Chamber Rehabilitation System is acceptable for day, nighttime or continuous 24-hour work schedules.

3.09 TESTING AND INSPECTION SECTION

A. SAMPLING

1. Use three 2-inch by 2-inch diameter cubes for testing compressive strength. Take 3 sets of cube molds from each day's work. Label each cube with the date, location, project and product batch numbers on each one. Product batch numbers are located on each cement bag. Testing shall be according to ASTM C 39. Send the cylinders to a certified lab, assigned by the Engineer. Test the mortar for 7 and 28-day compression test. Retain one sample for further instructions should the others fail to meet the 28-day test requirement.

B. INSPECTION

1. Each structure will be visually inspected the same day following the application of the repair liner and epoxy coating.

2. The Contractor will be required to use an Engineer approved third party inspector to inspect the completed lining system the next day. Use a NACE accredited inspector or the manufacturer's representative. Check for holidays and voids. Up on final completion of the work, the manufacturer will provide a written certification to the Engineer. The certification will confirm that the repair materials were applied per the manufacturer's recommendations. Contact your Standard Cement Materials representative for more help with the inspection services.

3. All remaining water leaks, which are detected, will be chipped back, plugged, lined with cement and coated immediately with the protective epoxy coating. Allow any areas that have been repaired to cure for 24 hours.

END OF SECTION

DIVISION 11

EQUIPMENT

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SECTION 11220 - SUBMERSIBLE MIXER ADD-1

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, delivery, installation, start up, testing, and placing into service all mixing equipment with all appurtenances associated with the Pump Station complete as shown on the Drawings and more fully described hereinafter.

B. Unless otherwise specified the mixer manufacturer shall furnish each mixing unit complete with drive motor and all other components and shall be entirely responsible for the compatibility in all respects of all components furnished.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical: Division 16

B. Instrumentation: Division 16

1.03 SUBMITTALS

A. General: The Contractor shall comply with the provisions of the specifications regarding submittals, unless otherwise specified herein.

B. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

C. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction shall be submitted on all items specified herein to the Engineer for review before ordering.

D. Content of Submittals: The following shall be included in submittals as a minimum. However, any additional information or data shall be added if and whenever requested by the Owner or the Engineer. Where applicable, submit separate data for each pump.

1. Descriptive Literature:

   a. Dimensions

   b. Materials of Construction

   c. Performance Data.

      (1) Propeller Diameter

(2) Horsepower rating of mixer motor

(3) RPM

2. Installation Information: Submit installation drawings and information for [illegible] connections, electrical connections, and auxiliary equipment.

The Contractor shall submit all other drawings, material lists and other information specified, requested and/or necessary to show complete compliance with all details of the contract documents.

3. Operation and Maintenance Manual: Manual shall contain all information necessary for proper operation and maintenance of mixing units, as well as the location of the nearest permanent service headquarters.

1.04 IDENTIFICATION - NAMEPLATES

A. Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number and principal rating date.

1.05 GUARANTEE PERIOD

A. After successful completion of tests and trials under operating conditions on all equipment, the Contractor shall guarantee all equipment and materials from undue wear and tear from mechanical and electrical defects, and from any failure whatever except those resulting from proven carelessness or deliberate actions of the Owner, for a minimum of one (1) year. This one (1) year minimum shall not replace a standard manufacturer's guarantee if it exceeds one (1) year.

1.06 MIXER WARRANTY

A. The contractor shall provide a prorated guarantee and warranties the mixers will operate satisfactorily and continuously, and that after due notice has been given by the Owner, he or the pump manufacturer will proceed, within a reasonable time to adjust, regulate, repair and renew at his expense such part or parts, equipment, auxiliaries appurtenances or perform such work as is necessary to maintain the guaranteed capacities, efficiencies and performances 100% during the first 2 years of operation, 50% during years 3 and 4, and 35% during year 5 from date the mixer is tested, placed in service and a written acceptance letter issued by the Owner.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE MIXERS

A. The principal items of equipment for the mixers shall include two (2) motor driven submersible mixers, two (2) mixer retrieval systems, electrical controls, slide rails, and other required appurtenances and wiring.

2.02 SUBMERSIBLE MIXERS AND APPURTANCENCES

A. Cable Entry: Cable entry shall consist of a compressible rubber bushing to seal off motor area and relieve strain on the cable. Cable entry housing shall be constructed of vinyl ester for shock and chemical resistance.

B. Junction Box: Box shall be sealed off from surrounding liquid and stator casing via terminal board and an O-ring.

C. Motor: Motors shall be squirrel cage, 3 phase induction shell type design NEMA B motors specifically designed for each mixer frame size and non-overloading for full performance range. Motor insulation shall be Class F with a maximum working temperature of 155°C (311°F). Combined service factor of 1.10. Motors shall be capable of being run continuously or intermittently. The stator shall be cooled by the surrounding mixed media.

D. Oil Casing: Seals shall be lubricated with a white paraffin based, FDA approved, non-toxic oil which shall act as an additional barrier to prevent liquid from penetrating the motor area. Pressure build-up within the casing shall be reduced by an inner and outer oil compartment design which transports any foreign liquids away from rotating components. Casing shall be constructed of vinyl ester for shock and chemical resistance.

E. Bearings: Bearings shall be rated in excess of 100,000 hours of operation (L-10aa rated life). Shaft shall be supported by a single row angular contact ball bearing and single row cylindrical roller bearing, plus a heavy duty single row angular contact ball bearing on the propeller side.

F. Shaft: Motor shaft and rotor shall be a single integral unit. Shaft shall be completely isolated to prevent coming in contact with the mixed media.

G. Active Shaft Seals: Outer mechanical seal shall isolate the oil housing and surrounding liquids and shall be tungsten carbide lapped end faced running in oil. Inner mechanical seal shall operate between oil casing and stator casing. Only seal faces operate in the mixed media, all other components are within motor housing. One seal face of the inner seal pair shall be laser etched spiral grooves. As the seal rotates, these grooves shall act to pump any leakage back into the oil casing from out of the stator housing.

H. Propeller: Propeller shall be two bladed, 316 stainless steel propeller. Blades have large width, thin profile and smooth surface with a back swept design for optimum efficiency and non-clogging operation. The blades shall be laser cut to exacting tolerances.

I. Monitoring Equipment: The stator shall incorporate three thermal switches connected in series (one in each phase) which open at 260°F (125°C).

J. Guide Rail Base Assembly:

1, There shall be no need for personnel to enter the wet well to remo[illegible] the mixers. In order to prevent binding or separation of the mixer [illegible] rail system, the mixer shall connect to the guide rail base auto[illegible] firmly, guided by one guide pipe extending from the bottom to [illegible] station. Guide pipes shall have bracing spaced every 10ft. Systems [illegible] cable in lieu of rigid guide bars or pipes shall not be considered accep[illegible]

2. The guide rail system shall be a non-sparking version, approved [illegible] Mutual for use in NEC Class 1, Division 1, Group C&D hazardous locations.

3. Chain and Chain Hanger: Each mixer shall be fitted with a proper length of 316 stainless steel lifting chain to allow the Operator to connect to the chain above the upper wet well hatch. The working load of the lifting system shall be 50% greater than the mixing unit weight. The manufacturer shall supply a 316 SS chain hanger to be fitted to the anchored to the concrete slab. The chain hanger shall be accessible from the hatch opening. The Contractor shall be responsible for the appropriate length of chain.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate with other trades, equipment and systems to the fullest extent possible.

B. Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this contract. All pertinent data and dimensions shall be verified by the Contractor.

3.02 INSTALLATION

A. The mixer shall be installed and placed into service in accordance with the manufacturer's recommendations, instructions and templates.

3.03 ACCEPTANCE TESTS

A. Perform a full scale factory test of all equipment before shipment.

B. Operate mixers for a period of 24 hours after installation to ensure that all parts are installed correctly and fully functional.

C. Make all adjustments necessary to provide for proper operation and full functionality.

4 MANUFACTURERS SERVICES

A. Provide the services of a manufacturer's factory trained representative for a total of one (1) trip of one (1) day to provide start up assistance and instruction on the proper operation of the equipment to the Owner's personnel.

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

END OF SECTION

SECTION 11286 - SLIDE GATES[ADD2]

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install the sluice gates and shall be the latest standard products of a manufacturer regularly engaged in the production of equipment of this type. All sluice gates shall be furnished by the same manufacturer.

B. Sluice gates shall be constructed of 316 stainless steel and to the nominal opening dimensions as indicated on the drawings. Sluice gates shall be as manufactured by Whipps, Inc., H. Fontaine Ltd., or engineer approved equal.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A.	Shop Drawings, Product Data and Samples:	Section 01340
B.	Operations & Maintenance Manuals:	Section 01780
C.	Concrete	Section 03300
D.	Precision Grouting:	Section 03600

1.03 SUBMITTALS

A. Descriptive literature, catalog cuts, dimension prints, shop drawings, installation, operation and maintenance instructions shall be submitted to the Engineer for review before shipment. The data shown on the shop drawings shall be completed with respect to dimensions, materials of construction, wiring diagrams, and the like, to enable the Engineer to review the information as required.

B. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the drawings may have from the requirements of the Engineer's specifications.

C. Comply with the provisions of Section 01340.

1.04 GUARANTY

A. The Contractor shall guarantee and warrant that the equipment furnished and installed is free from defects of design, material and workmanship, and will operate satisfactorily. In the event the equipment fails to perform as specified, and after the Owner has given due notice, the Contractor or Supplier, at their own expanse, shall promptly repair or replace the defective equipment without any additional cost to the Owner.

B. The guaranty period shall be as set forth in specification Section 01120, "General Provisions". In the event that the manufacturer's guarantee period exceeds that as stated

in the General Provisions, the manufacturer's guarantee period will stay in ef
shall not be replaced by that previously stated.

PART 2 - PRODUCTS

2.01 GENERAL

A. Gates shall be non self-contained and of the rising stem configuration. The gate sh
utilize self adjusting seals. Wedges and wedging devices shall not be accepted.

B. Except as modified or supplemented herein, all gates and operators shall conform to
applicable requirements of AWWA C561 latest edition.

C. All gate types shall be substantially watertight under the design head conditions. Leakage
shall not exceed 0.05 gallon per minute per foot of seal perimeter under the design
seating head and design unseating head. The gate's sealing system should have been
tested through a cycle test in an abrasive environment and should show that the leakage
requirements are still obtained after 25,000 cycles with a minimum deterioration.

D. All weld burn and weld slag shall be sand blasted in accordance with ASTM A380 to provide a uniform finish.

2.02 GUIDE FRAME

A. The frame shall be constructed of 316L stainless steel structural members. The frame shall be of the flange back design suitable for mounting on a wall thimble cast in the wall, unless otherwise shown on the Contract Drawings. The frame configuration shall be of the flush-bottom type and shall allow for the replacement of all seals and seats without removing the gate frame from the wall thimble or wall. All structural members shall have a minimum thickness of 1/4-inch.

B. Guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and fully support the complete vertical height of the slide in the fully open position.

C. Seals shall maintain the specified leakage rate in both seating and unseating conditions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open portion of the gate.

1. Side and top seals shall be made of UHMWPE of the self-adjusting type. A compression cord shall ensure contact between the UHMWPE guide and the gate in all positions.

2. The bottom seal shall be made of resilient neoprene or EPDM set into the bottom member of the frame and shall form a flush-bottom.

2.03 SLIDE .

A. The slide shall consist of a 316L stainless steel flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span, or 1/16-inch, whichever is less, under the design head. The slide and reinforcing stiffeners shall have a minimum thickness of 1/4-inch.

2.04 OPERATOR

A. Operation of the gate will be by means of an anti-friction floor stand hand wheel or hand crank. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings. If a chain drive is supplied with hand crank operator, the chain and gears will be constructed of stainless steel.

B. The bronze operating nut will be accurately machined and internally threaded to accept the rising stem counterpart, and sealed in the gear housing.

C. The lift mechanism must be capable of withstanding without damage an effort up to 200 lbs. Maximum effort on the hand wheel or hand crank shall not exceed 40 pounds pull to open or close the gate at maximum head.

D. The drive shall include stainless steel pinion shaft extensions, couplings, gear sprockets, roller chains, and bearings, all enclosed with a fabricated housing. A direction arrow will be attached to the housing with the word "OPEN" The crank shall be removable. The crank shall be removable and fitted with a corrosion resistant rotating handle.

E. The maximum crank radius shall be 15-inches and the maximum hand wheel diameter shall be 24-inches.

F. Operators shall be mounted on a 316 stainless steel pedestal or on 316 stainless steel wall brackets. The pedestal height and wall bracket shall be such that the hand wheel or pinion shaft on the crank-operated gearbox is located approximately 36-in above the operating floor. Wall brackets shall be reinforced to withstand in compression at least two times the rated output of the operator with a 40 lb effort on the hand crank or hand wheel.

F. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer and shall be approved by the ENGINEER. The gate manufacturer shall supply the bracket, anchor bolts and accessories as part of the gate assembly

2.05 STEM

A. The operating stem shall be of 316 stainless steel designed to transmit in compression at least 2-times the rated output of the operating manual mechanism with a 40-lb effort on the hand crank or hand wheel. The stem shall have a slenderness ration (L/R) less than 200. The stem shall have a minimum diameter of 1-1/2 inches. Stems shall be constructed of solid stainless steel round bar. Pipe extensions are not acceptable. The threaded portion of the stem shall have machine cut or machine rolled threads of the full depth ACME type polished to a 16 microinch finish or better. An internally threaded adjustable stop collar shall be provided on each stem to limit upward travel on gate systems having mechanical lifts.

B. For stems in more than one piece and with a diameter of 1.750-inches and [illegible] different sections shall be joined together by solid couplings. Stems with [illegible] smaller than 1.750-inches shall be pinned to an extension tube. The couplings [illegible] grooved and keyed and shall be of greater strength than the stem.

C. Stem guides shall be fabricated from type 316L stainless steel with a minimum thickness of 1/4-inch. The guide shall be equipped with a UHMWPE bushing. There shall be no metal to metal contact between the stem and the stem guide. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendations. The L/R ratio shall not be greater than 200.

D. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear Mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

2.06 FULL OPEN GATE

A. Each gate system will be designed to open fully above the maximum water level or to achieve a full open port unless otherwise shown on the contract drawings or specified herein.

2.07 MATERIALS OF CONSTRUCTION

A.	Frame, yoke, slide, reinforcing members:	316L Stainless Steel
B.	Side seals, stem guide liner:	UHMWPE (ultra high molecular weight Polyethylene) ASTM D-4020
C.	Compression cord:	Silicone or Nitrile ASTM D-2000 M6BG 708, A14, B14, E014, E034
D.	Bottom seal:	Neoprene or EPDM ASTM D-2000 Grade 2 BC-510
E.	Stem, threaded stem, stem guides:	316 Stainless Steel
F.	Fasteners:	ASTM F593 and F594 GR2 for type 316
G.	Operator wall bracket support:	316 Stainless Steel
H.	Hand wheel, hand crank, pedestal support:	Tenzaloy aluminum
I.	Gasket (between frame and wall):	EPDM ASTM 1056 or non-shrink grout
J.	Stem cover:	Clear Polycarbonate ASTM A-3935
K.	Lift nut:	Manganese bronze ASTM B584

PART 3 - EXECUTION

3.01 INSTALLATION

A. Slide gates shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 11310 - SUBMERSIBLE SEWAGE PUMPS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, delivery, installation, start up, testing, and placing into service all pumping equipment with all appurtenances associated with the Pump Station complete as shown on the Drawings and more fully described hereinafter.

B. Unless otherwise specified the pump manufacturer shall furnish each pumping unit complete with drive motor and all other components and shall be entirely responsible for the compatibility in all respects of all components furnished.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A.	Earthwork:	Section 02300
B.	Interior Processing Piping:	Section 11290
C.	Interior Process Valves:	Section 11295
D.	Access Hatches:	Section 08370
F.	Electrical:	Division 16
G.	Instrumentation:	Division 16

1.03 SUBMITTALS

A. General: The Contractor shall comply with the provisions of the specifications regarding submittals, unless otherwise specified herein.

B. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

C. The Contractor shall provide a notarized certification indicating that all piping products meet the required Specifications.

D. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction shall be submitted on all items specified herein to the Engineer for review before ordering.

E. Content of Submittals: The following shall be included in submittals as a minimum. However, any additional information or data shall be added if and whenever requested by the Owner or the Engineer. Where applicable, submit separate data for each pump.

1. Descriptive Literature:

   a. Dimensions

   b. Materials of Construction (including required coating).

   c. Performance Data.

      (1) Pump Impeller Size

      (2) GPM

      (3) TDH

      (4) BHP

      (5) RPM

      (6) Performance curves showing pump operation including shutoff head, operating point, and run-out.

      (7) Performance curves showing overall pump efficiencies.

      (8) Weight of pump

      (9) Horsepower rating of pump motor

2. Installation Information: Submit installation drawings and information for pump connections, connecting piping and valves, electrical connections, and auxiliary equipment.

   The Contractor shall submit all other drawings, material lists and other information specified, requested and/or necessary to show complete compliance with all details of the contract documents.

3. Operation and Maintenance Manual: Manual shall contain all information necessary for proper operation and maintenance of pumping units, as well as the location of the nearest permanent service headquarters.

1.04 IDENTIFICATION - NAMEPLATES

A. Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number and principal rating date.

1.05 TESTS

A. Shop Tests:

1. The pumps shall be fully tested at the manufacturer's works before shipment at their rated speed, capacity, and head, and at such other conditions of head and

capacity to establish that each has met all guarantees on the characteristic curves submitted. Testing shall be done in accordance with the Hydraulic Institute Standards, Level A. Five (5) certified copies of the results of these tests are to be sent to the Engineer. Also included with the test curves shall be a certified bill of material list depicting quality of construction. Such tests shall be accomplished at the manufacturer's facility prior to shipment.

2. The pumping units will be accepted upon the basis of the certified copies of the shop test and be subject to a four-hour field test of each unit. This test will be for the purpose of determining if each pumping unit will operate under installed conditions within a reasonable degree of correlation with the shop tests.

B. Field Tests:

1. The Contractor shall give at least two (2) week's notice to the Owner when the field tests are to be accomplished so that the Owner may have a representative present at the said tests.
2. The field tests shall be made by the Contractor in the presence of and as directed by the Engineer. Testing shall be done in accordance with the Hydraulic Institute Standards.
3. Field tests shall be made on each pumping unit. Included therein, each pump shall be run at maximum rated speed for at least three (3) rates of flow corresponding to minimum rate, design rate, and maximum rate of flows specified as evidenced by the corresponding total dynamic head shown by the pump gages; simultaneous ammeter readings shall be taken. Variation of the rate of flow shall be made by throttling the discharge valve (where applicable). The rated motor nameplate current and power shall not be exceeded at any rate of flow within the specified range.
4. Before any pump is rotated, the Contractor shall make certain that no debris is present in suction well, pumps or pipe lines. Any internal damage done to equipment while starting up shall be assumed to be caused by debris and shall be replaced at the Contractor's expense. No pump shall be rotated under power unless submerged with liquid.
5. When water can be pumped, the Contractor shall commence pumping and shall have representatives from the pump manufacturer to start the pumps. When flow conditions are favorable, the Contractor or pump manufacturer shall in the presence of the Engineer, run a series of tests to establish the adequacy of the pumping units.
6. Field tests shall also conform to Part 3, Paragraph 3.03 as specified hereinafter.

C. Failure of Tests:

1. Any defects in the equipment or failure to meet the guarantees or requirements of the specifications shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails or refuses to make these corrections or if the improved equipment, when tested, shall fail again to meet the guarantees of specified requirements, the Owner notwithstanding its having made partial payment for work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at his own expense.
2. In case the Owner rejects said equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him for said rejected equipment on

progress certificates or otherwise on account of the lump sum pri... specified, and upon the receipt of said sum of money the Owner will ex... deliver to the Contractor a bill of sale of all its rights, title, and interest ... said rejected equipment; provided, however, that said equipment shall ... removed from the premises of the Owner until the Owner obtains fro... sources the equipment to take the place of the rejected. The Owner ... agrees to obtain said other equipment within a reasonable time and the Cont... agrees that the Owner may use the equipment furnished by him without rental or other charge until said other new equipment is obtained.

D. Responsibility During Test: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

E. Manufacturer's Representative: For all pumping units, the Contractor shall furnish the services of accredited representatives of the pump manufacturer who shall supervise the installation, adjustment, and field tests of each pumping unit and give instructions to the operating personnel. As one condition necessary to acceptance of any pumping unit, the Contractor shall submit a certificate from the manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

1.06 GUARANTEE PERIOD

A. After successful completion of tests and trials under operating conditions on all equipment, the Contractor shall guarantee all equipment and materials from undue wear and tear from mechanical and electrical defects, and from any failure whatever except those resulting from proven carelessness or deliberate actions of the Owner, for a minimum of one (1) year. This one (1) year minimum shall not replace a standard manufacturer's guarantee if it exceeds one (1) year.

1.07 PUMP WARRANTY

A. The Contractor guarantees and warrants that during the first three (3) years of operation, (date the pump station is tested, placed in service and a written acceptance letter issued by the Owner) the pump stations will operate satisfactorily and continuously according to the pump requirements specified herein, and that after due notice has been given by the Owner, he or the pump manufacturer will proceed, within a reasonable time to adjust, regulate, repair and renew at his expense such part or parts, equipment, auxiliaries appurtenances or perform such work as is necessary to maintain the guaranteed capacities, efficiencies and performances. The approved pump manufacturer shall provide a full five (5) year prorated warranty for all pumps.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE NON-CLOG SEWAGE PUMPS

A. The principal items of equipment for the pump station shall include two (2) motor driven submersible non-clog sewage pumps, two (2) pump retrieval systems, two (2) plug valves, two (2) check valves, two (2) pressure gauges, required piping, electrical controls, automatic pumping level controls, access hatches, vent piping, slide rails, and other required appurtenances and wiring.

2.02 SUBMERSIBLE PUMPS AND APPURTANCENCES

A. Submersible pumping equipment shall comply with the following characteristics in the Pump Schedule:

Pump Schedule *ADD1*

No. of Pumps	*Shut-Off Head (Min) (Ft)*	*Design Point #1 (Duty Point)*		*Design Point #2*		*Design Point #3*		*Pump Eff. @ Duty Pt.*	*Max. Speed (RPM)*	*Motor HP/Min Each Pump*	*Motor Voltage*
		Flow (GPM)	*Head (Ft.)*	*Flow (GPM)*	*Head (Ft.)*	*Flow (GPM)*	*Head (Ft.)*				
2	*94*	*850*	*53*	*500*	*65*	*1100*	*43*	*75%*	*1750*	*25*	*460V 3 Phase*

B. Pump efficiency shall be a minimum of 75% at design operating point #1.

C. Larger horsepower than shown above may require electrical changes to accommodate motor loads. Contractor shall be responsible for all required electrical changes associated with larger horsepowers, including changes which may affect the generator specified.

D. Manufacturers:

1. The pump, mechanical seals and motor shall be from the same manufacturer.
2. The pump, mechanical seals and motor manufacturer shall be SULZER-ABS, FLYGT, or approved equal.

E. Pump Design:

1. The heavy-duty submersible wastewater pumps shall be capable of handling raw unscreened sewage, storm water, and other similar solids-laden fluids without clogging. The pump shall be driven by a **Premium Efficiency motor**, providing the highest levels of operational reliability and energy efficiency.

F. Guide Rail Base Assembly:

1, There shall be no need for personnel to enter the wet well to remove the pump(s). In a wet pit installation, the discharge base & elbow assembly shall be permanently installed in the wet well and connected to the discharge piping in order to prevent binding or separation of the pump from the guide rail system. The pump(s) shall connect to the guide rail base automatically and firmly, guided by one 2 inch guide pipe extending from the base elbow to the top of the station. Guide pipes shall have bracing spaced every 10ft. Systems using guide cable in lieu of rigid guide bars or pipes shall not be considered acceptable. The sliding guide bracket shall be a separate part of the pumping unit, capable of being attached to standard 6 inch ANSI class 125 or metric DN150 pump flanges, so that the pump mounting is non proprietary, and any pump with a standard discharge flange can be mounted on the base assembly. Base or bracket assemblies with proprietary or non standard flange dimensions shall not be considered acceptable.

2. A field replaceable Nitrile (Buna-N) rubber profile gasket or o-ring shall accomplish positive sealing of the pump flange/guide rail bracket to the discharge elbow. Base assemblies which rely solely on metal to metal contact between the pump flange and discharge base elbow as a means of sealing may be considered equal. No portion of the pump shall bear directly on the floor of the sump. The guide rail system shall be a non-sparking version, approved by Factory Mutual for use in NEC Class 1, Division 1, Group C&D hazardous locations.

3. Chain and Chain Hanger: Each pump shall be fitted with a proper length of 316 stainless steel lifting chain to allow the Operator to connect to the chain above the upper wet well hatch. The working load of the lifting system shall be 50% greater than the pump unit weight. The manufacturer shall supply a 316 SS chain hanger to be fitted to the anchored to the concrete slab. The chain hanger shall be accessible from the hatch opening. The Contractor shall be responsible for the appropriate length of chain.

