuous basis, is free from any known defects and that nothing in the installation will render the manufacturer's warranty null and void.

D. The Contractor's attention is directed to the fact that the services specified represent an absolute minimum acceptable level of service, and are not intended to limit the responsibilities of the Contractor to comply with all requirements of the Contract Documents. The Contractor shall procure, at no additional cost to the Owner, all services required, including additional or extended trips to the jobsite by manufacturer's representatives, to comply with said requirements.

END OF SECTION

SECTION 46 71 14
SPENT BACKWASH WATER DECANTING EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. SCOPE OF WORK

1. The work includes providing all operating equipment and special materials complete with all accessories and appurtenances required for a complete system.

2. Two (2) floating decanters will be installed in the backwash recovery basin. The backwash recovery basin is 123'-0" in diameter with a maximum side water depth of 15'-0" at the wall.

3. The backwash recovery basin receives spent backwash water from the conventional filters and GAC contactors. It also receives the supernatant from the sludge thickeners and filtrate from the sludge drying beds.

1.02 WORK SPECIFIED ELSEWHERE

A. The Contractor shall coordinate the work specified in this Section with the work addressed in other Sections in order that all necessary items shall be provided as required for satisfactory operation and so that various items of equipment will properly fit and operate in the spaces allotted to them.

1.03 SUBMITTALS

A. Submittals of all materials required to establish compliance with these Specifications shall be submitted in accordance with the provisions of Section 01 33 00. Submittals shall include at least the following:

1. Detailed shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalog cut sheets of each item of equipment.

3. Pipe support design calculations and information.

4. The empty weight and the maximum operating weight of each major item of equipment.

5. A complete total bill of materials and parts list for all equipment.

6. A list of the manufacturer's recommended spare parts and special tools. Include gaskets, packing and other parts on the list.

7. List of local facilities and service organizations to obtain parts and service labor.

8. Complete installation, handling, and storage instructions.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Six (6) copies of an operating and maintenance manual shall be furnished to the Engineer as specified herein and in accordance with Section 01 78 23. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions and necessary information required to instruct operating and maintenance personnel unfamiliar with all of the equipment specified herein. A complete, corrected and approved copy of the shop drawing submittal shall be included with each manual provided.

B. Complete operation and maintenance instructions shall be submitted after the Shop Drawings are approved, but prior to shipment of equipment.

1.05 WARRANTY

A. Refer to Section 01 74 00 for warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. The floating decanter shall remove supernatant from the tank by manually opening a valve external to the tank allowing liquid to enter the decanter head and discharging out the decanter manifold. The unit shall float on the liquid with the suction below the surface to prevent scum and floatables from entering the unit. A total of two decanters shall be provided. Each decanter shall be capable of passing discharge of up to 3,500 GPM throughout the travel with minimum 3'-0" head differential.

B. The Contractor shall have one (1) supplier furnish and deliver the decanting system complete in all detail and in strict accordance with the Drawings and Specifications. The equipment shall be as supplied by Fluidyne Corporation, or an approved equal.

C. All products provided for the contract, whether named product or substitutions, shall be suitable for the intended function and indicated installation. The cost of

any redesign or modifications to accommodate products provided, shall be borne by the Contractor.

2.02 MATERIALS AND EQUIPMENT

A. Decanter System:

1. The floating decanter system shall consist of an aluminum foam filled float assembly with built in ballast tanks for levelling and acquiring the correct buoyancy. Attached to the float assembly shall be a fiberglass FSED-20 decanter collection head. The collection head shall incorporate a slotted entrance facing down to minimize solids being entrapped in the decanter head.

2. All piping shall be fiberglass reinforced polyester (FRP) conforming to ASTM-D 2996 PS15-69. Pipe shall be joined together by flanged connections or field butt wraps. PVC and other thermoplastics are not acceptable.

B. Supports: All necessary supports for the supporting the floating decanter in the dewatered conditon shall be designed and supplied as part of the system. The supports shall be manufactured of Type 316 stainless steel.

C. Swing Joint: The swing joint assembly shall be 16" diameter. The unit shall be constructed of a cast iron "U"-shaped yoke, a specially manufactured tee, and two (2) bronze or Ni-Resist bushings with nitrile O-ring seals. The cross sectional area through the unit shall be larger than the pipe size and not have any interior obstruction to interfere with the flow. The swivel joint shall have drilled flanges straddling the centerline to mate to the Contractor supplied discharge piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. The installation of all equipment including setting anchor bolts and grouting base plates shall be as recommended by the manufacturer to conform to the particular application involved, in accordance with the details shown on the Drawings. All in basin anchor bolts shall be Type 316 stainless steel and supplied by the decanting system manunfacturer. Installation of equipment and connections to equipment shall be completed in every detail in a first-class workmanlike manner.

B. All bearings shall be properly lubricated. Necessary supports for all equipment shall be provided as required.

C. Prior to acceptance of all or any part of the work, the manufacturer's field engineer shall inspect and test each piece of equipment and furnish written certification that it has been installed in accordance with the manufacturer's requirements and is ready to begin operation.

3.02 MANUFACTURER'S REPRESENTATIVES

A. The Contractor shall provide the services of a competent factory trained engineer with at least three (3) years factory experience in floating decanting equipment. The factory engineer shall be qualified to supervise installation, test for proper installation, conduct start-up, and train operators in the operation of the equipment and the process.

B. The Contractor shall provide factory services for a minimum of two (2) visits for a total minimum duration of two (2) eight-hour days for the project. One (1) visit shall be during erection and installation of equipment and one (1) visit shall be during checkout, start-up, and training of the Owner's personnel.

C. The manufacturer's field engineer shall inspect and check the installation after erection. A letter certifying that all of the equipment has been properly installed, lubricated and is in satisfactory operating condition shall be filed by the manufacturer with the Engineer before the installation can be considered complete. Any additional time required to make this certification shall be paid by the Contractor at no additional cost to the Owner.

D. The manufacturer's representative shall instruct the plant personnel on operation, maintenance, and servicing of each unit of equipment. The Contractor shall schedule the manufacturer's representatives through the Engineer for coordination.

END OF SECTION