G. Pump Construction

1. Major pump components shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be stainless steel 1.4401 (AISI type 316) construction. All metal surfaces coming into contact with the pumped media (other than the stainless steel components) shall be protected by a factory applied spray coating of high solids two part epoxy paint finish on the exterior of the pump. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings, or for hooking from the wet well surface. The hoop shall ductile cast iron EN-GJS-400-18 (ASTM A536; 60-40-18) with an option of stainless steel 1.4462, and shall be rated to lift a minimum of four times the pump weight.

2. Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal-to-metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

H. Impeller: The impeller shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The impeller shall be of the semi-open, non-clogging, two vane design. The impeller shall be capable of passing a minimum of 3x4 inch spherical solids as are commonly found in waste water. The impeller shall have a slip fit onto the motor shaft and drive key, and shall be securely fastened to the shaft by a stainless steel bolt which is mechanically prevented from loosening by a positively engaged ratcheting washer assembly. The head of the impeller bolt shall be effectively recessed within the impeller bore or supporting washer to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation..

1. Wear Ring System: The wear plate shall be constructed from gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The wear plate shall be designed with a surface incorporating strategically placed cutting grooves on the side facing the impeller, to shred and force any stringy solids which attempt to become lodged between the impeller and wear plate outward from the impeller and through the pump discharge. The wear plate shall be mounted to the volute with four stainless steel securing screws and four stainless steel adjusting screws to permit close tolerance adjustment between the wear plate and impeller for maximum pump efficiency. Adjustment to allow for wear and restore peak pumping performance shall be easily accomplished using standard tools, and without requiring disassembly of the pump. The use of fixed or non-adjustable wear plates or rings, or systems that require disassembly of the pump or shimming of the impeller to facilitate adjustment shall not be considered equal or acceptable. The suction flange shall be integrated into the wear plate and its bolt holes shall be drilled and threaded to accept standard 8 inch ANSI class 125 flanged fittings.

J. Pump Volute: The pump volute shall be single piece gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. Discharge size shall be as specified on the pump performance curve. The discharge flange design shall permit attachment to standard ANSI or metric flanges/appurtenances. The discharge flange shall be drilled to accept both 6 inch ANSI class 125 and metric DN150 (PN 10) metric flanged fittings. Proprietary or non standard flange dimensions shall not be considered acceptable. The maximum working pressure of the volute and pump assembly shall be 10 bar (145 psi).

K. Premium Efficiency Motor:

1. The Premium Efficiency motor shall meet efficiency standards in accordance with IEC 60034-30, level IE3 and NEMA Premium*. Motor rating tests shall be conducted in accordance with IEC 60034-2-1 requirements and shall be certified accurate and correct by a third party certifying agency. A certificate shall be available upon request.
2. The Premium Efficiency motor shall be housed in a water tight gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) enclosure capable of continuous submerged operation underwater to a depth of 20 meters (65 feet), and shall have an IP68 protection rating. The motor shall be of the squirrel-cage induction design, NEMA type B, Premium Efficiency. The copper stator windings shall be insulated with moisture resistant Class H insulation materials, rated for 180°C (356°F). The stator shall be press fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is

unacceptable. The rotor bars and short circuit rings shall be made of aluminum.

3. The motor shall be designed for continuous duty. The maximum continuous temperature of the pumped liquid shall be 40°C (104°F), and intermittently up to 50°C (122°F). The motor shall be capable of handling up to 15 evenly spaced starts per hour without overheating. The service factor (as defined by the NEMA MG1 standard) shall be **1.3** in wet pit service and 1.15 in dry pit service. The motor shall have a voltage tolerance of +/- 10% from nominal, and a phase to phase voltage imbalance tolerance of 1%. The motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The surface temperature rating shall be T3C. The motor shall meet the requirements of NEMA MG1 Part 30 and 31 for operation on PWM type Variable Frequency Drives.

4. The motor shall be capable of operating, completely submerged, partially submerged, or unsubmerged. For submerged (wet pit) applications, the motor shall be self cooling via the process fluid surrounding the motor. The motor shall have a NEMA Class A temperature rise for submerged service, providing cool operation under all operating conditions.

L. Thermal Protection: Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 140°C +/- 5°C (284°F). They shall be connected to the control panel, and used in conjunction with, and supplemental to, external motor overload protection.

M. Mechanical Seals:

1. Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary industrial duty **silicon-carbide** seal ring and one rotating industrial duty **silicon-carbide** seal ring. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron EN-GJL-250 (ASTM A-48, Class 35B). The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate. The upper, secondary seal unit, located between the lubricant chamber and motor housing, shall contain one stationary industrial duty **silicon-carbide** seal ring, and one rotating one rotating industrial duty **silicon-carbide** seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall not require routine maintenance, or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal, and shall be easily accessible from the outside of the pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe non toxic material.

2. The following seal types shall not be considered equal: Seals of proprietary design, or seals manufactured by other than major independent seal manufacturing companies. Seals requiring set screws, pins, or other mechanical

locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, any system requiring a pressure differential to seat the seal and ensure sealing.

N. Mechanical Seal Protection System: The primary mechanical seal shall be protected from interference by particles in the waste water, including fibrous materials, by an active Seal Protection System integrated into the impeller. The back side of the impeller shall be equipped with a sinusoidal cutting ring, forming a close clearance cutting system with the lower submersible motor housing or seal plate. This sinusoidal cutting ring shall spin with the pump impeller providing a minimum of 75 shearing actions per pump revolution. Large particles or fibrous material which attempt to lodge behind the impeller, or wrap around the mechanical seal shall be effectively sheared by the active cutting system into particles small enough the prevent interference with the mechanical seal. The Seal Protection System shall operate whenever the pump operates, and shall not require adjustment or maintenance in order to function. Submersible pump designs which do not incorporate an active cutting system to protect the primary mechanical seal shall not be considered acceptable for wastewater service.

O. Seal Failure Early Warning System: The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned between the primary and secondary mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be filled with environmentally safe non toxic oil. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the primary mechanical seal, the probe shall sense the increase in conductivity and signal the solid state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage, thereby preventing damage to the submersible pump, and allowing scheduled rather than emergency maintenance. Systems utilizing float switches or any other monitoring devices located in the stator housing rather than in a sensing chamber between the mechanical seals are not considered to be early warning systems, and shall not be considered equal.

P. Shaft: The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation. Each shaft shall be stainless steel 1.4021 (AISI 420) material, and shall have a polished finish with accurately machined shoulders to accommodate bearings, seals and impeller. Carbon steel, chrome plated, or multi piece welded shafts shall not be considered adequate or equal.

Q. Bearings: Each pump shaft shall rotate on high quality permanently lubricated, greased bearings. The upper bearing shall be a cylindrical roller bearing and the lower bearings shall be a matched set of at least **three** heavy duty bearings, **two** angular contact ball bearings and **one** cylindrical roller bearing. All three lower bearings shall have identical outer race diameters to provide maximum bearing load capacity. Designs which utilize a roller bearing with a smaller outer diameter than the other bearings in the assembly do not provide maximum load capacity and shall not be considered equal. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump

housing and minimize shaft deflection. L-10 bearing life shall be a minimum of [illegible] hours at flows ranging from ½ of BEP flow to 1½ times BEP flow (BEP is the best efficiency point). The bearings shall be manufactured by a major international manufacturer of high quality bearings, and shall be stamped with the manufacturer's name and size designation on the race. Generic or unbranded bearings from non-major bearing manufacturers shall not be considered acceptable.

R. Power Cable: The power cables shall be sized according to NEC and CSA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil and water resistant, and shall be capable of continuous submerged operation underwater to a depth of 65 feet. Contractor shall be responsible for the correct length of power cable.

S. Cable Entry/Junction Chamber:

1. The cable entry design shall not require a specific torque to insure a watertight seal. The cable entry shall consist of cylindrical elastomer grommets, flanked by stainless steel washers. A cable cap incorporating a strain relief and bend radius limiter shall mount to the cable entry boss, compressing the grommet ID to the cable while the grommet OD seals against the bore of the cable entry. The junction chamber shall be isolated and sealed from the motor by means of sealing glands. Electrical connections between the power cables and motor leads shall be made via a compression or post type terminal board, allowing for easy disconnection and maintenance.

T. Access hatches for wet well and valve pit shall be as specified in Section 107445 of these specifications. Dimensions shall be as noted on the Drawings. Access hatch sizes will be verified by the pump manufacturer as to appropriate size. The Contractor shall be responsible for providing a hatch size which will allow pump installation and removal.

U. Pressure Gauges:

1. See Division 16 – Instruments, for Pressure Gauge Specification and Schedule.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate with other trades, equipment and systems to the fullest extent possible.

B. Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this contract. All pertinent data and dimensions shall be verified by the Contractor.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Anchor bolts shall be set in accordance with the manufacturer's recommendations and setting plans.

B. The Contractor shall also provide from the submersible pump supplier the service of a qualified start-up engineer (factory representative) who has had prior on-site start-up experience to assist in performing start-up, checkout and initial operation services of the pumping units. The start-up engineer shall also instruct the Owner's personnel on the operation and maintenance procedures for the station. Qualified supervisory services, including manufacturers' engineering representatives, shall be provided for a minimum of two (2) person-days to insure that the work is done in a manner fully approved by the respective equipment manufacturer. The pump manufacturer's representatives shall specifically supervise the installation of the pump and the alignment of the connection piping. If there are difficulties in the start-up or operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner. Services of the manufacturer's representatives and training shall be provided when the first pump is started, with follow-up visits upon start-up of each subsequent pump.

C. A certificate from each equipment manufacturer shall be submitted stating that the installation of his/her equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.03 FIELD TESTS

A. During the field tests, observations shall be recorded of head, capacity, and motor input. All defects or defective equipment revealed by or noted during the tests shall be corrected or replaced promptly at the expense of the Contractor, and if necessary, the tests shall be repeated until results acceptable to the Engineer are obtained. The Contractor shall furnish all labor, piping, equipment, and materials necessary for conducting the tests. A report of the field tests shall be submitted to the Engineer.

B. After installation of the pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's representative, each pump shall be given a running test in the presence of the Engineer, such tests as necessary to indicate that the pumps, motors, and drives generally conform to the efficiencies and operating conditions specified and its ability to operate without vibration or overheating. The pumps and motors shall operate at the specified capacities in the range of heads specified without undue noise or vibration. Any undue noise or vibration in the pumps or motors, which is objectionable, will be sufficient cause for rejection of the units.

C. An operating time period to be determined by the Owner, but not exceeding six 6) months, shall be required before acceptance. If a pump performance does not meet the Specifications, corrective measures shall be taken or the pump shall be removed and replaced with a pump which satisfies the conditions specified. All test procedures shall be in accordance with Hydraulic Institute Standards certified results of tests shall be submitted.

D. Provide, calibrate and install all temporary gauges and meters, shall make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the Engineer for approval 30 days prior to testing.

3.04 MANUFACTURERS SERVICES

A. The Contractor shall include with his bid the services of the Equipment Manufacturer's field service technician.

B. This service shall be for the purposes of check-out, initial start-up certification and instruction of plant personnel. A minimum of five (5) days start-up services shall be provided.

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

D. All check-out, start-up and installation approval shall be performed prior to instruction of plant personnel. The Contractor shall schedule with the Owner all instructional training.

E. After the pumps have been completely installed and wired, the contractor shall have the manufacturer do the following:

1. Megger stator and power cables.
2. Check seal lubrication.
3. Check for proper rotation.
4. Check power supply voltage.
5. Measure motor operating load and no load current.
6. Check level control operation and sequence

F. A factory representative shall provide a minimum of eight (8) man-hours of training to the Owner's operations staff concerning the recommended operation and maintenance of the equipment. Training shall be performed after substantial completion of the project wit the use of operating equipment.

END OF SECTION

SECTION 11311 – EXPLOSIONPROOF SUBMERSIBLE SUMP PUMPS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, delivering, installing, testing, and placing into service all pumping equipment and with all appurtenances associated with the Lift Stations complete as shown on the Drawings and more fully described hereinafter.

B. Unless otherwise specified the pump manufacturer shall furnish each pumping unit complete with drive motor and all other components and shall be entirely responsible for the compatibility in all respects of all components furnished.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 01340

B. Operating & Maintenance Manuals: Section 01780

C. Electrical: Division 16

1.03 MANUFACTURER

A. The pumping units shall be provided by a single manufacturer with a minimum of five (5) year's experience in designing and manufacturing pumping equipment of similar type, size and capacity. The pumps shall be manufactured by Zoeller, Ebara, Hydromatic, or equal.

B. Replacement Parts Capability: The manufacturer shall have the ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the pumps. Upon request, the Contractor shall submit evidence of the proposed manufacturer's ability to promptly fill replacement orders.

C. Quality Assurance: All pumping units shall be of approved design and make products of manufacturers who have built equipment of similar type, size and capacity.

D. Additional Submittals: The Contractor shall submit, upon request, any additional information that the Engineer may deem necessary to determine the ability of the proposed manufacturer to produce the specified equipment.

E. Manufacturer Information: All manufacturer information required by the specifications shall be submitted by the Contractor within thirty (30) calendar days of the date of receipt of the Notice to Proceed.

Any additional information or data, specifically requested by the Engineer, concerning manufacturer's capabilities (especially relating to requirements described hereinbefore), shall be submitted by the Contractor within fourteen (14) calendar days of the receipt of the written request thereof, unless otherwise specified.

Approval of manufacturers or suppliers will not be given until all information required by the specifications or requested by the Engineer has been submitted and acceptable.

F. Disqualification of Manufacturer:

1. Poor performance of similar pumping equipment now in operation under the specified conditions of service and pump rating constitute grounds for disqualification of the pump manufacturer, supplier, or both, unless such poor performance has been corrected.

2. Failure to successfully comply with the provisions of subparagraphs A through F, inclusive, will constitute grounds for disqualification of pump manufacturer.

1.04 SUBMITTALS (SHOP DRAWINGS)

A. General: The Contractor shall comply with the provisions of the specifications regarding submittals, unless otherwise specified herein.

B. At the time of submission, the Contractor shall, in writing, call the Engineer's attention to any deviations that the submittals may have from the requirements of the Engineer's Contract Drawings and Specifications.

C. The Contractor shall provide a notarized certification indicating that all piping products meet the required Specifications.

D. Descriptive literature, catalog cuts, and dimensional prints clearly indicating all dimensions and materials of construction shall be submitted on all items specified herein to the Engineer for review before ordering.

E. Content of Submittals: The following shall be included in submittals as a minimum. However, any additional information or data shall be added if and whenever requested by the Owner or the Engineer. Where applicable, submit separate data for each pump.

1. Descriptive Literature:

a. Dimensions

b. Materials of Construction (including required coating).

c. Performance Data.

(1) Pump Impeller Size

(2) GPM

(3) TDH

(4) BHP

(5) RPM

(6) Performance curves showing pump operation including shutoff head, operating point, and run-out.

(7) Performance curves showing overall pump efficiencies.

(8) Weight of pump

(9) Horsepower rating of pump motor

2. Installation Information: Submit installation drawings and information for pump connections, connecting piping and valves, electrical connections, and auxiliary equipment.

The Contractor shall submit all other drawings, material lists and other information specified, requested and/or necessary to show complete compliance with all details of the contract documents.

3. Operation and Maintenance Manual: Manual shall contain all information necessary for proper operation and maintenance of pumping units, as well as the location of the nearest permanent service headquarters.

1.05 PUMP WARRANTY

A. The Contractor guarantees and warrants that during the first one year of operation, the pumps will operate satisfactorily and continuously according to the pump schedule specified herein, and that after due notice has been given by the Owner, he or the pump manufacturer will proceed, within a reasonable time, to adjust, regulate, repair and renew at his own expense or perform such work as is necessary to maintain the guaranteed capacities, efficiencies and performances.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS

A. Scope of supply

Furnish and install one submersible sump. Each unit shall be rated at 55 GPM at 30 feet TDH. The pump(s) shall be designed to pump dirty waters containing 3/4" spherical solids without damage during operation. The pump(s) shall be designed so that the pump shaft horsepower (BHP) shall not exceed motor rated horsepower throughout the entire operating range of the pump performance curve. Pump(s) shall be built to operate whether fully or partially submerged.

B. The motor shall be 3450 rpm, ½ HP, 60 Hz, single phase.

C. The unit shall be thermally protected and rated for a Class 1, Division 2 hazardous environment.

D. Impeller shall be bronze class 88-8-0-4, non-clogging vortex impeller.

E. The pumping unit shall be UL listed and provided with a 30' cord.

F. The unit shall have automatic operation with an integral float switch that will operate within a 24" sump.

2.02 PUMP ACCESSORIES AND OTHER

A. All pumps and controls shall be completely wired at the factory for power and control and shall be color-coded. All wiring outside the control cabinet shall be rigid conduit. All accessory equipment shall be permanently wired with suitable disconnecting means and overload protection.

B. Contractor shall be responsible for supply of appropriate lengths of lifting chain, submersible power cable, and MG Hi conductor submersible cable.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate with other trades, equipment and systems to the fullest extent possible.

B. Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this contract. All pertinent data and dimensions shall be verified by the Contractor.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16100 - ELECTRICAL DEMOLITION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, equipment, materials, and supplies necessary for and reasonably incidental to demolition of work hereinafter specified, indicated on drawings, required or intended for completion of the work.

B. Major items included under demolition work include, but are not limited to:

1. Exterior electrical system in the existing pump station.

2. Site lighting refeed from new control panel.

3. Site underground raceway for lighting, control wiring and power in the existing pump station.

C. Repair those areas damaged under demolition work once new services and systems have been installed.

1.02 SUBMITTALS

A. No submittals are anticipated under this Section.

1.03 JOB CONDITIONS

A. Provide adequate protection to persons and property. Execute work in such a manner as to avoid interference with required operations and use of or passage to and from adjoining buildings and facilities.

B. Demolition work of equipment necessary for the operation of the power and control systems to be coordinated with the installation of new equipment. The new installation work is to be done quickly as possible to allow the new control panel to control the 1st wetwell correctly. Then the contractor shall be allowed to remove the rest of the electrical equipment and allow the new control panel to control the 2nd wetwell this way we minimize any burdens on the Owner.

1.04 CONDITION OF EXISTING FACILITIES

A. Contractor shall verify the areas, conditions and features necessary to tie new work into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities.

PART 2 – PRODUCTS

NOT APPLICABLE

PART 3 – EXECUTION

3.01 SCHEDULES

A. Schedule all demolition work as to cause minimal interference with existing facility operations. Refer to Specification Divisions 0 and Division 1 for additional requirements.

B. Obtain prior approval of the Owner at least seven days in advance before starting demolition of any equipment. Under no circumstances will demolition work be approved until new equipment is ready for installation.

3.02 PREPARATION

A. Disconnect or arrange for disconnection of utility service connections to equipment and areas to be demolished before starting demolition.

B. Preserve in operating condition all active utilities transversing the project site. Protect all equipment that remains (electrical and mechanical) during demolition, and repair all damage caused by this work to satisfaction of Engineer.

3.03 APPLICATION

A. Maintain the continuity of the existing branch circuits serving all existing light fixtures that are to remain, whether indicated or not on the drawings.

B. All existing walls, ceilings, floor slabs, etc., being cut or damaged under this Contract shall be patched back to match existing by General Contractor.

C. All existing switchgear, lighting fixtures, receptacles, control equipment and switches being removed shall be disposed of by the Contractor. Refer to 16925 for more details.

D. Remove exposed ground conductor back to source or point of contact with slab. Cut conductor off below slab and abandon with hole being patched back to match existing surface (floor, wall or ceiling). If reusable, simply disconnect ground conductor.

E. Conduits, wire and wood products that are not salvageable shall be disposed of legally.

F. Primary work shall be completed with all facilities kept in service or with short periods of scheduled momentary outages.

G. Holes in slabs or into classified areas to be patched to provide a gas, vapor and watertight barrier.

3.04 STORAGE AND HANDLING

A. The Owner reserves the right to save materials that are a part of the demolition work, and the Contractor shall turn over and store any such materials at the Owner's direction.

B. All materials not turned over to Owner shall become property of Contractor and removed promptly from project site at no additional cost to the Owner. Any permits or fees for disposal shall be the responsibility of the Contractor.

3.05 CLEANUP

A. Burn no materials or debris on premises.

B. Remove from site rubbish and debris found thereon and, except as otherwise specified, materials and debris resulting from work of demolition. Leave site in safe and clean condition.

END OF SECTION

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SECTION 16925 - WASTEWATER PUMPING STATION ELECTRICAL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Work included in this section of the Specification includes the furnishing of all labor, material, tools, approvals, utility connection fees, excavation, backfill, and other equipment necessary to install the electrical system as shown on the Contract Drawings and as specified herein.

B. It also includes installation and connection of all electrical utilization equipment included in this Contract but furnished by other Contractors or suppliers.

C. It is the general intent that motors be furnished with the pumps, unless it is a replacement motor, and then it shall be furnished under this Division of the Specifications.

D. The Contractor shall furnish and install all conduit, wire, control equipment, and miscellaneous material to make all electrical connections to all items of utilization equipment unless as otherwise specified.

E. The number and size of conductors between motors and control or protective apparatus shall be as required to obtain the operation described in these Specifications, and/or by the Contract Documents, and/or as shown in manufacturer furnished, Engineer reviewed Shop Drawings.

F. All items of electrical equipment, including those shown on the Contract Drawings but not specifically mentioned in the Specifications or those mentioned in the Specifications but not shown on the contract Drawings, are to be furnished under this section of the Specifications. Any such device or item of equipment, if not defined in quality, shall be equal to similar equipment and/or devices specified herein.

G. All devices and items of equipment mentioned in this section of the Specifications whether electrical or not or whether furnished under this or other Division of the Specifications, shall be installed under this Division of the Specifications, unless specifically indicated otherwise.

H. Where wiring diagrams are not shown on the Contract Drawings, they are to be provided by the supplier of the equipment served and such diagrams shall be adhered to except as herein modified.

I. The following is a list of items that may not be defined clearly on the Contract Drawings or in other parts of these Specifications. The list is meant to be an aid to the Contractor and is not necessarily a complete list of all work to be performed under this Contract:

1. Connect all motors and accessories furnished by equipment suppliers.

2. Furnish, install, and connect all motor controls.

3. Furnish, install, and connect items of instrumentation, and all associated power and signal lines.

4. Furnish, install, and connect all electrical conduit and cables.

5. Furnish, install, and connect all utility poles and hardware.

6. Furnish, install, and connect all power distribution equipment.

7. Abandon and remove all existing wiring and materials not to be reused, as shown in the Contract Drawings.

J. Gas Detector

1. Combustible Gas Detection shall be MSA Ultima X XIR gas monitor A-Ultima X #XP-E-31-U-3-S-2-0-0-1-2-1-1-0, and a Sampling Module/DC pump #10052822, or equal for each gas detection location.

   a. The combustible gas monitor shall be a combination sensor/transmitter with LED display, and shall operate on an infrared sensing technology. The unit shall utilize an infrared light source which is directed through two wavelength filters, providing a dual-beam concept with a reference beam and a target gas beams which are directed back to the corresponding detector. The difference in IR intensity shall be proportional to the gas concentration.

   b. The sensor shall provide a 4-20 mADC output which is proportional to the measured gas concentration.

   c. Input voltage shall be 24VDC. Provide optional power supply with 115VAC input.

   d. Two alarm relays shall be provided, with N.O. dry contact outputs rated 115VAC, 5A minimum.

   e. The sensor/transmitter shall be UL listed for Class I, Division 1, Group D hazardous locations. Enclosure shall also have a NEMA 4X rating.

   f. The combustible gas detection system shall be MSA Ultima IR, or equal.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Contractors bidding work under this Contract shall read and understand Division Zero and Division 1 - General Requirements. If any discrepancies are discovered between this Division and the General Requirements, the above mentioned documents shall overrule this section.

B. The Contractor shall bid as outlined in the above mentioned Specifications and shall be governed by any alternates or unit prices called for in the form of proposal.

C. Each Contractor bidding on the work included in these Specifications shall view the building site and carefully examine the contract Drawings and Specifications, so that he/she may fully understand what is to be done, and to document existing conditions.

1.03 SHOP DRAWINGS, DESCRIPTIVE LITERATURE, INSTALLATION, OPERATION AND MAINTENANCE INFORMATION

A. Shop Drawings including descriptive literature and/or installation, operation and

maintenance instructions shall be submitted in the amount of 8 copies for this Division. All Shop Drawings shall be submitted in loose-leaf three-ring cardboard reinforced vinyl binders.

B. Shop Drawings shall be submitted on the following materials specified in this Division:

1. Conduit - all types and sizes.
2. Boxes - all types and sizes.
3. Metal framing system.
4. Conduit fittings, expansion joints, support hardware.
5. Motor control equipment.
6. Power distribution equipment.
7. Wire - all types and sizes.
8. Wire markers, signs and labels.
9. Outdoor light fixtures.
10. Lightning/transient suppressors.
11. Motors.
12. Instrumentation and accessories.

C. The Engineer reserves the right to make modifications to motor control and power distribution equipment ratings after Shop Drawing review, if the Shop Drawings are submitted prematurely (meaning submitted before all utilization equipment has been reviewed and accepted). Cost any required modifications shall be the Contractor's responsibility.

1.04 SYMBOLS AND ABBREVIATIONS

A. The symbols and abbreviations general follow standard electrical and architectural practice, however, exceptions to this shall be as shown on the Contract Drawings.

1.05 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the electrical work with that of other trades to ensure proper final location of all electrical equipment and/or connections.

1.06 CODES

A. The minimum standard for all work shall be the latest revision of the Kentucky Building Code (KBC), and the National Electrical Code (NEC). Whenever and wherever state and/or local laws or ordinances and/or regulations and/or the Engineers design require a higher standard that the current NEC or KBC, then these laws and/or regulations and/or

the design shall be followed.

B. Following is a list of other applicable Standards or Codes:

1.	Kentucky Building Code	KBC
2.	National Electrical Code	NEC
3.	National Electrical Safety Code	NESC
4.	Underwriters Laboratories, Inc.	UL
5.	National Fire Protection Association	NFPA
6.	National Electrical Manufacturers Association	NEMA
7.	Occupational Safety and Health Administration	OSHA
8.	Insulated Cable Engineers Association	ICEA
9.	Instrument Society of America	ISA
10.	American National Standards Institute, Inc.	ANSI
11.	Anti-Friction Bearing Manufacturers Association, Inc.	AFBMA
12.	Federal Communications Commission	FCC

1.07 INSPECTIONS AND PERMITS

A. Inspection of the electrical system on all construction projects is required. If the local government has appointed a state licensed inspector, the Contractor shall be required to use that person to perform the inspections. If a locally mandated inspector does not exist, the Contractor shall select and hire a state licensed inspector, who has jurisdiction before any work is concealed.

B. At the time of completion of the project, there shall be furnished to the Owner a certificate of compliance, from the agency having jurisdiction pursuant to all electrical work performed. The Engineer shall also receive a copy.

C. All permits necessary for the complete electrical system shall be obtained by the Contractor from the authorities governing such work.

1.08 STORAGE

A. All work, equipment, and materials shall be protected against dirt, water, or other injury during the period of construction.

B. Sensitive electrical equipment such as motor starters, controls, transmitters, etc., delivered to the jobsite, shall be protected against injury or corrosion due to atmospheric conditions or physical damage by other means. Protection is interpreted to mean that equipment shall be stored under roof, in a structure properly heated in cold weather and ventilated in hot weather. Provision shall be made to control the humidity in the storage are at 50 percent relative. The stored equipment shall be inspected periodically, and if it is found that the protection is inadequate, further protective measures shall be employed.

C. The Contractor shall not store submersible pump units in the wetwell. If it is absolutely necessary to do so, the open power cable ends are to be suspended above the maximum flood elevation or maximum expected water level. If stored in this manner, the Contractor may be called upon to replace the pump motors and cables with new units to ensure that water has not penetrated the cable and entered the motor housing.

1.09 MATERIALS

A. All materials used shall be new and at least meeting the minimum standards as established by the NEC and/or National Electrical Manufacturers Association. All materials shall be UL listed for the application, where a listing exists. Additional requirements are found in Division 1. All equipment shall meet applicable FCC requirements and restrictions.

B. The material and equipment described herein has been specified according to a particular trade name or make to set quality standards. However, each Contractor has the right to substitute other material and equipment in lieu of that specified, other than those specifically mentioned at matching or for standardization, providing such material and equipment meets all of the requirements of those specified and is accepted, in writing by the Engineer.

C. The reuse of salvaged electrical equipment and/or wiring will not be permitted unless specified herein or indicated on the Contract Drawings.

D. All salvaged or abandoned electrical materials shall become the property of the Contractor and shall be removed from the job site upon completion of the project, unless otherwise noted on the Contract Drawings or specified herein.

1.10 ERRORS, CORRECTIONS, AND/OR OMISSIONS

A. Should a piece of utilization equipment be supplied of a different size or horsepower than shown on the Contract Drawings, the Contractor shall be responsible for installing the proper size wiring, conduit, starters, circuit breakers, etc., for proper operation of that unit and the complete electrical system at no extra cost to the Owner.

B. It is the intent of these Specifications to provide for an electrical system installation complete in every respect, to operate in the manner and under conditions as shown in these Specifications and on the Contract Drawings. The Contractor shall notify the Engineer, in writing, of any omission or error at least 10 days prior to opening of bids. In the event of the Contractors failure to give such notice, he/she may be required to correct work and/or furnish items omitted without additional cost.

C. Necessary changes or revisions in electrical work to meet any code or power company requirement shall be made by the Contractor without additional charge.

1.11 GUARANTEES AND WARRANTIES

A. The Contractor shall guarantee all work including equipment, materials, and workmanship. This guarantee shall be against all defects of any of the above and shall run for a period of 1 year from the date of acceptance of the work, concurrent with the one year guarantee period designated for the general construction contract under which electrical work is performed.

B. Repair and maintenance for the guarantee period is the responsibility of the Contractor and shall include all repairs and maintenance other than that which is considered as routine. (That is oiling, greasing, etc.) The Engineer shall be the judge of what shall be considered as routine maintenance.

1.12 TESTING

A. After the wiring system is complete, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for acceptance. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications and the Contract Drawings. The test shall be performed in the presence of the Engineer or his authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, as well as the necessary electrical power.

B. Before energizing the system, the Contractor shall check all connections and set all relays and instruments for proper operation. He shall obtain all necessary clearances, approvals, and instructions from the serving utility company prior to placing power on the equipment.

C. Tests may be performed by the Engineer to determine integrity of insulation on pump cables.

D. Cost of utilities for testing done prior to beneficial occupancy by the Owner shall be borne by the Contractor.

1.13 CLEANUP

A. Cleanup shall be performed as soon as possible after the electrical installation is complete. All control panels, switches, etc., shall be free from tags, stickers, etc. All painted enclosures shall be free from scratches or splattered paint. The interior of all enclosures shall be clean from dust, wire strippings, etc. Surplus material, rubbish, and equipment shall be removed from the jobsite upon completion of the work.

B. During construction, cover all Owner equipment subject to damage.

1.14 EXCAVATION AND BACKFILL

A. Excavation

1. Excavation for conduits shall be of sufficient width to allow for proper jointing and alignment of the type conduit used. Conduit shall be bedded on original ground. Where conduit is in solid rock, a 6 inch earth cushion must be provided. Conduit shall be laid in straight lines between pull boxes and/or structures unless otherwise notes on the Contract Drawings. The cost of solid rock excavation shall be included in the lump sum bid.

B. Backfill

1. Backfill shall be hand placed, loose granular earth for a height of 6 inches above the top of the largest conduit. This material shall be free of rocks over ½ inches in diameter. Above this, large rocks may be included but must be mixed with

sufficient earth to fill all voids.

1.15 POWER COMPANY COORDINATION

A. The Contractor is responsible for coordinating all activities onsite by the power company.

B. All power company metering equipment shall be located upstream of any manual/automatic transfer switches on projects requiring onsite emergency power generation equipment.

C. Any special provisions required by the serving electrical utility shall be as outlined on the Contract Drawings or as advised by the utility at the time of construction, and work required by these special provisions shall be furnished, installed, and connected by the Contractor.

1.16 TEMPORARY ELECTRICAL POWER

A. The Contractor shall be responsible for providing temporary electrical power as required during the course of construction and shall remove the temporary service equipment when no longer required.

1.17 OVERCURRENT PROTECTION

A. Circuit breakers or fused switches shall be the size and type as written herein and shown on the Contract Drawings. Any additional overcurrent protection required to maintain an equipment listing by an authority having jurisdiction shall be installed by the Contractor at no extra cost to the Owner.

B. The Contractor shall submit to the Engineer actual nameplate data from motors shipped to the jobsite, stating motor identification as well as characteristics. Overload relay thermal units shall correspond to actual nameplate data.

1.18 TRAINING

A. The required training shall consist of both classroom and hands-on. Classroom training shall include instruction on how the equipment works, its relationship to other accessories, detailed review of Shop Drawings, presentation of O&M manuals, and troubleshooting techniques. Hands-on training shall include check out of each key element of the equipment, including calibration, adjustment, and operating manipulations.

B. The training shall be scheduled by the Contractor with the Owner. The timing of the training shall closely coincide with startup, but no training shall be provided until all equipment is operational.

C. The minimum number of hours to be provided by manufacturers supplying equipment is as follows:

Item	Training Hours
Instrumentation	2

D. The training shall be conducted at the project site by a qualified manufacturer's representative.

E. The cost of the training shall be included in the bid price.

F. An outline of the training shall be submitted prior to the Engineer for review.

G. The Owner reserved the right to videotape all training sessions.

1.19 RECORD DRAWINGS

A. The Contractor shall maintain 1 set of the Contract Drawings on the job in good condition for examination at all times. The Contractor's qualified representative shall enter upon these Drawings, from day to day, the actual "as-built" record of construction and/or alteration progress. Entries and notes shall be made in a neat and legible manner and these Drawings delivered to the Engineer after completion of the construction, for use in preparation of Record Drawings.

1.20 MAINTAINING CONTINUOUS ELECTRICAL SYSTEM AND SERVICE

A. Existing service continuity shall be maintained at all times. In no way shall be installation and/or alteration of the electrical work interfere with or stop the normal operation of the existing facilities, except where prior arrangements have been made.

1.21 GROUNDING AND BONDING

A. All metallic conduit, cabinets, equipment, and service shall be grounded in accordance with NEC requirements. All supporting framework in contact with electrical conduit, cable, and/or enclosures, shall be properly grounded.

1.22 RELATED SPECIFICATION DIVISIONS

A. The following divisions contain Specifications on utilization equipment, accessories, and procedures related to execution of the electrical work. Bids shall be based on compete documents.

Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract
Division 1 - General Requirements
Division 11 - Equipment

1.23 SERVICE ENTRANCE

A. Conductors and terminations for service entrances shall be furnished and installed by the Contractor. Voltage, phase, and number of wires shall be as shown on the Drawings. Clearances for overhead entrance wires shall be per power company, NEC, and NESC requirements.

B. Any details not shown on the Drawings or written in the Specifications pertaining to the service entrance shall be per power company requirements. It is the Contractor's responsibility to contact the utility prior to bidding and obtain any special requirements or

costs they will be imposing. Those costs shall be included in the bid.

1.24 CONTRACTOR LICENSING

A. The Contractor performing the electrical work on this project shall be locally licensed, if required by local law or ordinance. If the Contractor has passed the State test, it may not be necessary to meet local testing requirements. It shall be the Contractor's responsibility to investigate these requirements.

1.25 ELECTRICAL COMPONENT MOUNTING HEIGHTS

A. Mounting heights shall be as shown on the Contract Drawings. Operators and control devices shall not be mounted higher than 6'6" above finished floor or grade.

1.26 WIRE AND CABLE

A. All wire and cable shall have size, grade of insulation, voltage rating, and manufacturer's name permanently marked on the outer covering at regular intervals.

1.27 MOTORS

A. Staring torque and slip ratings shall conform to the requirements of the driven equipment. All motors 15 hp and larger at 230 Volts, or 25 hp and larger at 460 Volts, shall be started via autotransformer reduced voltage starters, unless otherwise indicated.

B. Polyphase motors shall be squirrel cage induction type and single phase motors shall be of the capacitor start-induction run type except as otherwise indicated. All motors shall conform to the latest NEMA requirements.

1.28 EQUIPMENT IDENTIFICATION

A. All starters, feeder units, disconnects, instruments, etc., shall be marked to indicate the motors, circuit, they control or monitor. Marking is to be done with engraved laminated nameplates. Nameplates shall be fastened to equipment with stainless steel screws, one each side. In no way shall be installation of the mounting screws void the NEMA enclosure rating of the equipment in which they are installed. If there are more than one number, the equipment shall be number consecutively and labeled as such. Nameplate background color shall be white, with black engraved letters.

B. Disconnect switches, control panels, transfer switches, etc. shall be labeled with vinyl self-adhesive signs that warn of high voltage. The type of labels to be used shall have orange as the basic color to conform with OSHA requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Raceways

1. PVC Coated Rigid Steel Conduit – "Robroy," or equal.

2. Liquidtight Flexible Metal Conduit – "Carol Cable Co., Inc.," "OZ Gedney," or equal.

3. Conduit Fittings – "Crouse Hinds," "Appleton," "OZ Gedney," or equal.

4. Flexible Conduit Fittings – "Raco," "T&B," "OZ Gedney," or equal.

B. Wires and Cables

1. Building Wire (Types THWN and THW) – "Collyer," "Rome," "American," "Carol," or equal.

2. Control Cables – "Belden," "Eaton-Dekoron," "Okonite," or equal.

3. Instrumentation Cables – "Eaton-Dekoron," " Manhatton," "American," "Belden," "Okonite," or equal.

C. Boxes – "Appleton," "Crouse-Hinds," "Hoffman," "Hennessey," or equal.

D. Wire Connections and Connecting Devices

1. Termination and Splice Connectors – "3M Scotchlok," "Anderson," "T&B," "Burndy," or equal.

2. Connectors, Lugs, etc. – "T&B," "Anderson," "Burndy," or equal.

E. Motors – "General Electric," "Westinghouse," "U.S. Motors," "Baldor," "Marathon," "Reliance," "Magnatek," or equal.

F. Grounding Equipment – "Cadweld," "ITT Blackburn," "Copperweld Bimetallics Group," "Cathodic Engineering Equipment Co.," or equal.

G. Motor Control Equipment – "Square D," "Allen Bradley," "EATON," "Cutler Hammer," or equal.

H. Timers – "Paragon," "Tork," "Intermatic," or equal.

I. Instrumentation

1. Doppler Flowmeters – "Peek," or equal.

2. Circular Chart Recorders – "Chessell," "Foxboro," or equal.

2.02 MATERIALS

A. Conduit and Fittings

1. PVC coated rigid conduit shall be hot dip galvanized prior to PVC coating. All threads shall be galvanized. The exterior galvanized surface shall be coated with a primer prior to PVC coating to insure adhesion. The bond on conduit and fittings shall be greater than the tensile strength of the plastic coating. The PVC coating on the exterior of the conduits shall be applied by a plastisol dip method

to a nominal thickness of 40 mils, minimum. The interior of the conduit and fittings, and threads shall be painted with a urethane coating. The coating shall allow flexibility for field bending without cracking. PVC sleeves shall be formed at each female opening, with the inside diameter of the sleeve matching the outside diameter of the conduit.

2. All flexible conduit shall be liquidtight with sealtight fittings.

3. Locknuts shall be bonding type with sharp edges for digging into the metal wall of an enclosure.

4. Bushings shall be metallic insulating type, consisting of an insulating insert molded of locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.

5. Fittings for PVC coated rigid conduit shall be manufactured by the maker of the conduit.

B. Conductors (600 Volts and Below)

1. All conductors shall be insulated so that they are rated at 600 volts.

2. Insulated conductors minimum #12 AWG and shall be stranded.

3. All conductors brought to the job site shall be new and unused and where no special factory cut lengths are involved, shall be delivered to the job site in standard coils. Contractor shall provide verification to the Engineer of wire condition before wire is installed.

4. All conductors shall be soft drawn, 98% conductivity copper conforming to the latest ASTM Specifications and the requirements of the National Electrical Code.

5. Conductors shall be insulated with THHW or THHN insulation and all conduits shown on the Drawings are sized accordingly. At the Contractor's option, THWN insulation may be substituted. Type THHN may be used only in areas not subject to moisture.

6. Wiring adjacent to heat producing equipment and not subject to dampness or moisture shall be type TFE.

C. Boxes and Enclosures

1. Junction boxes for out of doors use, not mounted in concrete, shall be cast metal, rust and corrosion resistant, NEMA 4X, with at least 5 full threads for each conduit opening, and shall be suitable for surface mounting as required with drilled external, cast mounting extensions. Box covers shall be hinged or cap screw retained as required, of the same material as the box and provided with stainless steel hardware.

2. Control Panel Enclosures

a. Control panel enclosures shall be dead front with all operators accessible through a lockable switch door. The compartment shall include a removable back panel, and the door shall be double flanged on all four sides for strength and to prevent liquids or dirt from dropping into the

compartment when the door is open.

b. The control cabinet shall be marine grade aluminum or stainless steel, and shall meet or exceed the requirements of a NEMA 4X rating.

c. All welds shall be neatly formed and free of cracks, blow holes and other irregularities.

d. The door openings shall be double flanged on all four sizes to increase strength around openings, and to prevent dirt and liquids from entering the enclosure.

e. The cabinet shall have a sloped top to prevent water accumulation.

f. Each door shall be furnished with a gasket which forms a watertight seal between the door and the cabinet.

g. Hinges shall be continuous and bolted to the cabinet and door utilizing 1/4-20 stainless steel carriage bolts and any-lock nuts. The hinges shall be made of 0.093 inch thick aluminum and shall have a 3" open width with a 0.25 inch diameter stainless steel hinge pin. The hinge pin shall be capped top and bottom.

h. The latching mechanism shall be a 3-point draw roller type. Rollers shall have a minimum diameter of 0.875 inch and shall be made of nylon. The center catch shall be fabricated from 0.14 inch steel. Pushrods shall be turned edgewise at the outward supports and shall be 0.25 inch by 0.75 inch steel.

i. A lockable stainless steel operating handle shall be provided. The handle shall have a 3/4 inch diameter shank.

j. Two adjustable "C" mounting channels shall be provided on both side walls and back wall of the enclosure, allowing versatile positioning of shelves or panels. The mounting channels shall provide infinite vertical and horizontal adjustment and not limit the positioning of shelves or panels.

k. A back panel with a minimum thickness of 0.125 inch shall be provided.

l. A print storage pocket shall be provided, with as-built wiring diagrams.

m. Cabinets shall be pad or pedestal mounted as shown on the Drawings. Baseplates and/or mounting legs shall be provided as required.

D. Wire Connections and Connecting Devices

1. Terminals and spice connectors from #22 to #4 AWG shall be compression type with barrels to provide maximum conductor contact and tensile strength. Performance, construction, and materials shall be in conformance with UL standards for wire connectors and rated for 600 Volts and 105 degrees Celsius.

2. Lugs and splice connectors from #6 AWG to 1000 kcmil shall be compression types with barrels to provide maximum conductor contact and tensile strength. They shall be manufactured from high conductivity copper and entirely tin

plated. They shall be crimped with standard industry tooling. The lugs and connectors must have a current carrying capacity equal to the conductors for which they are rated and must also meet all UL requirements. All lugs above #4/0 shall be 2 hole lugs with NEMA spacing. The lugs shall be rated for operation through 35 KV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

E. Motors

1. Ratings and Electrical Characteristics:

a. Time:

1) All motors shall be rated for continuous duty.

b. Temperature:

1) Based on NEMA standards for a maximum ambient temperature of 40 C. and an altitude of 3,300 feet or less, according to service factor and insulation class employed.

c. Voltage:

1) All single phase motors shall be rated 115/208/230 volts and all polyphase motor 230/460 volts. All motors shall be capable of normal operation at balanced voltages in the range of + 10 percent from rated winding voltage.

d. Frequency:

1) All a-c motors shall be rated for 60 hz. operation. All motors shall be capable of normal operation at frequencies 5 percent above or below the normal rating of 60 hz.

e. Horsepower:

1) Horsepower of the motors shall be as given in the Specification Division on the driven equipment or as shown on the Contract Drawings. Submersible motors shall be allowed to be furnished even though the horsepower rating may not be in accordance with standard NEMA assignments. In many cases, the horsepower specified is a minimum requirement and certain alternate manufacturers may require larger horsepower motors. The larger motor shall be furnished at no extra cost to the Owner.

f. Locked Rotor Current:

1) Locked rotor current shall be in accordance with NEMA standards.

g. Efficiency and Power Factor:

1) Efficiency and power factor shall be given consideration during shop drawing review. The ratings at full, 3/4 and 2 load shall be

compared to similar motors manufactured by acceptable suppliers listed in these Specifications. Excessive variation shall be considered grounds for rejection.

h. Speed:

1) Synchronous speed of motors shall correspond to standard NEMA ratings. Actual speed shall be as given in the Specification Division on the driven equipment. Slip shall not exceed 5 percent at full load.

i. Service Factor:

1) The service factor shall be 1.15 unless requirements of the driven load necessitate a higher service factor.

j. Insulation Class:

1) Insulation shall be NEMA Class F, except as otherwise noted. Class F insulated motors shall operate at a Class B rise at nameplate horsepower loading.

k. Design Level:

1) Motors shall be NEMA design B, except as otherwise noted.

l. Enclosure:

1) Motors for process equipment 2 HP and smaller shall be totally enclosed. All motors for process equipment larger than 2 HP shall be TEFC (totally enclosed fan cooled), suitable for use indoors or outdoors, except as otherwise noted. Totally enclosed non-ventilated (or air-over) motors may be used for ventilators and other auxiliary equipment that by virtue of the load are provided with more than adequate ventilation. ODP (open dripproof) motors may be used for ventilators where the motor is outside the air stream yet still protected from the weather. Division 15 of the Specifications and the HVAC Contract Drawings will detail the type of enclosure required for ventilators. Submersible motors shall be air or oil filled and of watertight construction. Motors used in classified atmospheres shall be properly rated for that hazard.

m. Frame Size:

1) Frame designations shall be in accordance with NEMA standards. Provide necessary pump brackets to adapt new motors to existing pumps.

n. Winding Overtemperature Sensors:

1) All motors 15 horsepower and over shall be provided with motor winding thermostats. The devices hall be hermetically sealed, snap-acting thermal switches, actuated by a thermally responsive bi-metallic disk. A minimum of 1 per phase is required, with

switches wired into the control circuit of the starter to provide de-energization should overheating threaten. All submersible motors shall be equipped with motor winding thermostats.

o. All submersible motors shall be equipped to detect seal failure.

p. Motors on this project shall be "inverter duty" style.

2. Tests, Nameplates and Shop Drawings:

a. Test:

1) Tests shall be required on integral horsepower motors only. A factory certified test report of "electrically duplicate motors previously tested" shall be supplied on all motors under 200 horsepower. The test shall be certified by the factory and shall contain a statement to the effect that complete tests affirm the guaranteed characteristics published in the manufacturer's catalogs or descriptive literature.

2) Tests will be in accordance with IEEE test procedures.

b. Nameplates:

1) Each motor shall have a permanently affixed nameplate of brass, stainless steel, or other metal of durability and corrosion resistance. The data contained on the nameplate shall be in accordance with NEMA standards.

c. Shop Drawings:

1) Shop drawings shall consist of motor dimensions, nameplate data from each motor and tests as outlined above. Also included shall be efficiency and power factor at 100, 75, and 50 percent load. Operation, maintenance, and lubrication information (including bearing catalog numbers) shall be submitted with shop drawings for review.

3. Efficiency Requirements

a. The following motor full load efficiency requirements shall be met as a minimum for totally enclosed 3 phase integral horsepower motors (per NEMA test Methods):

Horsepower	Nominal 3600 RPM (Minimum %)	Nominal 1800 RPM (Minimum %)	Nominal 1200 RPM (Minimum %)
1	75.5	82.5	80.0
1.5	82.5	84.0	85.5
2	84.0	84.0	86.5
3	85.5	87.5	87.5
5	87.5	87.5	87.5
7.5	88.5	89.5	89.5
10	89.5	89.5	89.5

Horsepower	Nominal 3600 RPM (Minimum %)	Nominal 1800 RPM (Minimum %)	Nominal 1200 RPM (Minimum %)
15	90.2	91.0	90.2
20	90.2	91.0	90.2
25	91.0	92.4	91.7
30	91.0	92.4	91.7
40	91.7	93.0	93.0
50	92.4	93.0	93.0
60	93.0	93.6	93.6
75	93.0	94.1	93.6
100	93.6	94.5	94.1
125	94.5	94.5	94.1
150	94.5	95.0	95.0
200	95.0	95.0	95.0

b. Motors shall be energy efficient and shall be documented in the shop drawings submittal in sufficient detail to allow the Engineer complete review of what is offered. Motors shall meet the 1992 EPACT.

F. Secondary Power Arrestors

1. Arrestors shall be hermetically sealed with pre-ionized spark gap. The unit shall be capable of repeated overvoltages without significant change in breakdown level or insulation resistance. The arrestor shall be capable of mounting in any position and shall be capable of mounting through a box knockout with standard locknuts, and shall be weatherproof.

2. Capacitance shall be less than 50 picofarads, and insulation resistance shall be at least 100 megohms. Maximum arc-over with 10 KV/micro second rise time pulse applied shall be 1,500 volts. The arrestor shall be capable of withstanding repeated application of 10 kiloampere current surges and extinguish power-follow current in ½ cycle or less. Maximum voltage between terminals shall be 2,500 volts when conducting 10 KA current surges.

3. Operating temperature range shall be -40 degrees C to +75 degrees.

4. Lightning arrestors for instrumentation shall be of 2 types - those for protecting dc wiring, and those for protecting ac wiring. The dc protectors shall be the fast-acting metal oxide varistor type designed to fit and protect all typical 4-20 mA, field mounted transmitters from damaging transients induced by lightning or heavy electrical equipment, and shall provide protection each line to ground, and line-to-line. The ac protectors shall be the fast-acting MOV type in combination with a gas tube type secondary protector designed to provide protection against lightning and other high voltage surges for any ac line-to-ground system. Arrestors shall be installed at each end of each metering loop, and on all power supplies.

G. Safety Switches

1. All safety switches shall be heavy-duty load break type with a quick-make, quick-break, switch mechanism. The switches shall be fused or unfused as indicated on the Drawings. The handle position shall give visual indication of

open and closed switch position. Padlocking capability shall be provided for locking the switch in the "OFF" (open) position.

2. The switch jaws shall be multi-spring type for positive grip of the switch blades and shall be provided with arc suppressors. The fuse clips shall be spring reinforced, positive pressure type of electrolytic copper. Fuse clips shall be rejection type.

3. The switch shall be provided with cover-blade interlock so that the cover cannot be opened when the switch blades are closed, nor can the switch blades be closed with the cover open. Interlock bypassing devices shall be included for use by authorized personnel. Note: where indicated, safety switches shall have integral electrical interlocks. Contacts shall be open when the switch is in the off position.

4. Enclosures shall be NEMA 1 where used inside the building and NEMA 4X where used outside unless otherwise shown on the Drawings.

5. Each safety switch shall be provided with ground lugs as required to accept grounding conductors as shown on the Drawings. The grounding lugs shall be factory installed and shall have direct metal-to-metal contact with the switch enclosure.

6. Double throw fused safety switches shall be furnished where indicated.

H. Motor Control

1. Combination Starters

a. All magnetic starters and contactors shall be steel mounted, front wired with all terminals accessible for wiring directly from the front. Movable contact blocks shall depend on gravity only and not the use of springs for operation to the open position.

b. Starter and contactor NEMA standard sizes and other ratings shall be as indicated. In no case shall any starter or contactor be smaller than NEMA size 1.

c. All contactors shall be double break, solid silver cadmium oxide alloy, or equal. Bare copper or silver flashed copper contacts which require periodic filing or cleaning maintenance will not be permitted.

d. Operating coils shall be pressure molded and so designed that, if accidentally connected to excessive voltage they will not expand, bubble or melt. When a coil fails under and condition, the starter shall open and shall not "freeze" in the closed (on) position. Coils shall be replaceable from the front of the starter without having to remove the starter from the panel or enclosure.

e. Reduced voltage starters shall be the autotransformer type, consisting of two windings in an open delta. Taps for 50 hp and below shall be 65 percent and 80 percent. For above 50 hp, a 50 percent tap shall also be provided. Autotransformers shall be thermally protected with a thermostatic switch in each winding wired to shut the starting sequence down on overheating.

f. Combination starters shall be of the molded case circuit breaker type. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed such that an overload on one pole opens all poles simultaneously. Breakers shall be quick-make, quick-brake and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit. Breakers for full voltage starters shall be the magnetic only type. All others shall be thermal magnetic.

g. Each starter leg shall have a thermal overload device in each ungrounded leg. The overload shall be bimetal, ambient compensated, thermal element type. Solid state overload devices, are not acceptable. If the adjustable trip type are used, a lockable cover must be provided to prevent unauthorized adjustment.

2. Pilot Devices

a. Selector switches shall be oil-tight construction, and of the quick-make, quick-break type.

b. Pilot lights shall be oil-tight, push-to-test, transformer base. Green pilot lights shall be used for indicating "pump running," and yellow shall be used for "seal leak."

c. Elapsed time meters shall be non-resettable.

d. Timing relays shall have an adjustable time range, with the time delay occurring after energization.

I. Instrumentation

1. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water industry.

2. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mAdc (milliampere direct current), however, signals between instruments within the same panel or cabinet may be 0-10 V.d-c (volts direct current), or other manufacturer standard.

3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed for remote transmission.

4. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

5. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Contract Electrical Drawings, to comply with the National Electric Code. All signals coming from and going to hazardous areas shall have intrinsic safety barriers provided.

6. All indicators and LED readouts shall be linear, direct reading in process units, unless otherwise noted. Percentage scales and indicators are prohibited.

7. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent, unless otherwise noted.

8. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 95 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

9. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, in-so-far as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

10. All equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 115 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

11. All analog transmitter and controller outputs shall be 4-20 milliamperes into a load of 0-750 ohms, unless higher load capacity is required.

12. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless specifically noted otherwise.

13. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

14. All circuit boards in instruments mounted in damp locations or mounted outdoors shall be fungus proofed. All field transmitters mounted outside shall be equipped with sun shields and shall be capable of operation to -20° Fahrenheit.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Conduit

1. The Contractor shall be responsible for setting of all sleeves for his work. Passage of conduit through masonry and concrete walls shall be provided with Schedule 40 steel pipe sleeves. Sleeves shall be flush with each face of the wall. Seal space between sleeve and conduit with oakum and waterproof mastic.

2. All conduit 1-1/4 inches and larger shall be sleeved.

3. Where conduit is to be supported from poured concrete slabs, inserts shall be installed on the forms before the concrete is placed. Inserts installed by firing a power type driver shall be used only with prior approval of the Engineer.

4. Concrete encasements of underground conduit shall be installed where shown on the Drawings or specified herein. Concrete shall be 2500 psi in strength, dyed red throughout and shall be sized as detailed on the drawings.

5. PVC coated galvanized rigid steel conduit shall be used throughout. It shall be installed such that there are no nicks or cuts in the PVC upon installation.

6. During construction, all new conduits shall be kept dry and free of moisture and debris. Before the wire is pulled in, all conduits shall be swabbed to clear all moisture and debris which may have unavoidably accumulated.

7. Rigid conduits, where they entered panelboards, cabinets, pull boxes or outlet boxes shall be secured in place by galvanized, double locknuts (one inside and one outside) and bushings. Conduit bushings shall have insulating material which has been permanently fastened to the fittings. Bushings for conduit 1-1/2 inches trade size and larger shall be complete with grounding lug and shall be bonded to the box by means of bare copper wire.

8. All field bends shall be made with standard tools and bending equipment manufactured especially for this purpose. Bends in metallic conduit shall be made while cold and in no case shall the conduits be heated. Conduits shall not be bent through more than 90 degrees.

9. Size of conduits shall not be less than that required by the National Electrical Code. The Contractor shall install larger size conduits than detailed where there is more than 100 feet of unbroken run or where the total of the angles through which the conduit has been bent during a single run exceeds 270 degrees.

10. In general, flexible conduit is prohibited. Where absolutely necessary, it shall be liquidtight, with maximum lengths of 3 feet.

11. All conduit joints shall be made up tight and no running threads shall be permitted on threaded connections. No kinked, clogged or deformed conduits shall be permitted on the job.

12. During construction, all installed conduits shall be temporarily capped or corked.

13. All moisture proofing or other material for thread protection shall be removed from conduit threads prior to installation. No material of insulating quality shall be used on the conduit threads or other places which will reduce the overall conductivity of the conduit system.

14. Where conduits are installed in groups on a common steel channel type support, each conduit shall be secured thereto by Korns, Unistrut or Kindorf clamps.

15. Raceways shall be securely and rigidly fastened in place at intervals specified hereinbefore with conduit clamps, or approved conduit hangers. Bolts, screws, etc. used in securing the work shall be stainless steel and of ample size for the service. Assembly bolts, nuts, washers, etc., shall be stainless steel. Raceways shall NOT be welded to steel structures.

16. Horizontal and vertical conduit runs shall be supported by one hole straps with clamp backs, special brackets, or other approved devices with suitable bolts, expansion shields where required. All mounting hardware shall be stainless steel.

17. The use of perforated iron straps or wire for supporting conduits will not be permitted.

18. Where conduit is run in a concrete slab, the conduit shall be installed as close to the middle of the concrete slabs as practicable without disturbing the reinforcement. The outside diameter shall not exceed one-third of the slab thickness and conduits shall be placed not closer than three diameters on centers, except at cabinet locations where the slab thickness shall be increased upon consultation with, and approval by the Engineer.

19. Depth of bury for all conduit shall be as indicated but a minimum of 24 inches below finished grade.

20. All conduit shall have an insulated ground wire pulled to all equipment.

B. Wire and Cable (600 Volts and Below):

1. Wire shall not be installed until all work of any nature that may cause injury to the wire is completed.

2. Mechanical means shall not be used in pulling in wires No. 8 or smaller.

3. Approved wire pulling lubricant shall be used as required to prevent insulation damage and over stressing of the wire while pulling through conduit. In no case shall conductors be greased or coated with any substance injurious to the conductor insulation or sheath.

4. All wiring in control equipment, cabinets, etc., shall be neatly wrapped, taped, or laced into groups to provide a neat and orderly appearance in the equipment.

5. Unless specified otherwise herein or shown otherwise on the Drawings, all wiring shall be installed in PVC coated rigid steel conduit.

6. Where the wire is shown larger than that required for the load, it is done so for voltage drop or other purposes and must be installed as shown. Where the wire is stranded, the removal of strands in order to install the wire into a lug provided on any equipment will not be permitted. A larger lug shall be installed which will accept the wire size indicated.

7. For the wiring of circuits consisting of AWG No. 10 or smaller wire, self-insulated pressure connectors (wirenuts) shall be utilized for all splices or joints.

8. Where indicated on the Drawings, cables entering enclosures shall be sealed using strain relief connectors suitable for Class I, Division 1, Group D hazardous locations. The purpose of the connector is to provide a seal between the hazardous and non-hazardous location without the use of sealing fittings.

9. Each wire shall be labeled at both termination points. Individual conductor or

circuit identification shall be carried throughout, with circuit numbers or other identification clearly stamped on terminal strips and shown in wiring diagrams.

10. In all junction boxes, cabinets, control compartments and terminal boxes where no terminal board is provided, each wire, including all power wires, shall be properly identified by plastic coated, self-adhesive, wire marker.

11. In cases similar to the above where the terminal boards are provided for the control, indicating, and metering wires, all wires including motor leads and other power wires shall be identified by wire markers as specified above.

12. Equipment ground wire insulation shall be colored green or green with two or more yellow stripes. Isolated grounding conductors shall be green with striping that identifies the conductor as "isolated ground" and different from the equipment (bonded) ground.

13. In general and unless otherwise shown on the drawings, no two wires of the same color shall be run in the same conduit except such as control wiring, switch legs, neutral, and ground. Where a conduit run is shown on the drawings to have two or more wires connected to the same phase and, therefore, are the same color, pressure sensitive, plastic marked wire marker identification tape shall be used wherever the wire is accessible (junction boxes, panels, device boxes, etc.). The numbers shall in each case, correspond to the circuit number and panelboard from which the circuit emanates. Control wiring inside any compartment which may be energized from a source outside the compartment shall have insulation. Where yellow insulated wires are used inside any cabinet, compartment, etc., a machine engraved, laminated plastic identification marker shall be installed on the outside of the compartment.

14. Insulation on ungrounded conductors larger than AWG #10 and on grounded (neutral) and grounding (equipment ground) conductors larger than AWG #6 may be black with color coding accomplished with the use of colored plastic tape. Tape shall be installed on the conductors wherever they are visible and shall be wrapped at least three (3) turns around the conductor.

15. All wiring on this project, except control wiring, shall reflect the phase relationship as follows:

480 volt system:	brown, orange and yellow for ungrounded conductors, gray with brown tracer for neutral conductors.
208Y/120 volt system:	black, red and blue for ungrounded conductors, white for neutral conductors.
120/240 volt, 3-phase 4-wire,delta system:	black, red for ungrounded conductors, orange for ungrounded conductor connected to "high leg", white for neutral.

16. Where indicated on the Drawings, cables entering enclosures shall be sealed using strain relief connectors suitable for Class I, Division 1, Group D hazardous locations. The purpose of the connector is to provide a seal between the hazardous and non-hazardous location without the use of sealing fittings.

17. All instrument wiring shall consist of individually twisted pairs, including

thermocouple extension leads. Minimum size is #16 AWG. Insulation resistance at 68 degrees F between conductors and between conductors and ground shall be at least 500 megohms per 1,000 feet. Shielded is required using foil wrap, grounded at one end only of each loop, as close to the signal source as possible. Multipair cables shall include polyvinylchloride or teflon jacket, minimum 0.045 inches thick. Voltage rating shall be 600. No signal wiring may be run in the same conduit with power wiring. Maintain a minimum separation of 12 inches between signal and ac power leads.

18. Submersible pump power cables shall be of the extra hard usage type suitable for submerged duty and able to withstand common corrosive agents found in water and wastewater. They shall be provided with high grade non-magnetic stainless steel strain relief cable grips installed at the pump end and high grade non-magnetic stainless steel support cable grips anchored to the wet well structure where they enter the wetwell.

C. Grounding

1. Ground rods shall be driven vertically into the earth to at least one foot below finished grade. Where a counterpoise or grounding grid is indicated and where rock is encountered at a depth of less than four (4) feet, rods shall be buried in a trench at not less than two feet below finished grade, and at equal angles from any two adjacent sides on the OUTSIDE of the counterpoise or grid. In these cases, at the Contractor's option, equal lengths of bare conductor of the same size as the counterpoise or grid may be used in place of ground rods.

2. Conductors connecting the main ground bars in switchgear to the earth shall be continuous without joints or splices. Connections to the grounding system at the switchgear shall be made with pressure connectors such as defined in Article 100, "Connector, Pressure (Solderless)", of the National Electrical Code.

3. Connections to ground rods and all other ground connections below grade shall have a MINIMUM mechanical contact surface area between the conductor and the ground rod of not less than three (3) square inches.

4. All connections made below finished grade shall be exothermic.

5. Installation of grounding conductors shall be such that they are not exposed to physical damage. All connections shall be firm and tight. Conductors and connectors shall be so arranged and provided so that there is no strain upon the connection. Buried equipment grounding conductors shall be buried at least 24 inches below finished grade and shall not be buried below concrete pads, paving, etc. except where running a tap to the grid or where shown on the contract drawings. Where buried below concrete or paving, grounding conductors shall be in rigid conduit unless shown on the drawings as a part of a grid.

6. Resistance measurements shall be made between the main grounding bar in the switchgear and a good earth ground. If this resistance is not equal to or less than 5 Ohms, an additional grounding electrode system in the form of ground rods installed and connected together in a 10 feet by 10 feet grid shall be added. The rods shall be connected together and this grid connected to the system with AWG #3/0 bare tinned copper. The number of rods shall be as required to register the resistance value mentioned above. Measurements shall be made in normally dry conditions and, in no case, less than 48 hours after rainfall.

7. Where a bare conductor is the only conductor installed in conduit or other raceway, and this conductor is serving as a grounding conductor, it shall be bonded to the raceway that contains it at each end of the raceway. The bond shall be made using a grounding type bushing and bonding jumper. The size of the jumper shall be the maximum size that the grounding bushing lug will accept and it shall be connected to the bushing with the lug and to the grounding conductor with a split bolt connector.

8. All metal electrical equipment cabinets (wireways, panels, switchgear, device boxes, junction and pull boxes, motor control panels, etc.) shall be securely bonded to a grounding conductor running through any conduit terminating at the cabinet or enclosure by use of a grounding lug bushing and jumper wire to the enclosure wall. Switchgear, panelboards and motor control equipment shall be provided with an equipment ground bus (including lugs or screw terminals) securely bonded to the enclosure. Junction boxes and other enclosures shall utilize an equipment ground bus or lug as required to securely bond the equipment grounding conductor to the enclosure. The grounding conductor shall be connected with pressure connectors at the main switchgear to the main grounding system. Where screw terminals or set screw lugs are used, sufficient lugs shall be provided such that not more than one conductor is installed into each lug or terminal.

9. No raceway (including rigid steel conduit, EMT, etc.) shall serve as a grounding conductor.

10. All main feeder circuits and all branch circuits shall contain a grounding conductor sized according to Table 250-122, Article 250 of the National Electrical Code or as shown on the drawings. This grounding conductor shall be connected to the main grounding conductor in the switchgear from which the circuit emanates. Individual components of the system served by the main feeder circuit shall have their enclosures connected to the main feeder grounding conductor with pressure connectors.

11. The grounding conductor serving motor circuitry shall be connected inside the entrance compartment to the motor frame with a bolted solderless pressure connector. Bolts, nuts, washers and other assorted hardware shall be bronze, cadmium plated steel, or other corrosion resistant material. The motor ground connection shall be to the motor frame and independent of the mounting bolts or sliding base.

12. Where lightning arresters are furnished and installed either separately or with equipment and the grounding connections are not inherently provided, a suitable, separate, grounding conductor shall connect the lightning arrester with a separate ground rod. This rod shall be interconnected with any adjacent grounding system.

13. Grounded and Grounding Conductor: Connections to the grounding conductor and/or the neutral (grounded) conductor shall be made in such a manner that removal of any device or equipment will not interrupt the continuity of these conductors to any device downstream from the device removed.

D. Instrumentation

1. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms

and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Engineer during construction. Obtain in the field all information relevant to the placing of process control work, proceed as directed by the manufacturer and furnish all labor and materials necessary to complete the work in an acceptable manner.

2. The instrumentation installation details on the Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the manufacturer's recommended practice shall be followed.

3. All work shall be executed in full accordance with codes. Should any work be performed contrary to said codes and/or regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising therefrom. All equipment used in areas designated as hazardous shall be designed for the Class, Division, and Group as required on the Drawings for the locations.

4. Unless specifically shown in the Contract Documents, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves.

5. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors, and shut-off valves.

6. Field instruments requiring power supplies shall be provided with local electrical shut-offs and fuses as required.

7. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

8. The system supplier shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the system supplier shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The system supplier shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).

9. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

10. The system supplier, acting through the Contractor, shall coordinate the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's acceptance. He shall be responsible to ensure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to ensure a satisfactory functioning installation. The Contractor hereunder shall schedule and coordinate his work under this Section with that of the electrical work specified under applicable Sections of Division 16.

11. After equipment and materials have been shipped to the job site, the Supplier

shall furnish the services of a factory-trained service technician or Engineer to assist and advise the Contractor during installation and to provide calibration/adjustment at initial startup.

12. Following installation, checkout, and final adjustment of all panels, instruments, meters, monitoring, and control devices, the Contractor shall schedule a performance test in the presence of the Engineer on all equipment. The Contractor shall furnish the services of the system supplier's servicemen, all special tools, calibration equipment, and labor to perform the tests.

13. Meters shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of scale, if possible. All status and alarm switches as well as all monitoring and control functions shall also be checked. Testing shall be done from the signal source to the final element or device including all field wiring. Results of all testing shall be submitted to the Engineer in writing.

14. If, during running of the tests, one or more points appear to be out by more than the system accuracy statement, the system supplier's servicemen shall make such adjustment or alterations as are necessary to bring equipment up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to ensure compliance.

END OF SECTION

SECTION 02920 - LAWNS AND GRASSES[ADD1]

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment, and services required for seeding of all disturbed areas caused by construction activities and for installation of sod where indicated on the Contract Drawings or specified herein.

1.2 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to Work of this Section.

B. Earthwork: Section 31 20 00

1.3 MAINTENANCE

A. Maintenance shall begin immediately following the last operation of installation for each portion of lawn.

B. Lawns shall be maintained by watering, mowing, and for resodding for a period of forty-five (45) days. At the end of this period an inspection will be made and any deficiencies, which may be attributable to the Contractor, will be noted in writing. At this time, the Owner will assume the maintenance. Another inspection will be made at the beginning of the next planting season, and any of the previously noted deficiencies still existing shall be repaired by the Contractor.

1.4 INSPECTION FOR ACCEPTANCE

A. The Inspection of the Work:

1. The inspection of the work of lawns to determine the completion of contract work exclusive of the possible replacement of plants, will be made by the Architect/Engineer upon written notice requesting such inspection submitted by the Contractor at least ten (10) days prior to the anticipated date.

B. Acceptance:

1. After inspection, the Contractor will be notified in writing by the Owner of acceptance of all work of this Section, exclusive of the possible replacement of plants subject to guaranty, or if there are any deficiencies of the requirements of completion of the Work.

PART 2 - PRODUCTS

2.1 WATER

A. Water used in this work shall be suitable for irrigation and free from ingredients harmful to plant life.

B. Hose and other watering equipment required for the Work shall be furnished by the Contractor.

2.2 TOPSOIL

A. The Contractor shall furnish and place sufficient topsoil for the seeding and installation of sod.

2.3 FERTILIZER

A. Commercial fertilizer for lawn areas shall be complete fertilizer, formula 10-10-10, for lawns and shall conform to the applicable state fertilizer laws. Fertilizer shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guarantee analysis. Any fertilizer which becomes caked or otherwise damaged making it unsuitable for use will not be accepted.

B. Fertilizer shall be applied at the rate of 25 pounds per 1,000 square feet.

2.4 GRASS SEED ***FOR LIVESTOCK GRAZING, MUST USE SPECIAL SPEC***

A. The seed mixture to be sown shall be in the following proportions:

Common Name	Proportion By Weight	% of Purity	% of Germination
Fine Lawn Fescue	40	90	85
Chewings Fescue	25	90	85
Italian Rye Grass	20	90	85
Red Top	10	90	85
White Clover	5	95	90

B. All seed shall be fresh and clean and shall be delivered mixed, in unopened packages, bearing a guaranteed analysis of the seed mixture.

C. Germination must be certified to conform to the following minimums:

Purity	90%
Germination	85%

2.5 SOD

A. Sod shall be at least 70% Bluegrass, strongly rooted and free of pernicious weeds.

B. It shall be mowed to a height not to exceed 3" before lifting, and shall be of uniform thickness with not over 1-1/2" or less than 1" of soil.

2.6 MULCH

A. Mulch for seeded areas shall be Conwed Hydro Mulch, Silva-Fiber, or equal. It shall be suitable for use in a water slurry or for application with hydraulic equipment.

B. Clean straw is acceptable as mulch. It shall be spread at the rate of one (1) bale per 1,000 feet (approximately 2 inch loose depth).

C. Mulch on slopes greater than 1: 3 shall be held in place with erosion control netting.

D. Mulch on areas subject to surface water run-off or in drainage ditches shall be held in place with erosion control netting.

PART 3 - EXECUTION

3.1 TIME OF PLANTING

A. Planting operations shall be conducted under favorable weather conditions during seasons which are normal for such work as determined by accepted practice in the locality of the project. At the option and on full responsibility of the Contractor, planting operations may be conducted under unseasonable conditions without additional compensation.

3.2 LAWNS

A. Areas to be sodded are designated on the Drawings. All other lawn areas, including areas of cut and fill and where existing ground has been disturbed by construction operations shall be seeded.

B. Fertilizer:

1. Fertilizer shall be applied at the rate of 25 pounds per 1,000 square feet to the lawn area being prepared for planting and mixed lightly into the top few inches of topsoil. Fertilizer may be mixed with and distributed with grass seed.

C. Planting of Lawns:

1. Sowing of Seed:

a. Immediately before any seed is to be sown, the ground shall be scarified as necessary, and shall be raked until the surface is smooth, friable and of uniformly fine texture. Lawn areas shall be seeded evenly with a mechanical spreader at the rate of 4 pounds per 1,000 square feet of area, lightly raked, rolled with a 200-pound roller and watered with a fine spray. The method of seeding may be

varied at the discretion of the Contractor on his own responsibility to establish a smooth, uniform turf composed of the grasses specified. The sowing of seed shall be done only within the season extending from March 1st to May 15th and from September 1st to October 15th, unless other seasons may be approved by the Owner.

2. Laying of Sod:

   a. Before any sod is laid, all soft spots and inequalities in grade shall be corrected. Fertilizer spread shall be raked in. Sod shall be laid so that no voids occur, tamped or rolled and then thoroughly watered. The complete sodded surface shall be true to finished grade, even and firm at all points. Sodding shall be done only within the seasons extending from March 1st to May 15th and from September 1st to October 15th, unless other seasons may be approved by the Owner.

3. Sod on Slopes:

   a. Sod on slopes 2 to 1 or steeper shall be held in place by wooden pins about 1-inch square and about 6 inches long driven through the sod into the soil until they are flush with the top of the sod, or by other approved methods for holding the sod in place.

4. Mulching:

   a. All seeded areas are to be mulched with Conwed Hydro Mulch, Silva-Fiber, or equal, or with clean straw as specified under PRODUCTS. Mulch shall be applied at the rate of 1,500 pounds per acre. It may be applied with hydraulic equipment or may be added to the water slurry in a hydraulic seeder and the seeding and mulching combined in one operation. Clean straw may be spread by hand to cover the seeded areas at a depth of two (2) inches. Erosion control netting shall be installed and anchored per manufacturer's instructions in areas of slopes, ditches, or surface water runoff.

3.3 CLEAN UP

A. All soil, peat or similar material which has been brought over paved areas by hauling operations or otherwise, shall be removed promptly, keeping these areas clean at all times. Upon completion of the planting all excess soil, stone and debris which have not previously been cleaned up shall be removed from the site or disposed of as directed by the Owner. All lawns shall be prepared for final inspection.

3.4 OTHER WORK

A. The Contractor also shall be responsible for the repair of any damage caused by his activities or those of his subcontractors, such as the storage of topsoil or other materials, operations or equipment, or other usages to all on-site areas outside the contract limits. Such repair operations shall include any regrading, seeding or other work necessary to restore such areas to an acceptable condition.

3.5 QUALITY CONTROL

A. Areas seeded shall be protected until a uniform stand develops, when it will be accepted and the Contractor relieved of further responsibility for maintenance. Displaced mulch shall be replaced or any damage to the seeded area shall be repaired promptly, both in a manner to cause minimum disturbance to the existing stand of grass. If necessary to obtain a uniform stand, the Contractor shall refertilize, reseed and remulch as needed. Scattered bare spots up to one (1) square yard in size will be allowed up to a maximum of 10 percent of any area.

END OF SECTION 02920